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Effectiveness of flipped classroom in nursing education: A systematic review of systematic and integrative reviews☆

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ABSTRACT

Background: The flipped classroom is an active methodology that has been implemented for many years in the training of nursing students with multiple studies published on this subject to date.
Aim: This study sought to answer the question: is flipped classroom effective for improving nursing education?
Design: A systematic review of systematic and integrative reviews focused on studies that applied flipped classroom in the teaching of nursing students.
Data sources: Exhaustive literature searches were performed using five electronic databases: Medline, Cochrane, CINAHL Plus, Scopus and Web of Science. Review methods**:** In total, 670 studies were identified, published from 2010 until 2020. Data were collected by two reviewers following the predesigned extraction form. Quality was assessed with the modified AMSTAR scale. A narrative synthesis of the findings has been used to present the results.
Results: 15 reviews (9 integrative reviews and 6 systematic reviews) were selected, comprising 274 studies, and providing a sample of 34,608 students. Most of the studies were conducted in China and the United States. A great heterogeneity and a medium-low methodological quality were detected. In the pre-class stage, individual instruction of students through reviews of articles and textbooks or electronic books is highlighted. In class, group activities were most frequently used, including assignments, presentations, projects, or discussion of topics, and in the post-class stage, course evaluation and self-study. The post-class stage was only recorded in two of the systematic reviews selected. When comparing the flipped classroom with the traditional methodology, better results were obtained in performance ($k = 122$), competencies ($k = 92$) and satisfaction ($k = 10$).
Conclusion: The results suggest that the use of the flipped classroom in nursing education increases performance and is satisfactorily evaluated by both students and faculty. However, more studies are needed that meet methodological quality standards to consolidate the evidence.

What is already known

- The flipped classroom has become popular in the nursing literature.
- Several integrative reviews and systematic reviews have been published exploring the use of flipped learning in nursing studies.
- The contradictory results of published studies on the flipped classroom generate uncertainty regarding its effect.

What this paper adds

- Most integrative and systematic reviews support the efficacy of the flipped classroom.
- No standard tool exists to assess the effectiveness of the flipped classroom.
- Performance, competencies, and satisfaction are the most recorded parameters.

☆ Contributions: Idea, Literature Review, Methodology, Results, Discussion and Conclusions, Writing (original draft) and Final Revisions: B-H M., A-B R y O-M C.

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1. Introduction

1.1. Historical background and current status of the ubject

The challenges and opportunities for supplementing traditional teaching methods while maintaining quality instruction are numerous (McDonald et al., 2018). To address this growing problem, educators have adopted multiple learning strategies that combine active learning and the use of technologies (River et al., 2016), such as the flipped classroom approach to teaching.

In 2007, the Flipped Classroom was consolidated by Bergmann and Sams, two chemistry teachers at Woodland Park High School in Colorado (USA) (Bergmann and Sams, 2012). Their goal was to ensure that students who for various reasons had been unable to attend class would be able to keep up with the pace of the course and would not be disadvantaged by lack of attendance (Bergmann and Sams, 2012). To this end, Bergmann and Sams encouraged the recording and distribution of videos, and, in addition, they realized that this same model allowed the teacher to focus more attention on the individual learning needs of each student (Bergmann and Sams, 2012; Berenguer, 2016).

In 2014, a consortium of educators implemented these pedagogical strategies and formed the Flipped Learning Network (Flipped Learning Network (FLN), n.d.), defining Flipped Learning as "a pedagogical approach in which direct instruction is shifted from the group learning dimension to the individual learning dimension, transforming the remaining group space into a dynamic and interactive learning environment, in which the educator guides students in the application of concepts and in their creative engagement with the course content". They further state four pillars of F-L-I-P flipped learning:

- Flexible environment: students choose the time, space and pace of their learning, i.e., when, where and how.
- Learning culture: the traditional teacher-centered model is being replaced by a student-centered model, in which the student takes responsibility for his or her learning, taking advantage of class time for subjects that require greater depth.
- Intentional content (targeted content): educators prioritize content that is accessible to students on their own, create relevant content and utilize effective class time, using active student learning according to level and academic area.
- Professional educator: the role of the educator in flipped classroom seems less prominent than in the traditional approach. However, during class, the educator is available to students by providing individual or group feedback, assessing through observation and recording, and liaising with other educators to complete instruction.

The flipped classroom approach is therefore based on active learning, defined as any instructional method that involves students in the learning process (Talbert and Mor-Avi, 2019), with three main components (Barbour and Schuessler, 2019; Flores et al., 2016):

- Individual pre-class instruction, which often relies on digital resources prepared by the teacher, and allows students to engage with the content, complete readings, view pre-recorded lectures in the form of webcast videos and/or narrated PowerPoint slides, podcasts, and interactive videos.
- During classroom time, collaborative work prevails through interactive group activities, which focus on enabling students to apply the content by interacting and exchanging ideas through multiple modalities.
- After the classes, an evaluation process is established through comments, addressing doubts and clarifications.

In addition to the increasing complexity of the healthcare environment and the rapid advancement of competing healthcare technology, a global pandemic emerged, caused by Covid-19. The pandemic has triggered a global educational movement toward blended learning to meet the technological and practical learning needs of nursing students. Indeed, at no time in history has there been such a sudden transition to this type of learning (Jowsey et al., 2020), where flipped classroom can be included.

