Baig and Yadegaridehkordi
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Flipped classroom in higher education: a systematic literature review and research challenges

Maria Ijaz Baig[1] and Elaheh Yadegaridehkordi[2*]

*Correspondence: yellahe@gmail.com

[1] Department of Information Systems, Faculty of Computer Science and Information Technology, University of Malaya, 50603 Kuala Lumpur, Malaysia
[2] College of Information and Communications Technology, School of Engineering and Technology, Central Queensland University, NSW, Sydney, Australia

Abstract

Flipped learning has garnered substantial attention as a potential means to enhance student engagement, improve learning outcomes, and adapt to the evolving educational landscape. However, despite the growing interest and potential benefits of flipped learning, several challenges and areas of concern persist. This systematic literature review critically examines the implementation of the flipped classroom in higher education by focusing on the role of technologies and tools, pedagogical activities and courses, and existing challenges. Using a systematic approach, a total of 30 research articles published between 2014 and 2023 were chosen for the review. This study identified video creation tools, learning management systems (LMS), content repositories, collaborative platforms, podcasts, and online assessment tools as technologies that play a central role in the flipped classroom. Moreover, this study identifies specific pedagogical activities within different courses that contribute to the effectiveness of flipped learning in higher education. The implementation challenges that teachers and students may face in the flipped classroom were presented, and potential strategies to alleviate these challenges were provided. This study will contribute to a more comprehensive understanding of flipped learning's benefits, technologies and tools, challenges, and potential to improve higher education.

Keywords: Flipped classroom, Higher education, Pedagogical activities, Challenges

Introduction

The flipped learning approach has recently gained popularity as an educational innovation in educational technology, especially as it applies to higher education (Divjak et al., 2022). The most effective way to motivate students is by using technology-enhanced teaching methods that go beyond traditional lectures (Yıldız et al., 2022). Technology plays a crucial role in enhancing student engagement and satisfaction (Wang et al., 2019), with the flipped classroom model relying heavily on technology (Tomas et al., 2019). Flipping a classroom involves turning the usual classroom on its side (Güler et al., 2023). Outside of class, students are encouraged to actively learn new material by reading or watching recorded lectures. It demands that students retain and analyze the knowledge supplied for the class (Bachiller & Badía, 2020). The student is then asked to use

what they have learned in class to complete group problem-solving exercises using peer instruction (Huang et al., 2023). As a result, students gain a deeper learning experience by gaining a comprehensive understanding of the subject matter. Compared to the conventional lecture approach, this form of learning is more dynamic and student-centered (Karjanto & Acelajado, 2022). A flipped classroom can reduce the amount of time spent lecturing, provide hands-on experience, and help students become more prepared and motivated for their studies (Jiang et al., 2022). As a result, it can also enhance students' academic performance, engagement with the material, and comprehension, as well as their self-assurance and critical thinking abilities (Mortaza Mardiha et al., 2023). Flipping the classroom offers time-pressed students the benefit of following course material at their own pace (Torío, 2019). Teachers provide pre-recorded videos for students to access, allowing them to adjust their learning pace and time based on their proficiency level. Teachers and students may both become more tech-literate (Huang et al., 2023). Additionally, a flipped classroom encourages student collaboration and offers additional chances for teacher-student engagement throughout the teaching and learning process (Güler et al., 2023).

Flipped learning in higher education offers a cost-effective, student-centered approach to accommodate growing enrollments and can mitigate funding and structural issues that prioritize faculty research over student learning (Zou et al., 2020). Meanwhile, it equips students with 21st-century skills needed for global challenges (Zhao et al., 2021) and knowledge needed to meet current market demand (Ng & Lo, 2022). The flipped classroom approach enhances critical thinking, teamwork, and problem-solving skills in real-world settings, enhancing learning, academic performance, and practical knowledge (Castedo et al., 2018; Rodríguez-Chueca et al., 2019; Sevillano-Monje et al., 2022). Students with strong academic backgrounds as well as a set of practical knowledge, skills, and abilities are always preferred by employers. Employers favor hiring people with the abilities and dispositions necessary to turn ideas into reality (Pattanaphanchai, 2019). Due to the obsolete teacher-centered teaching methodology, the traditional education system has failed to build crucial employability skills, behaviors, traits, and competences (Khan & Abdou, 2021). In the traditional teacher-centered teaching approach, the development of necessary abilities and inspiring students by personalizing learning around their interests are disregarded. Students are unable to put their theories into practice in a real-world working environment (Lopes et al., 2019). The above-mentioned problems with traditional teaching methods could be resolved by flipped learning. It involves students practicing theories and necessary skills in a variety of student-centered activities such as presentations, group activities, and hands-on activities while being guided by the instructors (Galway et al., 2014; McLean & Attardi, 2018).

Numerous systematic review studies on flipped classrooms have been published, covering a wide range of significant topics. These review studies have limited publishing coverage, focus on one learner category, or focus on a single academic field. Huang et al. (2023) suggested video tutorials for a systems programming course in a flipped classroom to enhance students' learning interest. Senali et al. (2022) provided the state-of-the-art in flipped classroom business and entrepreneurship education. Another review conducted by Divjak et al. (2022) highlighted the flipped classroom methods used during the pandemic. Jiang et al. (2022) summarized the studies in flipped language teaching by

using articles from the social sciences citation index. Flipped learning in higher education is gaining popularity, but systematic literature review (SLR) is lacking on investigating technologies, pedagogical activities, and courses. This can be helpful for teachers to apply technology according to the nature of the course. Moreover, the identified pedagogical activities can be helpful for other teachers to enhance students learning. Furthermore, this study identifies the challenges of implementing flipped classrooms and provides recommendations on how to overcome them. The recommendations can be helpful for teachers and students to cope with issues related to the flipped classroom.

The research objectives (RO) for the study are presented as:

RO1: To analyze the role of technologies and tools that are being used in the flipped classroom to support teaching and learning in higher education.
RO2: To identify the pedagogical activities and courses that make flipped classrooms effective for higher education.
RO3: To identify the challenges of implementing flipped classrooms in higher education and how they can be overcome.

Review methodology

A method for analyzing, understanding, and assessing the plan is called a systematic review. It discusses the topic and relevant research issues. Understanding and evaluating the existing studies, are the goals of a systematic review.

The study follows Kitchenham and Charters' (2007) methodology, which includes six fundamental phases: review protocol, inclusion/exclusion criteria, search procedure, selection procedure, quality evaluation and extracting data and synthesizing. The objective aligns with the findings, and the study adheres to the SLR's planning, doing, and reporting steps for a comprehensive analysis.

Review protocol

The major goal of the review methodology is to lessen research bias. The likelihood of bias in the review is reduced by outlining the approaches in advance.

