Universidad y Salud
ISSN: 0124-7107
ISSNe: 2389-7066

SECTION: DEVELOPMENT OF HUMAN RESOURCES FOR HEALTH
Review Article
DOI: https://doi.org/10.22267/rus.242601.310

Effectiveness of the Flipped Classroom in Health Sciences University Programs: A Literature Review

Efectividad del Aula Invertida en carreras universitarias de Ciencias de la Salud: Revisión de literatura

Efetividade da sala de aula invertida nas carreiras universitárias de ciências da saúde: revisão de literatura

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Received: Sep 23 - 2022 Revised: Nov 01 - 2022 Accepted: Aug 15 - 2023 Published: Sep 20 - 2023

Citation: *Nocetti-García D, Auad-Brito M, Henriquez-Villarroel D. Effectiveness of the Flipped Classroom in Health Sciences University Programs: A Literature Review. Univ. Salud. 2023;25(3):C8-C17. DOI: 10.22267/rus.242601.310*

Abstract

Introduction: Higher education institutions have implemented active learning approaches, such as the Flipped Classroom, to promote the education of their students. Nevertheless, there is conflicting evidence regarding the benefits derived from its implementation. **Objective:** To determine the effectiveness of the Flipped Classroom application in the education of university students from Health Sciences undergraduate programs. **Materials and methods:** A systematized narrative review of the literature published between 2012 and 2022. *Pubmed*, *SciELo*, *Scopus* y *Web of Science* were used as sources of primary articles. A revised version of the Kirkpatrick model was used to assess the effectiveness of the Flipped Classroom. **Results:** 34 out of the 1020 retrieved articles reached the quantitative synthesis phase. Students value positively this didactic model and acknowledge its contributions in the development of attitudes, knowledge and skills. In contrast, some studies show an increase in the workload and stress levels of students. **Conclusions:** The evidence suggests that Flipped Classroom is a valid didactic model for the education of Health Sciences students. Future studies should consider the effectiveness of its implementation at a long term organizational level.

Keywords: Teaching; health sciences; higher education; active learning. (Source: DeCS, Bireme).

Resumen

Introducción: Las instituciones de educación superior han implementado enfoques activos de aprendizaje como el Aula Invertida para favorecer la formación de sus estudiantes. Sin embargo, existe evidencia diversa respecto de los beneficios derivados de su implementación. **Objetivo:** Determinar la efectividad de la aplicación del Aula Invertida en la formación de estudiantes universitarios de carreras de pregrado de las Ciencias de la Salud. **Materiales y métodos:** Se realizó una revisión narrativa sistematizada de la literatura publicada entre 2012 y 2022, utilizando *Pubmed*, *SciELo*, *Scopus* y *Web of Science* como fuentes de artículos primarios. Se utilizó la versión revisada del modelo de *Kirkpatrick* para valorar la efectividad del Aula Invertida. **Resultados:** Se obtuvieron 1020 artículos, 34 de ellos ingresaron a la fase de síntesis cuantitativa. Los estudiantes valoran positivamente este modelo didáctico y reconocen su aporte en el desarrollo de actitudes, conocimientos y habilidades. Algunos estudios mencionan un aumento de la carga de trabajo y niveles de estrés en los estudiantes. **Conclusiones:** La evidencia sugiere que Aula Invertida es un modelo didáctico válido para la formación de estudiantes de las Ciencias de la Salud. Futuros estudios deberían considerar la efectividad de su implementación a nivel organizacional y a largo plazo.

Palabras clave: Enseñanza; ciencias de la salud; educación superior; aprendizaje activo. (Fuente: DeCS, Bireme).

Resumo

Introdução: As instituições de ensino superior têm implementado abordagens de aprendizagem ativa como a Sala de Aula Invertida para promover a formação dos seus alunos. No entanto, existem evidências contraditórias sobre os benefícios derivados da sua implementação. **Objetivo:** Determinar a efetividade da aplicação da sala de aula invertida na formação de estudantes universitários dos cursos de graduação em Ciências da Saúde. **Materiais e métodos:** Foi realizada uma revisão narrativa sistematizada da literatura publicada entre 2012 e 2022, utilizando *Pubmed*, *SciELo*, *Scopus* e *Web of Science* como fontes de artigos primários. A versão revisada do modelo Kirkpatrick foi utilizada para avaliar a eficácia da sala de aula invertida. **Resultados:** foram obtidos 1.020 artigos, dos quais 34 entraram na fase de síntese quantitativa. Os alunos valorizam positivamente este modelo didático e reconhecem o seu contributo no desenvolvimento de atitudes, conhecimentos e competências. Alguns estudos mencionam aumento na carga horária e nos níveis de estresse dos estudantes. **Conclusões:** As evidências sugerem que a sala de aula invertida é um modelo didático válido para a formação de estudantes em Ciências da Saúde. Estudos futuros deverão considerar a eficácia da sua implementação a nível organizacional e a longo prazo.