Flipped classroom has become popular in the nursing literature, however, the large number of published studies on flipped classroom, many of them with contradictory results, generates uncertainty regarding its effect. Systematic reviews, by synthesizing the available evidence, enable the consistency of results to be analyzed and provide a more solid basis for decision making. Several systematic reviews exploring the use of flipped learning in nursing studies have been published. However, to our knowledge, there is no systematic review of systematic reviews on the subject that would allow us to pool the different results. Therefore, following the PICO structure, the main objective of this review is to answer the question: is flipped classroom effective in nursing education?

2. Methods

2.1. Search strategy

A literature search was conducted (MMR) between November and December 2020 in five databases: Medline, Cochrane, CINAHL Plus, Scopus and Web of Science.

The Boolean operators "AND" and "OR" were used to combine the search terms which, in some cases, were truncated to generate the maximum number of results (Annex 1).

2.2. Inclusion criteria

For the selection of manuscripts, the following inclusion criteria were established: 1) the study had to synthesize information on the use of the flipped classroom in nursing education; 2) nursing students or nurses had to participate; 3) the design had to be a systematic review with or without meta-analysis, an integrative review, a literature review, or a narrative review; 4) published as of 2010; 5) written in Spanish or English.

2.3. Data extraction

For the systematic review, a protocol was created that included a coding manual with the corresponding coding procedures and coding forms (available upon request) that were developed according to the PICO criteria (population/problem, intervention, comparison, and outcome). The population (P) were reviews with or without meta-analyses, analyzing the use of flipped classroom in nursing education. The identified intervention (I) was the use of the flipped classroom in nursing education and were reviewed in comparison (C) to traditional teaching pedagogy. The expected results (O) were better outcomes in academic performance, competencies and satisfaction when the flipped classroom is applied in nursing education. The protocol was registered in PROSPERO under registration number CRD42021226469.

2.4. Quality assessment

To assess compliance with the current quality standards of the selected SRs, a modified version of the AMSTAR (Assessment of Multiple Systematic Reviews) scale (Shea et al., 2007) was used, the AMSTAR-M adaptation (Huedo-Medina et al., 2016), which contains a total of 14 items, constructed from the 11 AMSTAR items. Thus, two new questions have been created in the adaptation, one in section A and the other in section D of the scale. AMSTAR item 3 has been divided into two (section B, questions 4 and 5 of AMSTAR-M), one focusing on the completeness of the search and the other on whether the search is replicable, because it is possible for a review to be complete but not replicable. AMSTAR

elements 1, 6, and 8 are somewhat more detailed by adding an interpretation of the scores. AMSTAR elements 2, 5, 7, and 9 are expanded by including 1 or 2 more scoring categories. The maximum modified AMSTAR score is 22 points.

3. Results

The comprehensive search began on November 18, 2020, and ended on December 22, 2020, and identified 670 studies, of which 15 were included in the systematic review (Hu et al., 2018; Njie-Carr et al., 2017; Evans et al., 2019; Oliver and Luther, 2020; Betihavas et al., 2016; Ward et al., 2018; Presti, 2016; Liu et al., 2018; Chung and Lai, 2010; Chen et al., 2018; Xu et al., 2019; Pangandaman et al., 2019; Tan et al., 2017; Li et al., 2020a; Ramasubramaniam et al., 2017). Fig. 1 shows the flow chart of the screening process according to PRISMA guidelines (Moher et al., 2009).

3.1. Characteristics of selected systematic reviews

The nine integrative reviews and six systematic reviews provided a sample of 34,608 participants distributed among 274 primary studies. The main characteristics of the selected systematic reviews are shown in Table 1.

Two coders (BHM and OMM) independently extracted the data from the 15 systematic reviews. Once the studies were coded, the degree of intercoder agreement was estimated to be 0.90 (Cohen's mean Kappa was $\kappa = 0.91$ and the mean Spearman-Brown correlation was $r = 0.90$). Disagreements were resolved by inter-coder deliberations and, when necessary, the judgment of a third reviewer was used.

The number of primary studies included in the selected systematic reviews ranged from 5 to 46, published between 2010 and 2019. A total of 33.3% ($n = 5$) of the reviews included exclusively experimental analytical studies, while 66.7% ($n = 10$) contained both quantitative and qualitative studies, as well as mixed studies. The most frequent primary study type was the randomized controlled trial, followed by the quasi-experimental design, and the cohort study. Studies on flipped classroom were conducted in different parts of the world, although most of the primary studies involving the selected systematic reviews were conducted in China and the USA.

Regarding methodological quality, the mean score on the AMSTAR-M scale was 10.2 (SD = 4.9, range 2–18) (Table 1). In Table 2, the AMSTAR-M items are grouped according to four domains: Agreement, Unsatisfactory, Not completely satisfactory and completely satisfactory. All the reviews (100%) met the a priori design criterion and included conflict of interest. Of the reviews, 86.7% provided lists of the included studies and, in the majority, the characteristics of each study analyzed were provided (93.3%). In 80% of the reviews, an exhaustive literature search was carried out by reviewing the references of the included studies. In addition, 73.3% studies complied with the items related to replication of the literature search, and the scientific quality of the studies was evaluated and documented.