Inclusion and exclusion

Inclusion and exclusion criteria were established in order to make sure that only studies that are extremely relevant to this analysis are included (Table 1). Finding domain-relevant articles requires conducting a thorough keyword search. The titles, abstracts, and

Table 1 Inclusion and exclusion criteria

Inclusions	Exclusion
Relevant keywords are found in the titles or abstracts or keywords section	Studies that do not have relevant keywords in the titles or abstracts or keywords section
Empirical studies based on the flipped classroom in higher education	Non-empirical studies based on surveys and perceptions, reviews, meta-analyses, and bibliometric analyses
Research papers published in English between January 2014 and July 2023	Research papers that were not in English and published beyond this period
The articles described flipped classroom methodology in the higher education sector	The articles do not describe flipped classroom methodology in the higher education sector

keywords were therefore searched for relevant terms. For this review, empirical research is taken into account. Continuous examination and revision of the work are benefits of an empirical method (Rodríguez-Chueca et al., 2019). It raises the standard and reliability of the research being done. In addition, English is the language that is read and written the most. Additionally, the flipped classroom trend became more widespread in 2014 (Galway et al., 2014; Li & Li, 2022). The analysis encompassed all relevant research that had been published in English between January 2014 and July 2023. This study's objective is to describe flipped classroom technologies, courses, and activities. Therefore, only studies that provide a detailed description of flipped classroom practices and methodologies are considered in this review.

Search procedure

The search process consists of two steps, namely manual search and automatic search. The primary studies of the flipped classroom and higher education sectors were initially located using a manual search. Science Direct, Taylor & Francis, MDPI, SAGE, Springer Link, Wiley, and IEEE Xplore were all thoroughly researched. They provide comprehensive coverage of journal and conference articles, ensuring a more thorough analysis of the subject (Kitchenham & Charters, 2007).

The search used a comprehensive set of keywords to minimize the risk of overlooking any crucial documents. Boolean operators were employed in the search queries to extract the most pertinent documents. In the first step of the search, combinations of ("flipped" OR "inverted") AND ("classroom" OR "learning" OR "teaching" OR "pedagogy") AND ("higher education" OR "higher education institute" OR "university" OR "universities").

Kitchenham (2004) suggested conducting a manual screening of the primary study resources. Thus, a manual search through all of the initial research's references is also conducted in the second stage.

Selection process

The selection process is used to find research studies that respond to the review study's research questions. The selection process for the study is shown in Fig. 1. An automatic search that used the keyword string yielded a total of 493 studies. The 405 studies were eliminated since they did not qualify as empirical research. Kitchenham and Charters (2007) suggested excluding pointless studies from the reviews. Therefore, inclusion and exclusion criteria were applied to the remaining 88 studies. As a result, 64 articles were deleted for failing to explain flipped classroom implementation, leaving 24 articles discussing it in higher education. The snowball method was applied to make sure the results of the automatic search were comprehensive. The second phase was conducting a manual Google Scholar search on all related papers (Fig. 1).

There were a total of 12 studies found while using Google Scholar. The 36 studies were subjected to the quality assessment requirements. The study included 30 relevant research articles after disqualifying 6 studies due to quality assessment criteria.

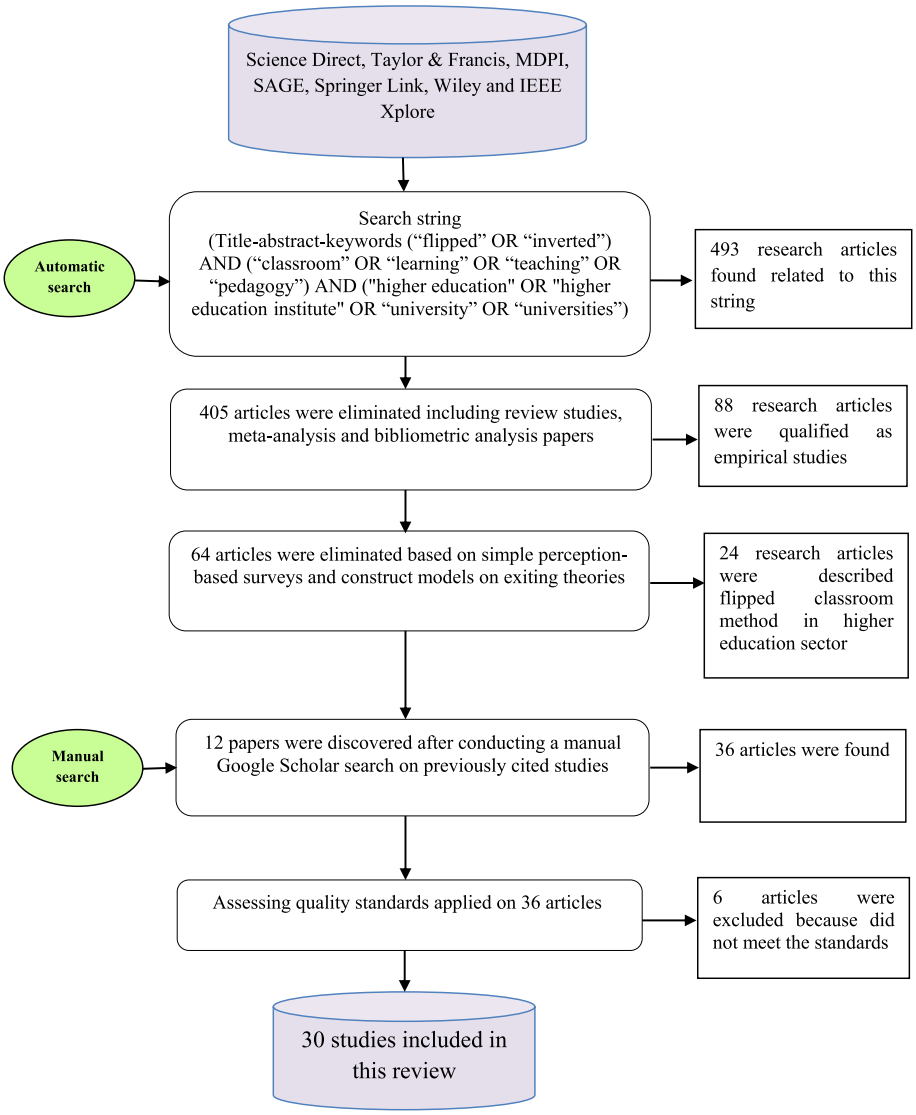

Fig. 1 Selection process

Assessing quality

According to Kitchenham and Charters (2007), the evaluation procedure is essential for determining the caliber of the study. The foundation of the evaluation process may be a component checklist or a series of questions. A list and a number of questions are used to assess each study's quality. This study established four quality measurement standards to evaluate the efficacy of each research endeavor. The following are the assessing quality (AQ) criteria:

AQ1. Does the study's topic address flipped learning in higher education?
AQ2. Did the author use an empirical method in this article?
AQ3. Does the paper mention the flipped classroom technology used?
AQ4. Does the article demonstrate how flipped learning is implemented?