Palavras chave: Ensino; ciências da saúde; ensino superior; aprendizado ativo. (Fonte: DeCS, Bireme).

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Introduction

Modern societies have increasingly structured themselves as knowledge and information societies[1]. The quality of higher education systems is conceived as one of the purposes of any institution that adopts a global management approach and pursues the achievement of goals, objectives, criteria, and standards to succeed[2]. In this sense, a high quality education drives the development and the reorganization of societies, which makes possible the progress of nations, based on a global economy and culture. Thus, education becomes the central axis of functioning in the developed countries[3] and, possibly, in those who aspire to be.

In this context, and considering the social changes that have modified the dynamics of populations in recent years, access to higher education has become an egalitarian process, which has led to a more diverse student population[4]. Current students have academic skills that are different from those of their professors, which is added to the fact that they have to face new educational demands[5]. This scenario has redirected the effort of the teaching endeavor from the paradigm focused on the transmission of information towards the innovation of training processes through active learning[6].

An active learning approach is understood as any educational method that involves students in the teaching-learning process. Here, the professor designs activities taking into account the interests and skills of the students, in order to encourage them to participate continuously in this process[7]. Thus, the formative experiences of the students is enriched through the construction of their own knowledge, the guidance of their deep learning, and the development of critical and creative thinking[8,9]. Therefore, these active methodologies or approaches are part of a student-centered teaching model[10].

The term Flipped Classroom was used for the first time in 1997[11] and it was established by professors Jonathan Bergmann and Aaron Sams in 2012[12]. They described Flipped Classroom as a pedagogical approach where direct education shifts from a group learning scenario towards an individual one, which is followed by group interactions guided by the professor, that are characterized by dynamism and active communication. This environment allows the students to apply their knowledge and engage creatively with the contents of the subjects[13].

Even though other authors conceive the Flipped Classroom as a didactic model[14], it is accepted that both lines of thought merge in four central aspects: (1) flexible environments that promote learning spaces tailored to the time availability of each student; (2) learning culture, which fosters more active, deep, and enriching student-centered formation settings; (3) purposeful selection of contents by professors, which are ordered and structured with the aim of promoting students' conceptual understanding and maximizing the time management in the classroom; and (4) professional professors, who both facilitate the training process by providing continuous feedback and improving continuously through reflective practice[13].

In general, the success of a didactic method, approach or model depends on its ability to improve student learning[4]. However, this learning process can be assessed differently. For instance, Kirkpatrick proposed a model that allows for the assessment of the effectiveness of the Flipped Classroom implementation through four levels: (1) Reaction, which corresponds to the evaluation of the individual's response to the learning experience; (2) Learning, which implies an assessment of the extent to which knowledge or intellectual capacity increases from the formative experience; (3) Behavior, which corresponds to the extent to which students applied what they had learned and, as a consequence, this changed their behavior; and (4) Evidence, which accounts for the effect on context or environment resulting from the improvement in student performance[16].

Several studies have compared the effectiveness of the traditional methodology to that of the Flipped Classroom. The results suggest that the Flipped Classroom improves students' interactions, develops both competencies and self-regulation of the learning process, and has a positive effect on academic performance[17,18].

Certainly, these benefits represent an important contribution to the education of students, which is relevant in all disciplines. This is relevant especially in Health Sciences, where the Flipped Classroom implementation fosters a favorable environment to solve those problems that students will face in their professional practice[19]. Since there is also conflicting evidence regarding the benefits of Flipped Classroom[7], it is important to know the most recent data on this subject. Finally, it is also relevant to highlight the significant increase in publications on Flipped Classroom from the beginning of the COVID-19 pandemic[11].

Therefore, the objective of this article is to determine the effectiveness of the Flipped Classroom application in the training of university students of Health Sciences undergraduate programs. The results obtained may provide professors with evidence regarding the advantages and limitations associated with this didactic model, as well as with valuable information to guide its implementation.