In 66.7% there was a selection of duplicate studies and data extraction, but inter-rater reliability was not reported, and 53.3% allowed the inclusion of gray literature. Forty percent of the reviews used appropriate methods to combine study findings, 46.7% statistically justified the chosen effect size index, and 33.3% assessed the likelihood of publication bias. However, in only 13% of the reviews, population variables were defined in the methods, and no review provided an actual list of excluded studies, nor demonstrated how the results may depend on study quality, either alone or in interaction with other dimensions.

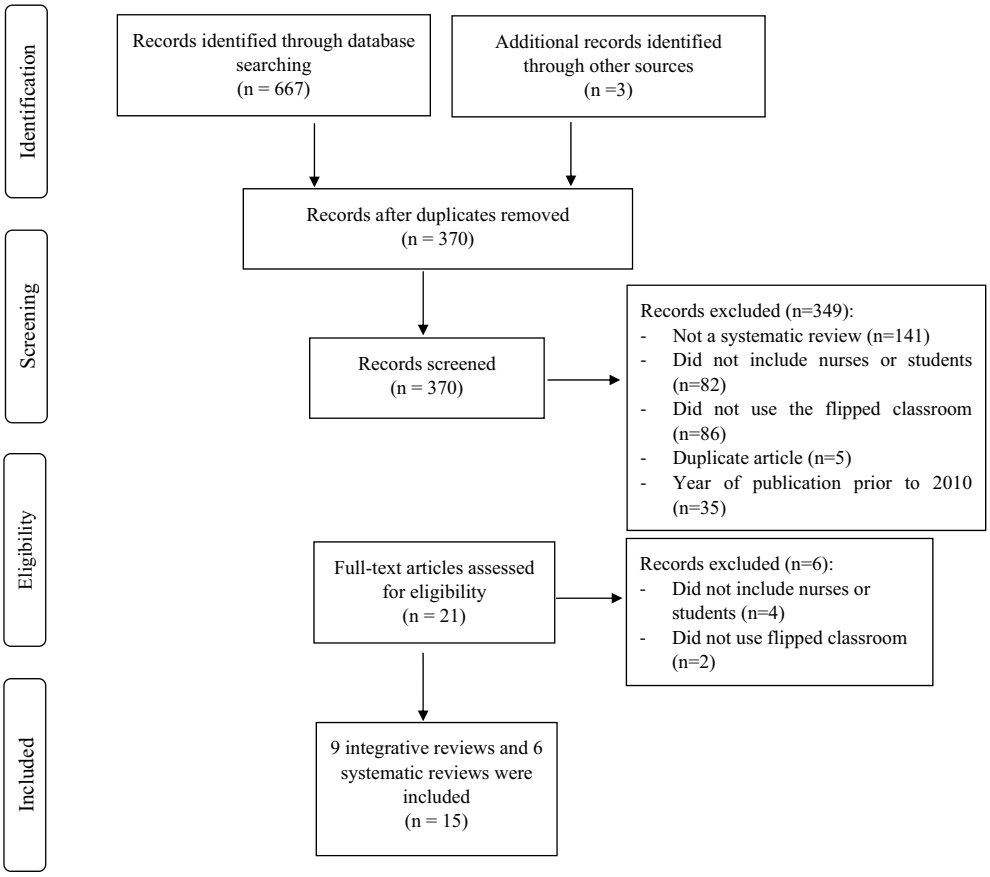

Fig. 1. Flow chart. Selection process.

Table 1
Description of the studies included in selected reviews.