The study evaluated the integrity of 36 selected papers using four assessment parameters: weak, medium, and high. The quality of each study was determined by summing its overall scores. A score of 2 was awarded for every requirement met, 1 for only a portion, and 0 for no fulfillment (Appendix A). Studies were classified as weak if their aggregate grade is less than 4, medium if it is exactly 4, and strong if it exceeds four. 6 studies were excluded due to non-compliance with the quality assessment standard.

Synthesis and extraction

The 30 studies were examined to complete the data extraction and synthesis. The essential data was then extracted after carefully reviewing the papers. The objective of this stage is to compile the required data from studies. Table 2 provides detailed descriptions of each item. The procedures for data synthesis and extraction are described in the upcoming sections.

Research findings

To analyze the role of technologies and tools that are being used in the flipped classroom to support teaching and learning in higher education (RO1)

A flipped classroom, a vibrant and collaborative learning environment, is a key component of technology integration in higher education (Günbatar, 2021). It enhances student engagement and academic results by incorporating interactive multimedia and digital platforms, such as simulations and gamification, into lesson plans (Yıldız et al., 2022). Previous studies utilized various tools and technologies, including video creation, learning management systems (LMS), content repositories, collaboration, podcasts, and online assessment, for teaching and learning in higher education (Table 3).

Video creation tools

It has been found that previous studies have used multiple tools for video creation. Park et al. (2018) study reported that Camtasia were used for video creation. TechSmith developed and released the Camtasia software package, also known as Camtasia. It is used for making and recording screencasts or direct recording plug-ins for Microsoft PowerPoint. Background narration and voice tracks can all be added individually or simultaneously with other multimedia recordings (microphone, camera, and system audio).

Table 2 Items' description

Items	Description
Research Id	To provide the research article a unique identity
Author names	The research's creator
Research name	The study's primary premise
Publication year	Date of release (e.g. 2020)
Research context	The stance (e.g. flipped classroom)
Research technology	Electronic media (e.g. video, phones)
Research activity	Analyze learning outcome (e.g. multiple-choice questionnaires)
Course name	Name or title of the subject

Table 3 Role of technologies used in flipped classroom

Role of technology	Tools/platforms	Frequency	References
Video creation tools	Camtasia Screencast YouTube	29	Al-Zahrani (2015), Bachiller and Badia (2020), Buil-Fabregá et al. (2019), Castedo et al. (2018), Fraga and Harmon (2015), Galway et al. (2014), Günbatar (2021), Hao et al. (2016), Karjsnto and Acelajado (2022), Kazanidis et al. (2018), Khan and Abdou (2021), Li and Li (2022), McLaughlin et al. (2016), McLean and Attardi (2018), Murillo-Zamorano et al. (2019), Ng and Lo (2022), Park et al. (2018), Pattanaphanchai (2019), Rodríguez-Chueca et al. (2019), Sevillano-Monje et al. (2022), Steen-Utheim and Foldnes (2017), Tomas et al. (2019), Torio (2019), Van Vliet et al. (2015), Wang and Zhu (2019), Yıldız et al. (2022), Zhao et al. (2021) and Zou et al. (2020)
Learning management system	Moodle BigBlueButton MatActiva	7	Bachiller and Badía (2020), Fraga and Harmon (2015), Hao et al. (2016), Lopes et al. (2019), Mortaza Mardiha et al. (2023); Ng and Lo (2022) and Zou et al., 2020
Content repositories and resources	Pharmaville and Pharmatopia Khan Academy NextGenU e-books	4	McLaughlin et al. (2016), Galway et al. (2014), Yıldız et al.'s (2022) and Zhao et al. (2021)
Podcasts	Microsoft PowePoint	2	Khan and Abdou (2021) and Mortaza Mardiha et al. (2023)
Collaboration tools	Cloud classrooms Zoom Facebook Gmail groups Google drive	2	Khan and Abdou (2021) and Li and Li (2022)
Online assessment tools	Clickers Instant response Kahoot Kahoot	5	Hao et al. (2016), McLaughlin et al. (2016), Sevillano-Monje et al. (2022), Torio (2019) and Van Vliet et al. (2015)

Steen-Utheim and Foldnes (2017) used video screencasts for developing course lectures. A screencast is a type of educational video that includes voice narration and screen recording, often a digital recording of a computer screen. These videos, similar to screenshots, are excellent for teaching or sharing concepts and are also known as screen capture videos or screen recordings.

Most of the studies reported that they uploaded videos to YouTube and the course-related website for student viewing (Al-Zahrani, 2015; Castedo et al., 2018; Park et al., 2018). Online video watching is made simple by the free video-sharing platform YouTube.

Learning management systems (LMS)

A learning management system (LMS) functions as a centralized platform for hosting and arranging educational information, such as videos, readings, assignments, and supplemental resources. Zou et al. (2020) study employed an interactive learning platform, namely Moodle. A learning management system (LMS) called Moodle is used to plan, carry out, and assess online training and education. Moodle is undoubtedly a popular LMS platform and is conceivably the most well-known of its sort. Moodle is used in universities and other sectors for blended learning, distance learning, flipped classrooms, and other online learning projects. Ng and Lo (2022) and Bachiller and Bada (2020) develop learning materials and videos and upload them on Moodle for students.

Mortaza Mardiha et al. (2023) used BigBlueButton software as an online learning system. BigBlueButton is a virtual classroom application created for online learning. The application, which may be accessed most frequently through different LMSs, offers analytics and engagement capabilities for teachers to communicate with their students remotely.

Lopes et al. (2019) employed MatActiva. The major objective of the mathematics project MatActiva, which was created on the Moodle platform, is to inspire students, encourage them to overcome their challenges through self-study, boost their confidence, and pique their interest in mathematics.

Online assessment tools

Online assessment tools have been developed to provide auto-evaluation, report generation, and even grading functions that speed up the typically lengthy marking process. It has been found that McLaughlin et al. (2016) employed clickers for in-class assessment. With the help of an interactive tool called a clicker, teachers can ask students questions and instantly compile and examine the entire class's responses. Multiple-choice questions are presented by instructors (verbally or via clicker software). Students enter their responses using remote transmitters. The technology instantaneously tabulates the results, which teachers can monitor and save.

Hao et al. (2016) used an instant response system in class. This system may evaluate student responses based on pre-set stored answers to swiftly produce a summary report of their findings. Students used an instant response system through smartphones, laptops, and tablets.

Sevillano-Monje et al. (2022) used Kahoot to create a questionnaire and test student's knowledge. Kahoot is a Norwegian site that offers educational games. The platform offers educational games, or "Kahoots," which are user-created multiple-choice tests accessible through a web browser or the Kahoot application.

Content repositories and resources

A place where materials are kept is called a content repository. A Resource, on the other hand, is an artifact that aids in the learning process. McLaughlin et al. (2016) reported the use of Pharmaville and Pharmatopia for pharmacy students. Pharmville is a teaching tool that integrates real-world issues into undergraduate degrees, addressing the undervaluation of sciences and challenges in integrating information across disciplines. It provides context and supports the application of academic theory to students. Pharmatopia

aims to provide problem-based pharmacy learning modules for universities and industry, utilizing a shared-practice model where educators create modules tailored to specific training needs.