n° RS	Main author (year of publication)	Country of the authors/Country/ies of the primary studies	Range of years of publication of primary studies included	Type of studies	N°. of participants	Type of participants included	Overall AMSTAR-M score
1	Betihavas et al. (2016)	AU/ US (k = 5)	2013–2015	2 quasi-experimental studies, 1 experimental with a randomized convenience sample, 1 cross-sectional, 1 descriptive exploratory.	934	Undergraduate and postgraduate nursing students. A postgraduate course in pediatrics and undergraduate courses in pharmacology, medical-surgical nursing, adult health and public health are included.	10
2	Chen et al. (2018)	TW/ US (k = 37) CA (k = 1), UK (k = 1), AU (k = 2), TH (k = 3), TW (k = 2)	2012–2016	4 RCT 19 quasi-experimental studies, 23 cohorts.	9026	Health science education students: medicine (k = 14), pharmacy (k = 9), nursing (k = 3) and other disciplines (k = 6). Non-health science students (k = 14). Participants were medical residents, doctoral, master's, graduate and postgraduate students.	13
3	Chung and Lai (2010)	TW/ Not mentioned.	2013–2017	8 surveys 4 experimental, 1 experimental + survey 6 mixed methods 5 didactic advice 3 qualitative methods, 3 research summaries 3 literature reviews.	Not mentioned.	Nursing education students, working adults or not specified. Studies include professional knowledge training courses, skills training courses, and clinical nursing techniques and computer literacy.	5
4	Evans et al. (2019)	US/ Not mentioned.	2012–2017	7 mixed methods, 12 quasi-experimental studies, 1 descriptive study 4 experimental (2 RCTs).	3555	Chiropractic health (k = 2), medical (k = 11), nursing (k = 5), pharmacy (k = 5), and public health (k = 1) students. In addition, the studies comprise 16 undergraduate students (k = 18), and students, both undergraduate and postgraduate (k = 6).	11
5	Hu et al. (2018)	CN/ CN (k = 11)	2015–2017	11 RCTs.	1484	Chinese undergraduate nursing students.	16
6	Li et al. (2020a)	CN/ CN (k = 32)	2015–2019	32 RCTs.	4389	Chinese university nursing students (k = 23), and higher vocational and secondary school students in China (k = 11).	14
7	Liu et al. (2018)	CN/ CN (k = 10), CA (k = 1), IR (k = 1)	2010–2017	8 RCTs 4 quasi-experimental studies	1440	Nursing students and senior professional nursing students.	14
8	Njie-Carr et al. (2017)	US/ US (k = 9), AU (k = 1), KR (k = 1), EG (k = 1), DK (k = 1)	2013–2016	1 experimental 3 quasi-experimental studies, 5 descriptive studies (qualitative and quantitative), 4 mixed methods,	1716	Undergraduate nursing students (k = 11), associate degree nursing students (k = 1), and nursing graduates (k = 1). Content areas: pediatrics, adult health, pharmacology, anatomy and physiology, psychiatry, maternal health, and community health.	10
9	Oliver and Luther (2020)	US/ US (k = 5)	2012–2017	3 mixed methods. 1 retrospective non-experimental 1 descriptive cross-sectional study.	214	Postgraduate nursing students in a statistics course, a pharmacology course, two pediatrics courses, an evidence-based practice course, and a qualitative research course.	8
10	Pangandaman et al. (2019)	PH/ US (k = 9), TW (k = 1)	2014–2019	1 quasi-experimental study 9 studies designed in qualitative and quantitative synthesis.	Not mentioned.	Nursing students.	2
11	Presti (2016)	US/ US (k = 11)	2013–2016	7 descriptive studies 3 quasi-experimental studies 1 experimental.	1906	Undergraduate, graduate and postgraduate nursing students enrolled in courses in mental health-psychiatry, pediatrics, pharmacology, medical-surgical nursing, public and community health, nursing fundamentals, algebra and statistics.	4

Table 1 (*continued*)

n° RS	Main author (year of publication)	Country of the authors/Country/ies of the primary studies	Range of years of publication of primary studies included	Type of studies	N°. of participants	Type of participants included	Overall AMSTAR-M score
12	Ramasubramaniam et al. (2017)	OM/ US (k = 5), IN (k = 1), NZ (k = 1)	2013–2016	1 cross-sectional study, 1 descriptive phenomenological study, 1 simulated case, 1 experimental 2 quasi-experimental studies, 1 descriptive exploratory design.	403	Students in a medical-surgical nursing course, undergraduate nursing students, and 3rd year nursing students.	6
13	Tan et al. (2017)	CN/ CN (k = 29)	2015–2016	29 RCTs.	3694	Undergraduate students (k = 15) and associate degree students (k = 14). The research setting includes 25 schools and 4 clinical areas.	18
14	Ward et al. (2018)	US/ US (k = 10), CA (K = 1), KR (k = 1), EG (k = 1), DK (k = 1)	2013–2016	7 qualitative designs 2 quantitative (descriptive and exploratory), 3 quasi-experimental studies, 2 mixed methods.	1552	Undergraduate nursing students (k = 7). Doctoral, graduate, and associate degree students were represented by one study each. Four studies did not specifically designate the type of nursing students.	6
15	Xu et al. (2019)	CN/ CN (k = 22)	2015–2018	22 RCTs.	4295	High school, postsecondary, as well as college-level students. The studies comprised courses in emergency nursing, internal medicine, community nursing, obstetrics and gynecology, pediatric, surgical, nursing fundamentals, and skills training.	16

n° SR	l	Meta-analysis[1]	Intervention	Control	Assessment tool	Results[2]					
						Performance	Satisfaction	Competencies			Others
								Instrumental[3]	Interpersonal[4]	Systemic[5]	
1	5	0	FC with pre-class and in-class activities	Traditional education.	Tests and satisfaction surveys.	2 (+) 1 (−)	2 (+)				
2	46	1	Different active learning modalities.	Traditional teaching or other non-active learning.	Exam scores, course grades, and OSCE.	44 (+) 2 (−)					
3	33	0	Pre-class, in-class and post-class FC.	None.	Tests, learning sheets, mix of strategies or not measured (k = 19).						
4	24	0	Active or blended pre-class and in-class learning.	Various traditional learning modalities.	Scoring of different types of exams and tests, does not specify scales.	17 (+) 8 (−)					
5	11	1	FC with pre-class and in-class activities.	Traditional face-to-face conference.	GRADE system in terms of theoretical knowledge and skills scores.	8 (+) 1 (−)		4(+) 1(−)			
6	32	1	FC.	Lecture-based learning.	Measurement of theoretical and skill scores, does not specify scales.	26 (+)		22 (+) 1 (−)			
7	12	1	Pre-class, in-class and post-class FC.	Traditional teaching (k = 11) and web search teaching (k = 1).	Self-Regulated Learning Scale (SRL), Autonomous Learning Competencies Scale (ALC), Self-Directed Learning Readiness Scale (SDLRS), Self-Directed Learning Readiness Scale for Nursing Education (SDLRSNE), Student Autonomous Learning Competencies in Nursing (CALNS), and others.			5 (+)		10 (+) 2 (−)	