McLaughlin et al.'s (2016) study utilized Khan Academy, which offers practice exercises, instructional videos, and a personalized learning dashboard for students to learn at their own pace.

Galway et al. (2014) employed NextGenU. The NextGenU free online learning platform, NextGenU.org, allows anybody to enroll in university- and graduate-level courses through reputable, approved institutions and organizations for personal interest or for free credit.

Yıldız et al.'s (2022) study highlighted the use of electronic books (e-books) for digital distribution and screen reading. E-books can be created from printer source files or from databases. Zhao et al. (2021) used printers for learning pre-class material.

Collaboration tools

Collaboration tools enable one-on-one and group communication, real-time messaging, group chat, file sharing, shared calendaring, and project management through voice and video. Li and Li (2022) used cloud classrooms on desktops and mobile devices for both students and teachers to collaborate. Cloud classrooms provide spaces for collaboration and facilitate communications between faculty and students. Khan and Abdou (2021) study reported the use of Zoom, Facebook, Gmail groups, and Google Drive.

Zoom and Facebook are communication platforms used for synchronous and asynchronous interactions. Zoom allows phone, chat, video, and audio interactions, while Facebook allows users to connect and share views, opinions, and content. Khan and Abdou (2021) used Facebook for educational purposes.

Google Groups enable students to communicate, create chat sessions, is invited to Google Meets, and share documents. Google Drive, a file syncing and storage service, allows data sharing and cloud storage.

Podcasts

The creation and dissemination of audio files is known as podcasting. Mortaza Mardiha et al. (2023) and Khan and Abdou (2021) used audio with PowerPoint slides for lectures. PowerPoint can record both video and audio simultaneously.

To identify the pedagogical activities and courses that make flipped classrooms effective for higher education (RO2)

Activity-based learning involves actively participating in various tasks or activities to learn (Zou et al., 2020). Activity-based learning involves students actively participating in tasks, enhancing problem-solving, logical reasoning, and imaginative thinking. This approach fosters meaningful experiences, promoting independent investigation and learning in a personal learning environment.

Flipped classrooms involve various activities that enhance students' understanding and collaboration. They improve retention of information and higher-order skills (Bachiller & Badía, 2020). Effective implementation depends on selecting appropriate learning activities based on the specific needs of the area (Wang & Zhu, 2019). Designing

activities that align with the course content can better inspire and encourage students to enjoy their educational experience through activity-based learning. It assists students in learning and retaining information by encouraging active intellectual participation in the learning process. Through this process, students are able to recall and comprehend lessons based on their own experiences. The following sections provide information on pedagogical activities and courses that make flipped classrooms effective for higher education.

Accounting and management courses

The accounting and management domain contains a total of 7 (23.3%) courses presented in Table 4. In this domain, multiple class activities were conducted, including multiple-choice questionnaires (MCQs), gamification competitions, online exercises, quizzes, multiple-choice-style game, problem solving cases, assignments, question and answer, assignments for hands-on practice, (e.g., Mortaza Mardiha et al., 2023; Ng & Lo, 2022).

In the classroom, students apply technology-based resources and cooperative learning methods to develop MCQs. Teachers use various technologies to solve problems and apply module content. Competitions, including gamification, test students' learning. Problem-solving case studies enhance writing, analytical abilities, teamwork, and communication skills in accounting and management curricula. This approach boosts and enhances student motivation (Ng & Lo, 2022). Multiple choices and online exercises effectively gauge accounting learning by providing immediate feedback and assessing cognitive ability beyond mere data memorization (Zhao et al., 2021). In accounting and management domain, students were able to clarify some "grey" concepts in their heads through discussion, and solve problems by asking questions. The teachers provided supervision and assistance in numerous conversations regarding certain assignments.

Science courses

The science realm contains a total of 5 (16.6%) courses. The domain involved various activities such as worksheet exercises, instructor discussions, debates, group discussions, online exercises, multiple-choice questions, assignments, and focused explanations (Karjsnto & Acelajado, 2022; Wang & Zhu, 2019).

Worksheets aid in assessing students' science knowledge, outcomes, and processes, while tracking progress. Encouraging scientific thinking through experimentation and worksheet completion can enhance participation (Steen-Utheim & Foldnes, 2017). Debates form the foundation for science courses, teaching students evidence-based reasoning, research conduct, idea generation, peer interaction, opposing viewpoints, and new judgments.

In science courses, group discussions provide students with a safe space to express their ideas and opinions, fostering a deeper understanding of the subject matter and enhancing their analytical skills and critical thinking abilities (Wang & Zhu, 2019).

Science blogging is an informal platform for sharing scientific knowledge and opinions. It helps students learn through quizzes, online exercises, and multiple-choice questions, aiding teachers in identifying areas for assistance and enhancing their understanding of the topic (Karjsnto & Acelajado, 2022; Wang & Zhu, 2019).

Table 4 Pedagogical activities, domains, and courses

Domain	Percentage (%)	Activities	Courses name	References
Accounting and Management	23.3	Multiple-choice questionnaires and gamification competitions	Macroeconomics	Murillo-Zamorano et al. (2019)
		Questionnaire	Financial markets	Bachiller and Badía (2020)
		Online exercises and online quizzes	Financial mathematics	Lopes et al. (2019)
		Multiple-choice-style game	Media Making with Chinese Culture	Zhao et al. (2021)
		Problem solving cases	Business	Ng and Lo (2022)
		Assignments	Research methodology	Mortaza Mardiha et al. (2023)
		Questions and answering	Environmental management, Environmental engineering and industrial ecology	Rodríguez-Chueca et al. (2019)
Science	16.6	Group discussions/ blogs and online exercises	Inorganic chemistry	Wang and Zhu (2019)
		Worksheet exercises, discussion with instructors, debate on solution	Mathematics	Steen-Utheim and Foldnes (2017)
		Multiple-choice questions	Mathematics education	Karjsnto and Acelajado (2022)
		Assignments	Physics	Torio (2019)
		Focused explanation	Polymer science and technology	Yıldız et al. (2022)
Arts and education	26.6	Discussion	Reading for teachers grades	Fraga and Harmon (2015)
		Quizzes	Technology and education—classroom observation	Hao et al. (2016)
		Multiple-choice and blank-filling questions	English	Li and Li (2022)
		Question and answer sessions, Group discussions	Educational psychology	Khan and Abdou (2021)
		Mind map construction	Science and sustainability education	Tomas et al. (2019)
		Online assignment	Theory and history of physical education-Physical activity and sport	Sevillano-Monje et al. (2022)
		Groups, discussion and debate	Creativity and innovation	Buil-Fabregá et al. (2019)
		Group discussions	Instructional media design courses	Kazanidis et al. (2018)

Table 4 (continued)

Domain	Percentage (%)	Activities	Courses name	References
Medical	13.3	Class debate	Flipped environmental and occupational health	Galway et al. (2014)
		Problem solving, quizzes and explanations	Pathophysiology of the CNS-Higher mental processes	Van Vliet et al. (2015)
		Literature analysis, Debate on patient profiles	Medical sciences	McLean and Attardi (2018)
		Problem solving	Pharmacy	McLaughlin et al. (2016)
Engineering	20	Design and simulate	Engineering design	Park et al. (2018)
		Problem solving, questions/exercises, Solving the exercise on the blackboard	Energetic engineering	Castedo et al. (2018)
		Discussion, problem solving and feedback	E-learning	Al-Zahrani (2015)
		Quizzes, Practice activities on computer	Structured programming	Pattanaphanchai (2019)
		Discussion	Web-based system	Zou et al. (2020)
		Question–answer, exercises and practices	Computer networks and communication	Günbatar (2021)

A focused explanation is necessary to accomplish specific goals (Yıldız et al., 2022). Therefore, in science courses, focused explanations and strategies are helpful to accomplish the objectives.