(*continued on next page*)

Table 1 (*continued*)

n° SR	l	Meta-analysis[1]	Intervention	Control	Assessment tool	Results[2]					
						Performance	Satisfaction	Competencies			Others
								Instrumental[3]	Interpersonal[4]	Systemic[5]	
8	13	0	FC with pre-class and in-class activities.	Control group with traditional method (k = 4).	Whittemore and Knafl integrative review method.	3 (+) 2 (−)					
9	5	0	FC with pre-class and in-class activities.	Traditional classroom (k = 1).	5-point Likert-type survey, anonymous pre- and post-test satisfaction questionnaires, and exam scoring.	3 (+)	4 (+)				Teacher satisfaction 2 (+)
10	10	0	Innovative active learning methods (FC, collaborative classroom simulation, self-directed learning).	Traditional classroom.	Not mentioned.	2 (−)	1 (−)				
11	11	0	FC with pre-class and in-class activities.	Traditional learning (k = 3).	Student comments, Likert-type satisfaction surveys, final standardized examination (HESI), tests, questionnaires, overall grades, and pre- and post-intervention tests.	2 (+)	1 (+)				Flexibility 1 (+) Complexity level1(+)
12	7	0	FC.	Traditional classroom (k = 3).	Participants' perceptions and comments and test scores.						
13	29	1	FC.	Lecture-based learning.	Theoretical, skill, self-learning, satisfaction, study attitude, teacher evaluation, critical thinking and problem solving tests and questionnaires.	13 (+)	3 (+)	13 (+)	2 (+)	2 (+)	
14	14	0	FC with pre-class and in-class activities.	Traditional learning (k = 2).	Surveys, unit tests, final exams and/or online test scores, or none.	4 (+) 1 (−)					
15	22	1	FC, problem-based learning, case-based learning, and open online courses.	Traditional classroom.	Scoring of skills and student comments.			10 (+)	18 (+)	6 (+)	Enjoyment 6 (+), Effects of curriculum 8 (+), Interest 15 (+)

RCT = Randomized controlled trial; k = primary study.
US = United States; UK = United Kingdom; CA = Canada; AU = Australia; TH = Thailand; TW = Taiwan; KR = South Korea; EG = Egypt; DK = Denmark; CN = China; OM = Oman; NZ = New Zealand; IN = India; IR = Iran; PH = Philippines.
SR: Systematic review; k: primary studies; FC: flipped classroom; OSCE: Objective structured clinical exam; GRADE: Grading the Quality of Evidence and the Assessment of Recommendation; l: Number of primary studies included in the systematic review.
[1] 0: The systematic review does not provide meta-analysis; 1: The systematic review does provide meta-analyses.
[2] (+): Primary studies that obtained significant results; (−): Primary studies that did not obtain significant results.
[3] Instrumental: capacity for analysis and synthesis, organization and planning, information management skills, problem solving and decision making.
[4] Interpersonal: critical and self-critical capacity, teamwork and interpersonal skills.
[5] Systemic: ability to apply knowledge in practice, ability to adapt to new situations, leadership, ability to work autonomously, project design and management.

3.2. What were the most common features of the flipped classroom programs?

All reviews reflected a wide range of flipped classroom implementation strategies or activities that were distributed in three stages. The most common activities within each of the stages are shown in Table 3.

Seven reviews included flipped classroom activities prior to class, and during class time (Hu et al., 2018; Njie-Carr et al., 2017; Evans et al., 2019; Oliver and Luther, 2020; Betihavas et al., 2016; Ward et al., 2018; Presti, 2016), in addition, two reviews included post-class activities (Liu et al., 2018; Chung and Lai, 2010), highlighting self-learning, learning journals, reflection and evaluation.

In the pre-class stage, individual instruction of students stands out (Liu et al., 2018), through previously assigned reviews of articles and textbooks or electronic books, (Hu et al., 2018; Njie-Carr et al., 2017; Oliver and Luther, 2020; Betihavas et al., 2016; Presti, 2016; Chung and Lai, 2010). In addition, most instructors provided instructional videos as learning material before class (Evans et al., 2019; Oliver and Luther, 2020; Betihavas et al., 2016; Ward et al., 2018; Presti, 2016; Chung and Lai, 2010).

The most frequently adopted learning strategy in the class was group activities, which included assignments, presentations, projects, or discussion of topics (Hu et al., 2018; Evans et al., 2019; Oliver and Luther, 2020; Betihavas et al., 2016; Ward et al., 2018; Presti, 2016;

Table 2
AMSTAR-M scale items assessing methodologic quality of the reviews, modified AMSTAR (n = 15)[a].