Arts and education courses

The art and education domain contained a total of 8 (26.6%) courses. In this realm, discussion, quizzes, MCQS and blank filling questions, mind map construction, online assignment, group's discussion and debate were utilized for flipped class activities (Khan & Abdou, 2021; Sevillano-Monje et al., 2022). Discussion and debate in art and education enhance students' critical thinking skills by allowing them to process information rather than just consume it (Fraga & Harmon, 2015).

Quizzes, MCQs, and fill-in-the-blank exercises assess arts students' memory and comprehension of knowledge. They help students respond accurately and encourage critical thinking (Hao et al., 2016). Arts teachers can use these tools to assess concepts covered in class or reading materials.

A mind map is essentially used to "brainstorm" a topic and is an excellent method for arts students (Tomas et al., 2019). Mind mapping in arts and education courses facilitates assessment activities, allowing students to apply classroom learning and

instructors to evaluate their progress through well-designed assignments (Sevillano-Monje et al., 2022).

Medical courses

The medical domain contained a total of 4 (13.3%) courses. This realm conducted several activities, including class debate, problem solving, quizzes and explanations, literature analysis, and debate on patient profiles (McLaughlin et al., 2016; McLean & Attardi, 2018).

Debates are crucial in the medical field for a thorough examination of topics, enabling evaluation, critique, and problem-solving (Galway et al., 2014). They also help medical students identify issues to resolve, as healthcare professionals constantly encounter new evidence and must distinguish reliable from unreliable.

Quizzes are beneficial in medical courses as they assess the class's understanding of concepts and help students identify their knowledge gaps (Van Vliet et al., 2015).

Moreover, literature analysis is important for medical courses. Medical students can develop their critical thinking skills through literature (McLaughlin et al., 2016). Literature can help to understand the viewpoint, the experiences, and the ailments of the patient better.

Debate on patient profiles enables tailoring interactions with patients and gives healthcare organizations a patient-centric emphasis. They also help gain a better understanding of their needs and preferences.

Engineering courses

The engineering domain contained a total of 6 (20%) courses. This realm conducted several activities, including design and simulation, problem solving and feedback, questions and exercises, practice (Castedo et al., 2018; Park et al., 2018).

Design simulation is necessary for engineering courses as it enables to validate and confirm the intended use of a product in development as well as the product's ability to be manufactured. The design simulation's objective is to assist students in producing an original, creative, and innovative animated engineering product (Park et al., 2018).

It helps engineering students employ moving components created using Autodesk Maya, simulated with it, and produced with 3D printers (Castedo et al., 2018).

For engineering courses, problem-solving, questions, and exercises are accomplished by putting a focus on science and technology, as they do with most disciplines. In an engineering course, problem-solving might entail creating innovations.

Discussion, exercises, and providing feedback to students were helpful for engineering courses. It improves students' learning, particularly in terms of higher-order thinking abilities like programming (Al-Zahrani, 2015). Compilation of the programming codes and practice in the computer lab can be helpful for students to thoroughly understand the topics.

Table 5 Challenges and solutions to implement flipped classroom

Challenge	Sub-categories	Solutions	References
Time consumption 	-Video recording increases workload of teachers -Finding pre-class online materials needs extra effort for teachers - Students need more time to study before class - Overall effort increase for students and teachers	- Teachers can divide the course for flip class initially and record a few lectures - Teachers can add related pre-existing material first - The institute can provide teacher assistants to manage the workload - Teachers can create student activity timings according to traditional class	Buil-Fabregá et al. (2019); Hao et al. (2016), Rodríguez-Chueca et al. (2019), Sevillano-Monje et al., (2022) and Zou et al. (2020)
Lack of motivation for pre-class work 	- Teachers find it challenging to engage students in learning activities before class - Students lack motivation to study before class	- Teachers can develop interesting pre-class material- - Teachers can use gamification in pre-class activities - Teachers can include graded pre-class activities	Al-Zahrani (2015), Castedo et al., (2018), Karjsnto and Acelajado (2022), Khan and Abdou (2021), Ng and Lo (2022), Park et al., (2018), Steen-Utheim and Foldnes (2017), Yıldız et al., (2022), Zhao et al. (2021), Zou (2020) and Van Vliet et al. (2015)
Lack of guidance out of class 	Students unable to ask questions in pre-class	- Develop online channels of communication for students to ask questions	Fraga and Harmon (2015), Günbatar (2021), Li and Li (2022), McLean and Attardi (2018) and Zhao et al. (2021)
Quality of recorded lectures 	Students lose interest while watching poor quality lecture	Teachers can develop short video lectures to maintain student interest (5–10 min)	Fraga and Harmon (2015), Kazanidis et al., (2018), Li and Li (2022), Murillo-Zamorano et al., (2019), Pattanaphanchai (2019), Rodríguez-Chueca et al. (2019), Torio (2019) and Wang and Zhu (2019)

Table 5 (continued)

Challenge	Sub-categories	Solutions	References
Lack of technological resources 	Teachers and students lack computers, laptop, mobile and high speed reliable internet connection	- Before flip class method make sure students have required technology to avoid further problems - Teachers should set up a backup plan in case speed of internet is down (e.g., lecture availability via USB etc.)	Al-Zahrani (2015), Bachiller and Badía (2020) and Mortaza Mardiha et al. (2023)
Adoption of flipped classroom 	Hesitant to adopt technology Faced difficulties in using technology	- Provide training, guidance, and proper support to both teachers and students	Al-Zahrani (2015), Galway et al., (2014), Li and Li (2022), Lopes et al. (2019) and Tomas et al. (2019)

To identify the challenges of implementing flipped classrooms in higher education and how they can be overcome (RO3)

Although flipped classrooms provide many benefits for educational settings, there are also some challenges to this method. This study identified a number of issues in implementing flipped classrooms and also reported how to overcome these obstacles (Table 5).

Time consumption

Despite the fact that there are many educational videos available online, some teachers report that they are having difficulty locating them or that they do not exactly correspond to what they want their students to learn (Hao et al., 2016). As a result, a lot of teachers try to make their own materials, which takes a lot of time and work. Therefore, flipping the classroom necessitates an increase in instructor preparation time during the initial transformation. Teachers are still struggling to flip large numbers of classes and maintain the effort necessary to enable student learning (Zou et al., 2020). Teachers have been criticized for claiming that the pre-class workload in flipped classrooms is more time-consuming than in traditional courses (Sevillano-Monje et al., 2022).

A teacher may not be able to create full course materials for a flipped class at once. It could be more feasible to focus on the half-course first and add related preexisting material initially. Another choice is for a group of teachers to create a course while working together to produce the material. Moreover, a teaching assistant can be provided to lessen the work load of the main teacher.

Instructors should estimate the time needed for traditional homework and plan their pre-class activities accordingly because a flipped course should have the same amount of work as a regular course. It is important to keep in mind that because students frequently stop and rewind videos, they will watch them for longer periods of time than the actual playtime. Therefore, the maximum amount of video content for each class should be 5–10 min.

Lack of motivation for pre-class work

Flipped classrooms face challenges in directing students to participate in pre-class learning activities, potentially reducing their effectiveness due to inadequate preparation, as teaching techniques heavily rely on pre-class tasks (Ng & Lo, 2022).

Gamification, an increasing trend in education, appears to boost student engagement and motivation (Yıldız et al., 2022). This method often includes awarding badges to students and monitoring their development on a leader board. Some learning management systems, like Moodle, have game components integrated right into them (Steen-Utheim & Foldnes, 2017). Additionally, there are third-party programs that provide every student access to an online activity that they can personalize as they accrue points by finishing pre-class assignments. This method will be helpful for teachers to motivate students for pre-class work.

Lack of guidance out of class

In traditional classrooms, students simultaneously ask questions if they face any difficulty in the lecture. However, during pre-class activities, several students complained that they were unable to ask questions. Unanswered queries can lead to misunderstandings or knowledge gaps, making in-class activities more challenging for students who frequently apply newly learned material in subsequent class time.

In a flipped classroom, students require more support outside of class because it is difficult to study the subject independently. Creating channels of communication for students to communicate with one another and their teacher outside of the classroom might be helpful. This may be accomplished with online discussion boards and many learning management systems, such as Moodle, chat forums, etc.

Quality of recorded lectures

Videos of pre-class education that are poorly made may unintentionally hinder learning. For instance, some students lose interest while watching lectures and stop halfway through (Li & Li, 2022). Other students express dissatisfaction with videos, saying they distance themselves from the teacher appearing on screen. They consequently observe inertly and overlook crucial ideas (Torio, 2019).

According to experts on multimedia learning, students watch videos for an average of ten minutes before losing interest. Therefore, longer topics should be divided into smaller ones. Additionally, more conversational videos will enhance engagement by fostering a deeper sense of connection between students and the teacher.

Lack of technological resources

Flipped classrooms utilize video conferencing, screencasting programs, and cloud-based platforms for teacher development and delivery (Mortaza Mardiha et al., 2023). However, poor quality, defective, and outdated ICT equipment can hinder implementation (Al-Zahrani, 2015; Bachiller & Badía, 2020). Students need internet access and a computer or mobile device at home for flipped learning, so ensuring technology accessibility is crucial for all students.

To get around this, teachers should set up a backup plan for all students, including what to do in the event that the internet is down or they are without a device.

Adoption of the flipped classroom

Teachers who were recently exposed to the flipped classroom could not comprehend the method or the benefits of the strategy (Galway et al., 2014; Lopes et al., 2019). Many students were unfamiliar with the flipped classroom method (Li & Li, 2022). It may make it difficult for them to grasp its benefits and adapt to new information outside of traditional classroom settings (Hao et al., 2016).

The demand for related training should rise as flipped and blended learning become more widespread. Training in lesson planning and video production could introduce

new teachers to a wider range of teaching strategies and forge a stronger link between educational theory and practice (Tomas et al., 2019).

Teachers should establish a line of interaction with students before flipping to ensure they understand the benefits of the flipped classroom. Teachers should encourage students to express concerns, provide guidance, and provide specific directions for group work to reduce stress. They should also provide examples of effective video learning and group work.

Discussion and conclusions

The applicability of the flipped classroom in higher education was thoroughly assessed using SLR in this study. This study had three objectives to identify the flipped classroom technologies, activities according to courses, and implementation-related challenges. A set of criteria was utilized to extract relevant studies from Science Direct, Taylor & Francis, MDPI, SAGE, Springer Link, Wiley and IEEE Xplore and Google Scholar databases. Finally, a total of 30 papers that were released between January 2014 and July 2023 were chosen to be a part of this study. The summary of findings is illustrated in Fig. 2.