Question	Kappa coefficient	Unsatisfactory %	Not completely satisfactory %	Completely satisfactory %
A priori design				
1. Was an a priori design provided	1	0	NA	100
2. Were population variables defined and considered in the methods?	0.998	86.7	NA	13.3
Literature search and duplicate effort				
3. Was there duplicate study selection and data extraction?	0.999	33.3	NA	66.7
4. Was a comprehensive literature search performed?	0.449	20.0	46.7	33.3
5. Is it possible to replicate the search?	0.579	26.7	60.0	13.3
6. Did the inclusion criteria permit gray literature?	0.449	46.7	NA	53.3
7. Was a list of studies (included and excluded) provided?	1	13.3	86.7	NA
Coding of studies				
8. Were the characteristics of the included studies provided?	1	6.7	NA	93.3
9. Was the scientific quality of the included studies assessed and documented?	0.999	26.7	20.0	53.3
Analysis and interpretation				
10. Did results depend on study quality, either overall or in interaction with moderators?	1	100.0	NA	NA
11. Were the methods used to combine the findings of studies appropriate?	1	60.0	40.0	NA
12. Was the effect size index chosen justified statistically?	1	53.3	20.0	26.7
13. Was the likelihood of publication bias assessed?	0.999	66.7	NA	33.3
14. Was the conflict of interest included?	0.999	0	NA	100

[a] Kappa Coefficient between 2 coder responses. Satisfactory percentages are based out of the totel meta-analyses and systematic reviews for wich the dimension was judged applicable, depending on the type of review. AMSTAR, Assesment of Multiple Systematic Reviews; NA, not applicable.

Chung and Lai, 2010), followed by case studies (Njie-Carr et al., 2017; Evans et al., 2019; Oliver and Luther, 2020; Betihavas et al., 2016; Ward et al., 2018; Presti, 2016) and problem solving (Hu et al., 2018; Evans et al., 2019; Oliver and Luther, 2020; Betihavas et al., 2016; Chung and Lai, 2010). Regarding the technologies adopted in class, the use of cell phones, and/or tablets was highlighted as a means to carry out learning (Chung and Lai, 2010).

Table 3
Flipped classroom activities used in the selected reviews.

Pre-class activities	Study.
	Review of articles and textbooks or electronic books.
	Pre-recorded online lectures.
	Online surveys.
	Voice-over Power Point.
	Instructional didactic videos and animations.
	Interactive e-learning modules, through a web platform.
	Directed reading.
	Interactive skills lab with simulation.
	Discussion forums.
	Pre-recorded mini-videos.
	Worksheets and podcasts.
	YouTube patient case study.
Classroom activities	Face-to-face teaching.
	Critical discussions.
	Case studies.
	Role playing.
	Problem solving.
	Classroom simulation.
	Feedback on skill development.
	Small group activities, such as papers, projects or discussion of topics.
	Individual projects.
	Web searches.
	Timed response videos.
	Question and answer sessions.
	Concept mapping.
	Peer instruction.
	Medication management.
Post-class activities	Learning diaries.
	Self-learning.
	Reflection.
	Evaluations.
	Discussions.

In the subsequent stage, post-class, two systematic reviews emphasize course evaluation and self-learning (Liu et al., 2018; Chung and Lai, 2010). However, most reviews did not provide strategies after class, and no commonly used activities were found at this stage. Only one review used discussion forums (Evans et al., 2019) to provide instant feedback to their students during home assignments.

The objective of 93.3% (n = 14) of the reviews was to compare the flipped classroom methodology with the traditional classroom or similar, through a control group. However, a careful review of the primary studies included in each review showed that not all of them included a control group. To assess the efficacy of the intervention, various instruments were used, including different types of tests, examinations, and questionnaires. In addition, one review provided data on the most common activities to implement flipped classroom (Chung and Lai, 2010).

Some reviews compared different active learning modalities (Chen et al., 2018; Xu et al., 2019), included innovative pedagogies (Pangandaman et al., 2019), or compared flipped classroom with traditional methodology without determining what type of pre-, inter- and post-class activities were used (Tan et al., 2017; Li et al., 2020a; Ramasubramaniam et al., 2017).

3.3. What variables were associated with improved educational outcomes?

The outcomes most frequently recorded in the selected reviews were academic performance, competencies, and satisfaction. Regarding academic performance, 122 primary studies included in the selected reviews showed better results with the use of flipped classroom compared to the traditional method, and in 17 studies, worse results were obtained (Hu et al., 2018; Njie-Carr et al., 2017; Evans et al., 2019; Oliver and Luther, 2020; Betihavas et al., 2016; Ward et al., 2018; Presti, 2016; Xu et al., 2019; Tan et al., 2017; Li et al., 2020a). When implementing flipped classroom, 95 studies demonstrated improvements in performance, through test scores (Njie-Carr et al., 2017; Evans et al., 2019; Chen et al., 2018) and final course grades (Chen et al., 2018), or theoretical knowledge and skills scores (Hu et al., 2018; Tan et al., 2017; Li et al., 2020a). However, this trend did not hold across all primary studies in the included reviews (Njie-Carr et al., 2017; Betihavas et al., 2016), nor across all health science disciplines, including nursing (Chen et al., 2018).

An improvement in Competencies through the flipped classroom was reported in 92 primary studies. The literature reviewed (k = 15)

demonstrated significant post-intervention improvement in undergraduate students' self-learning ability (Tan et al., 2017), and increased confidence levels (n = 1) in their clinical competencies during a medical-surgical nursing course (Ramasubramaniam et al., 2017). Through the use of various tools to measure self-directed learning ability, a review reported that flipped classroom could improve nursing students' self-directed learning ability and capacity (Tan et al., 2017), including motivation, and self-management and information literacy skills (Liu et al., 2018). For example, based on a student survey, a previous study reflected students' perceptions of greater flexibility to control the pace of the course in mental health-psychiatry, pediatrics, pharmacology, medical-surgical nursing, public and community health, algebra fundamentals and statistics through flipped classroom (Presti, 2016), and two other studies reflect statistically significant improvements in students' critical thinking compared with traditional instruction (Tan et al., 2017). However, certain problem-solving and decision-making skills of students did not show significant results (Tan et al., 2017).

Three reviews included self-regulated learning capacity as a variable to evaluate the effectiveness of flipped classroom (Liu et al., 2018; Tan et al., 2017; Li et al., 2020a), demonstrating a better self-learning capacity through pre-class inverted learning methods.

One of the selected reviews (Liu et al., 2018) indicated that the blended learning approach might be better suited to nursing students and senior professional nursing students, depending on their level of motivation and readiness to engage in self-directed learning.

Regarding satisfaction, 10 primary studies reported undergraduate, graduate, and postgraduate nursing students' satisfaction with the implementation of the flipped classroom approach (Oliver and Luther, 2020; Betihavas et al., 2016; Presti, 2016; Tan et al., 2017). However, it is unknown whether this translated into better scores on final exams, as other students less satisfied (n = 1) with the flipped classroom performed better academically (Betihavas et al., 2016), and expressed difficulty keeping up with pre-class work, even though the homework did not differ from previous course assignments in the traditional format (Oliver and Luther, 2020). According to one review, student satisfaction may be inversely related to higher performance and thus, some students do not approve of the new method (Presti, 2016).

A study that used student comments among the outcome measures indicated that flipped classroom improved cooperative spirit and sense of teamwork, practical ability, enjoyment of the course and interest in the same, expression and communication, ability to think and analyze problems, and resolution and resilience (Xu et al., 2019).

In terms of teacher satisfaction, in two studies conducted with undergraduate and postgraduate nursing students, faculty expressed satisfaction with the flipped classroom approach compared to the traditional model (Ramasubramaniam et al., 2017), and an increase in class attendance was reported as a result of employing flipped classroom in class (Oliver and Luther, 2020). Moreover, two other studies among nursing students in courses in undergraduate psychiatric-mental health, medical-surgical nursing theory, and graduate pediatric course reported the need for more time and technological support for teachers to engage with course content, as some students were not adequately prepared before class, leading to student frustration and dissatisfaction (Njie-Carr et al., 2017). In addition, in one review, most nursing students, postgraduate students, and faculty were found to prefer the traditional passive learning method in the classroom compared to active learning, as a result of the considerable time commitment required by the student and faculty for flipped classroom preparation (Ward et al., 2018).

4. Discussion

The results obtained in this systematic review of systematic and integrative reviews enables us to affirm that the flipped classroom applied to nursing studies proves to be effective in nursing education, especially with regard to academic performance, measured through exam scores and final grades of the courses, highlighting a general positive opinion of most the students regarding this methodology, citing aspects such as its usefulness, flexibility, the greater autonomy it provides or the greater student involvement.

According to the cognitive foundation related to the learning cycles of Bloom's taxonomy, with the flipped classroom methodology the student works at home on the first two phases of the learning process, which are the simplest, whereas class time is used to increase and enable the more complicated phases through active learning with the help of the teacher and classmates (Parra, 2017).

In addition, the flipped classroom method demonstrates certain advantages over traditional learning. Flipped classroom is student-centered while making students responsible for their own learning (Shiau et al., 2018), taking into account their individual differences. Thus, through pre-class activities, students can learn at their own pace, which is perfect for more flexible learning (Elian and Hamaidi, 2018; Ponikwer and Patel, 2018). Likewise, through this method, students interact independently with the learning materials, and increase interaction among classmates, and between students and teachers (Limniou et al., 2018). Similarly, through the use of e-learning applications, students can devote more time to extracurricular learning to acquire further knowledge, which is not available in traditional teaching (Zheng et al., 2018).

Research suggests that the flipped classroom method can be included in nursing curricula, as it has been shown to be beneficial for teaching both theory and clinical courses. In addition, this method will also be useful for students to review their lessons prior to exams, which would increase knowledge retention and the ability retain knowledge for longer periods of time (Chen et al., 2017). Saunders et al. (2017) argue that flipped classroom can become clinical learning, the setting of which deepens nursing students' understanding of professional roles. Presti (2016) believes that educators can guide students in the application of concepts and creative participation, fostering decision-making and problem-solving skills in complicated scenarios.

Jensen et al. (2015) point out that in-class activities are the main contributions of the flipped model, and may be the most influential elements for positive learning outcomes. In the same vein, Kay and MacDonald (2016) argue that instead of devoting considerable time and resources to developing online videos and other out-of-class materials, the flipped model may be better off focusing on carefully selecting in-class instructional methods and designing better active learning strategies to use within traditional instruction. Likewise, Njie-Carr et al. (2017) point out that the design of pre-class education should cover the key points related to the content of the class, simplifying it and not going into too much detail. Moreover, Sharma et al. (2015) and Li et al. (2020b) consider that the method must involve the student through an orientation on the inverted model to improve their experience and satisfaction. In addition, according to Akçayır and Akçayır (2018), if students do not take the time to study at home, they may not perform well in classroom activities, and this may decrease the advantages of the flipped approach. To avoid this situation, students need clear guidelines regarding how they should use their pre-class time and course materials.