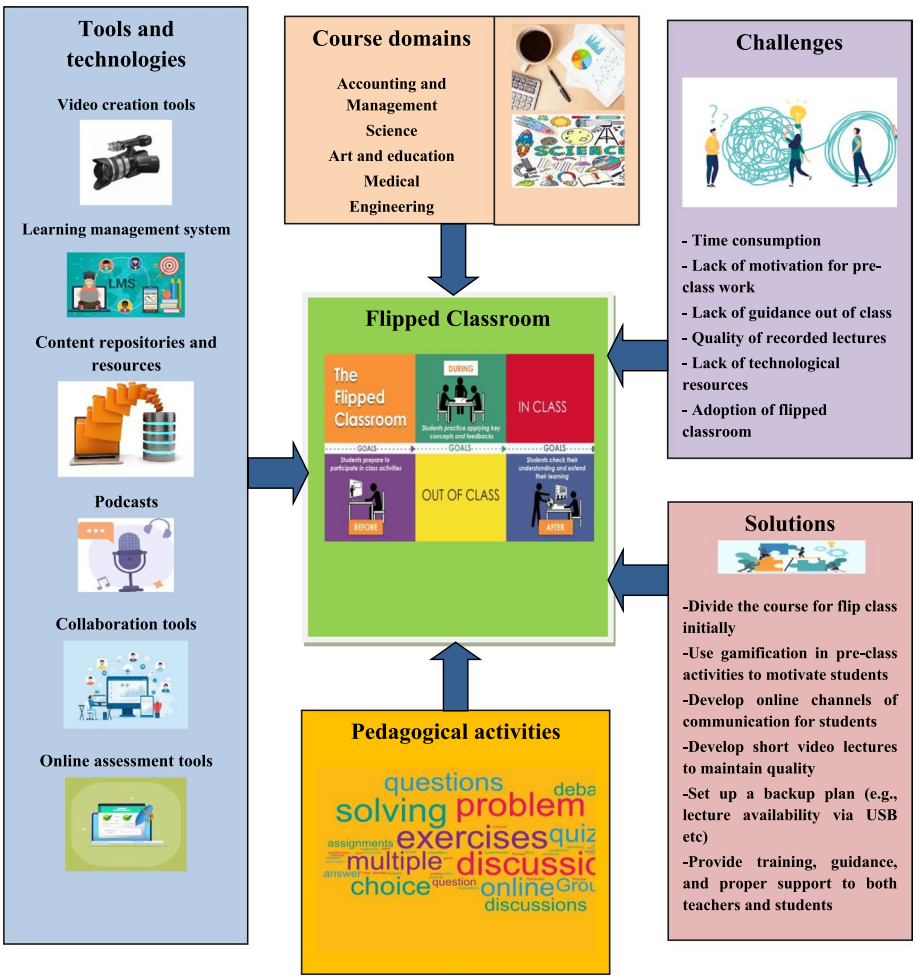

Fig. 2 Summary of findings

This study analyzed the technology and tools that are being used for flipped classrooms in the higher education sector. The findings revealed that most of the studies used tools for creating videos. In today's digital environment, tools for creating videos, such as Camtasia, screencasts, and YouTube, are crucial. Each of these technologies has a specific function and helps in different ways with content production, sharing, and communication. These instruments revolutionized education, communication, and ideas in the digital age (Ng & Lo, 2022). They enable higher education in ways that were never imagined producing, distribute, and engage with a variety of groups (Sevillano-Monje et al., 2022).

It has been found that the LMS significantly contributes to and supports flipped classroom learning. In a flipped classroom, students independently review their readings before class, and conversation, problem-solving, and active learning take place during that time. The flipped classroom model is made more effective by the LMS (Bachiller & Badía, 2020). It makes sure that both teachers and students have the resources and equipment they need to be successful in this cutting-edge pedagogical strategy (Mortaza Mardiha et al., 2023).

Online assessment tools are a helpful technology of the flipped classroom model. Clickers and instant response platforms like Kahoot provide real-time feedback and increased interactivity for both teachers and students (McLaughlin et al., 2016; Torio, 2019). They assist teachers in gauging students' comprehension of class materials and offer insightful information for customizing activities (Hao et al., 2016).

The flipped classroom concept relies on resources and content repositories for access to various educational materials such as Pharmaville and Pharmatopia, Khan Academy, NextGenU, and e-books, allowing learners to progress at their own schedule. It promotes diverse learning styles and fosters collaboration for data-driven improvements in teaching and learning (Yıldız et al., 2022). It has been found that creating podcasts via Microsoft PowerPoint has emerged as an important and powerful medium for flipped learning. It provides a variety of interesting, accessible content, making it a useful tool for learning, entertaining, and maintaining knowledge on a variety of subjects (Khan & Abdou, 2021). Students can participate in pre- and in-class discussions, ask questions, and share ideas using collaboration platforms like online classrooms, Zoom, Facebook, Gmail groups, and Google Drive (Li & Li, 2022). It ensures they are well-prepared for class and actively participate in productive discussions (Khan & Abdou, 2021).

Secondly, this study analyzed the pedagogical activities and courses that make flipped classrooms effective for higher education. The findings indicated that the accounting and management domain involves multiple activities like multiple-choice questionnaires, gamification competitions, online exercises, quizzes, and problem-solving cases. These activities align with the nature of accounting, a discipline that demands precision, critical thinking, and effective communication. They contribute to the enhancement of students' skills. The science realm involves activities like worksheet exercises, discussions, debates, group discussions, multiple-choice questions, assignments, and focused explanations. These activities offer benefits for students and educators. Science often involves complex problem-solving and the application of theoretical concepts. Thus, worksheet exercises provide valuable practice and application opportunities. Discussions encourage critical thinking, communication, and diverse perspectives, while debates require

critical thinking, persuasive communication, and research. They provide a platform for students to analyze and debate various scientific concepts, fostering a deeper understanding of complex topics. Multiple-choice questions provide immediate feedback and help identify areas of weakness (Karjsnto & Acelajado, 2022). Focused explanations provide clarity, confidence, and personalized guidance, promoting personal growth and understanding of complex scientific concepts.

Flipped class activities in the art and education domains involve discussion, quizzes, multiple-choice questions, blank-filling questions, mind map construction, online assignments, group discussion, and debate. Discussions encourage critical thinking and a deep understanding of complex topics. In both the art and education domains, discussion is a valuable activity that makes the exchange of ideas and diverse viewpoints more effective. Quizzes and multiple-choice questions cover diverse content, requiring higher-order thinking skills (Li & Li, 2022). In art, they can evaluate students' understanding of art history, techniques, and concepts. In education, they serve as formative assessments to gauge students' comprehension of educational theories and practices. Mind maps are versatile tools that assist in analyzing art movements, brainstorming ideas, and visualizing complex educational theories. Group discussions and debates promote collaboration, critical thinking, and communication skills (Khan & Abdou, 2021). Such activities assist students in learning from one another's creative ideas. Meanwhile, aligning with the cooperative nature of teaching and learning, collaborative projects foster teamwork and the sharing of knowledge.

The medical domain courses involve activities like class debate, problem-solving, quizzes, literature analysis, and patient profile debates. Debates require medical students to think critically, analyze information, and develop persuasive arguments. Quizzes assess medical students' understanding, provide immediate feedback, and help them retain information (Van Vliet et al., 2015). Literature analysis requires critical thinking, writing skills, and empathy (McLean & Attardi, 2018). Patient profile debates help develop clinical reasoning skills, communication skills, ethical considerations, and teamwork. By incorporating these activities into the curriculum, the higher education sector can create dynamic learning environments that prepare medical students for success in academic and real-world contexts. Engineering courses utilize design, simulation, problem-solving, feedback, exercises, and practice activities to foster innovation, reduce risk, and improve practical skills (Günbatar, 2021). As a result, information retention and networking possibilities are improved. These activities fill the gap between academic knowledge and practical application.

Finally, this study focused on the challenges associated with the execution of flipped classrooms in higher education and proposed strategies to overcome these challenges. The identified challenges include time consumption, lack of motivation for pre-class work, lack of guidance out of class, quality of recorded lectures, lack of technological resources, and adoption of the flipped classroom. Despite these challenges, the flipped classroom model is often a valuable approach that enhances student learning. Therefore, with careful planning, support, and ongoing assessment, these challenges can often be mitigated or overcome.

Limitations and directions for future research

This study obtained articles from well-reputed databases and publishers, including Science Direct, Taylor & Francis, MDPI, SAGE, Springer Link, Wiley, IEEE Xplore, and Google Scholar. Even though these sources cover a broad spectrum of scholarly literature, future studies can include additional databases and publishers in order to ensure more comprehensive coverage of the available literature. This study mainly focused on flipped learning in the higher education sector. Future studies may expand the scope by examining the efficiency and effectiveness of flipped classrooms in other educational settings such as school, training and professional development, and vocational and technical education, as the educators and students may have distinct expectations.

This study analyzed the tools and technologies that are being used in higher education. Future studies can analyze the developments in flipped classroom technology that are influenced by a variety of factors, including pedagogical research, developing technologies, and changing demands on both students and teachers. This study did not explore the implementation of cutting-edge technologies such as augmented reality and artificial intelligence in flipped classrooms. Future studies can focus on such technologies and their impact on student engagement and success. Future investigations can also focus on the application of augmented reality and artificial intelligence to fulfill the unique learning needs and expectations of various academic majors and courses within the context of flipped classrooms. Additionally, the adoption and effectiveness of flipped classrooms can differ across different cultures and geographical regions. This study has not explicitly considered such variations. Therefore, examining the influence of cultural and geographical factors on the outcomes of flipped classrooms is recommended in future studies.

This study identified the pedagogical activities and courses in the flipped classroom. The future of flipped classroom course activities can be shaped by a blend of innovative technologies, pedagogical research, and a focus on enhancing the learning experience for students. Future studies can investigate how instructors can tailor pedagogical activities to match specific learning objectives and student needs in different subject areas by assessing the adaptability of these activities across various disciplines. Finally, this study primarily reported the immediate outcomes of using flipped classrooms in higher education. Future longitudinal studies are recommended to trace the effectiveness of this pedagogical approach on students' learning, success, and retention rates in the long-term.

Research implication

This investigation can shed light on the current state of flipped learning as an emerging educational approach and its implications for teaching and learning. This study can help researchers, educators, and institutions better understand how flipped learning is being implemented, its impact on students and instructors, and its potential benefits and challenges.

The identified flipped classroom technologies have numerous implications for educators, researchers, and institutions. The identified technologies (e.g., Camtasia and Screencast) for flipped classrooms can be helpful for educators to tailor content according to student needs. Educators can provide additional resources for struggling students and challenge more advanced learners accordingly. In flipped classrooms, technology

(such as clickers and instant response) can automate assessment and provide quick feedback. These can allow educators to spot problem areas and modify their instruction accordingly. Flipped classroom technology can be implemented at scale, making it a cost-effective solution for institutions looking to improve teaching and learning outcomes. Moreover, researchers can explore the effectiveness of the indicated technologies to see what works best for different subjects and student populations.

Through research, educators can gain insights into effective strategies for using flipped learning in their classrooms, and institutions can make informed decisions about adopting and supporting this pedagogical approach. The analysis of flipped classroom technologies can direct pedagogical approaches and resource allocation, eventually influencing how higher education develops in the future. The results of the study will show the extent to which technology is integrated into higher education for the purpose of flipped learning. In this way, institutions can better plan to use technologies that work well in flipped classrooms in order to maintain their competitiveness and deliver high-quality instruction. Resources may need to be set aside by universities and colleges to train teachers in the efficient use of these technologies. Programs for faculty development, workshops, and continuous assistance for teachers are needed to make the most of these tools. Meanwhile, understanding the technologies being used can affect how curriculum is designed. Lecturers and curriculum designers can match their courses with the flipped classroom model by incorporating technology-friendly content and activities into their lessons.

Secondly, this study explored the pedagogical activities and courses that make flipped classrooms effective for higher education. Recognizing that different subject domains may require distinct pedagogical activities highlights the importance of tailoring teaching strategies to suit the nature of the course. New teachers can benefit immensely from this insight as it encourages them to avoid conventional way of teaching. They can adapt their teaching methods to align with the specific content and learning goals of their courses. This can lead to effective resource allocation. When teachers are aware of which activities are most effective for particular subjects, they can allocate their time and resources more efficiently. This knowledge allows them to focus on developing and implementing activities that are known to work well for their subject matter, optimizing the learning experience for their students. The right class activity provides the structure that will allow students to build on what they have already learned. This approach will ultimately result in increased student participation, greater comprehension, and better information retention.

It has been found that gamification activities can be an effective flipped classroom strategy in accounting and management courses. Educators can design gamification activities in a manner to reinforce important ideas, promote critical thinking, and make learning memorable for students. In science courses, problem-solving-based activities were found to be very important. Educators can design the problem-solving activity, ensuring it is engaging and interactive. Educators can consider various formats, such as case studies, experiments, simulations, or research projects. It has been found that interactive activities can improve art and education courses by encouraging student creativity and a deeper comprehension of artistic ideas. Institutions and educators can provide online resources for students to experience virtual museum

tours and art galleries. Students can talk about well-known pieces of art, styles, and artists. Additionally, institutions might schedule routine art critique events where students can exhibit their work and get input from their peers.

It has been observed that a literature analysis helps students understand the current state of knowledge in a particular medical area, ensuring that their practice is evidence-based. Therefore, institutions can provide free access to databases and journals to medical students. It has been found that computer-based practice exercises hold significant importance for engineering courses. Educators can organize the computer-based practice exercises with a clear structure. Educators can employ multimedia components including simulations, and augmented reality to illustrate questions in computer-based tasks.

Lastly, the identification of challenges in implementing flipped classrooms serves as a roadmap for future research endeavors. Other researchers can use these challenges as a starting point to investigate specific issues in greater detail. This can lead to more targeted and experimental studies aimed at finding practical solutions. Educational institutions can use the identified solutions as a basis for professional development. They can provide training and resources to better incorporate flipped classroom techniques and overcome challenges. Meanwhile, institutions can allocate resources to support the implementation of the identified solutions. This can include investing in technology and creating support structures for students to navigate challenges successfully. The identified solutions can contribute to the creation of more conducive learning environments. Students and teachers can implement these solutions to manage challenges effectively, resulting in a more productive and engaging learning experience. Finally, the solutions offered can have a direct impact on student success. Effective management of challenges by students and teachers can lead to better comprehension of course material, and increased academic achievement.

Appendix A. Assessing quality results

No.	AQ1	AQ2	AQ3	AQ4	Score
1	2	2	2	2	8
2	1	2	2	2	7
3	2	2	1	2	7
4	2	0	2	2	6
5	2	2	2	2	8
6	2	2	2	2	8
7	2	2	2	2	8
8	2	2	2	2	8
9	2	2	2	2	8
10	2	2	2	2	8
11	2	2	2	2	8
12	2	1	2	2	7
13	2	2	2	2	8
14	2	2	2	2	8
15	2	2	2	2	8

No.	AQ1	AQ2	AQ3	AQ4	Score
16	2	2	2	2	8
17	2	2	2	2	8
18	2	2	2	2	8
19	2	2	2	2	8
20	2	2	2	2	8
21	2	2	2	2	8
22	2	2	2	2	8
23	2	2	2	2	8
24	2	2	2	2	8
25	2	2	2	2	8
26	2	2	2	2	8
27	2	2	2	2	8
28	2	2	2	2	8
29	2	2	2	2	8
30	2	2	2	2	8

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MIB was in charge of the research design, data collection and analysis, and writing. EY was in charge of conceptualization, data analysis, writing and editing. The author(s) read and approved the final manuscript.

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This is a review paper and all data has been presented throughout the paper.

Declarations

Competing interests
The authors have no competing interest to declare.

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