Most systematic reviews did not provide strategies after class, and no commonly used activities are found at this stage. Li et al. (2020b) found similar findings, explaining that few activities helped to address students' inability to ask questions while working outside of class. McDonald et al. (2018), Li et al. (2020b) and Persky and McLaughlin (2017) advocate that one of the most important reasons for incorporating after-class activities is to provide students with the opportunity to clarify doubts or frustrations related to class content through immediate feedback. Therefore, it is recommended to include post-class activities to apply the inverted methodology. In this sense, Fautch (2015) proposes using e-mail or creating online forums to resolve students' doubts after class.

As reflected by Chen et al. (2017) and Hew and Lo (2018), a large proportion of students and faculty were satisfied with the flipped

classroom approach. However, also in some of the reviews sectioned, students and faculty were in favor of the traditional approach. Especially because flipped classroom forced the need for significant time investment to prepare materials by faculty, overloading students due to excessive pre-class work, or the need for more technological support. It follows, therefore, that the design and educational context of flipped classroom must be carefully planned. Njie-Carr et al. (2017) and Betihavas et al. (2016) report factors related to faculty dissatisfaction, and these include the need for more technological support for faculty, and adequate and quality internet access for both instructors and students. Thus, Rasheed et al. (2020) indicate that educational institutions should periodically assess the level of technological competence of students and faculty as a prerequisite for implementing successful flipped learning.

If teachers invest more effort in implementing the flipped learning model and manage to increase their students' motivation to engage in pre-study and homework in class time, their learning, test scores and academic performance will improve significantly, as noted by Prieto Martín et al. (2020).

4.1. Limitations

Several limitations of this study are worth mentioning. The heterogeneity of the reviews selected, their medium-low methodological quality and the lack of standardized criteria for evaluating the efficacy of the interventions, has made comparisons and synthesis of the results difficult, as well as the fact that most of the primary studies were carried out in China. Therefore, caution is advised when interpreting and extrapolating the results. Articles published in languages other than Spanish or English, and the scarcity of statistical data or information provided by some of the reviews selected are other limitations that could also imply that some research results could have been ignored, therefore it is advisable to incorporate new studies to reach a more precise conclusion.

5. Conclusion

Technological advances in recent years have enabled the development of new pedagogies, including flipped classroom, which has gained popularity and has proven to be effective in the learning of college-level nursing students. However, more research is needed on this educational approach to be considered a preferred approach. To substantiate the flipped approach, the evidence must be supported by more rigorous methods that confirm the findings of this systematic review of systematic and integrative reviews, and support its implementation in higher education, and in different educational contexts.

The potential for implementation of flipped classroom is considerable, although validated method evaluation tools are needed, as well as further educational platforms, technologies, learning strategies, and proven practices, to guide educators who intend to change the traditional method to flipped classroom, and provide a reference for flipped classroom researchers in the future.

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Declaration of competing interest

The authors have no conflicts of interest to disclose.

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Appendix A

Annex 1
Search strategy.

Database: N°. of results	Terms used (free text)	Search field Limits used
Medline: 101	#1 flipp* [All Fields] #2 inverted [All Fields] #3 #1 OR #2 #4 classroom [All Fields] #5 #3 AND #4 #6 nurs* [All Fields] #7 nursing [MeSH] #8 #6 OR #7 #9 #5 AND #8	Search field: All Fields Mesh Search limits: English
Cochrane Library: 12	#1 flipp* (Word variations have been searched) #2 inverted (Word variations have been searched) #3 #1 OR #2 #4 classroom (Word variations have been searched) #5 #3 AND #4 #6 MeSH descriptor: [Nursing] explode all trees #7 nurs* (Word variations have been searched) #8 #6 OR #7 #9 #5 AND #8	Search field: All Fields Mesh
CINAHL: 108	#1 (MH "education, nursing +") #2 nurs* #3 #1 OR #2 #4 flipp* #5 inverted #6 #4 OR #5 #7 classroom #8 #6 AND #7 #9 #3 AND #8	Search field: *All Fields* Mesh Search limits: English
WoS (all databases): 169	#1 TOPIC: (flipp*) #2 TOPIC: (inverted) #3 #1 OR #2 #4 TOPIC: (classroom) #5 #4 OR #3 #6 TOPIC: (nurs*) #7 TOPIC: (nursing*) #8 #6 AND #7 #9 #5 AND #8	Search field: Topic Search limits: English
Scopus: 277	#1 TITLE-ABS-KEY (nurs*) #2 TITLE-ABS-KEY (nursin*) #3 (nursing AND education) #4 #1 OR #2 OR #3 #5 TITLE-ABS-KEY (flipped AND classrooms) #6 TITLE-ABS-KEY (inverted) #7 TITLE-ABS-KEY (flipp*) #8 #5 OR #6 OR #7 #9 #4 AND #8	Search field: Article title, Abstract, Keywords Search limits: English

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