Materials and methods

A systematic narrative review was carried out. Articles were retrieved from June to July 2022 from four main information sources: *Pubmed*, *SciELo*, *Scopus*, and *Web of Science*. The descriptors used for the search were: Flipped Classroom, Health Sciences, and effectiveness. The filters applied to the search were: primary articles, English and Spanish language, publication date between 2012 and 2022. This last criterion was established based on the growing number of articles about Flipped Classroom published since 2012[20], which shows a significant increase as a result of the COVID-19 pandemic[11].

The inclusion criteria applied to the selection of articles were: (i) studies that evaluated the effectiveness of the Flipped Classroom; (ii) undergraduate university programs; (iii) research conducted on Health Sciences programs. Articles about subjects not relevant to the main topic, studies with multiple and simultaneous interventions, and/or incomplete documents were excluded. The article selection process followed four stages, based on the recommendations of the PRISMA initiative[21], which are described in Figure 1.

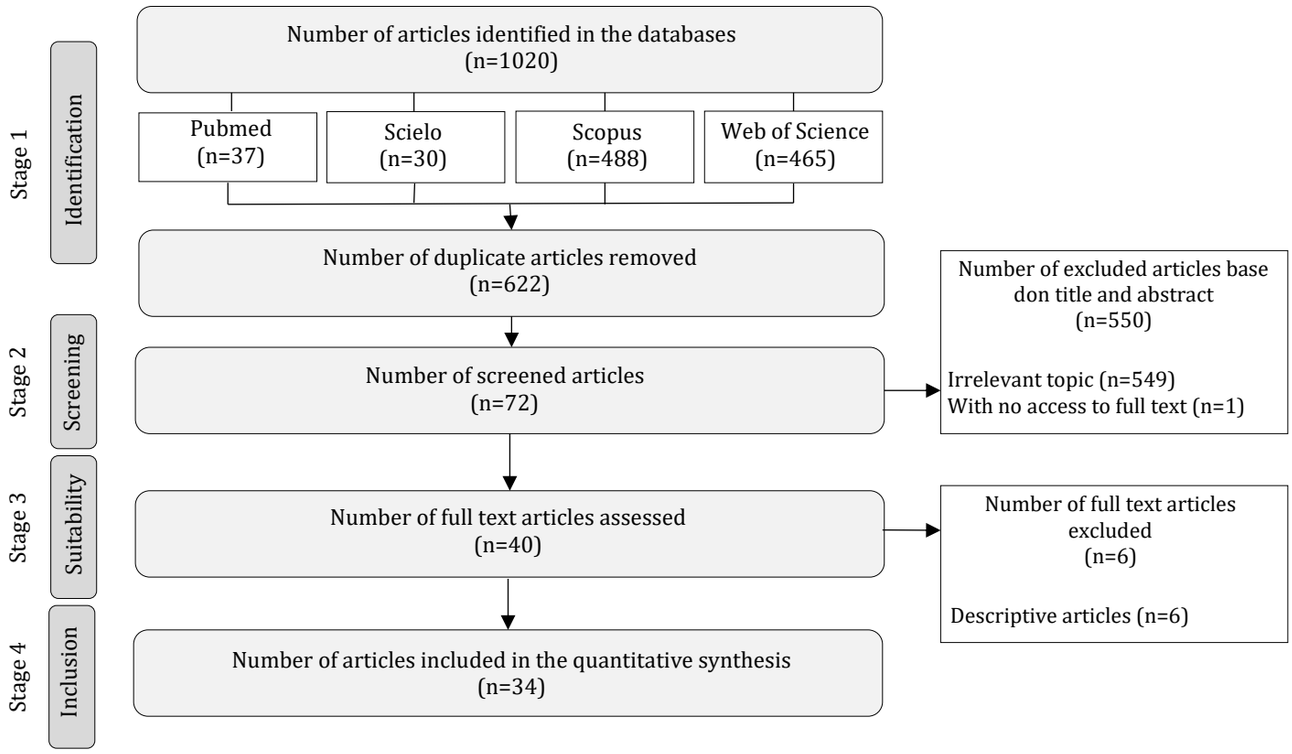

Figure 1. PRISMA[21] flowchart for the article selection process

After removing duplicate records, the authors reviewed individually the titles and abstracts and discussed the conclusions. In case of agreement, the article went to the next stage, otherwise and prior to its selection, the relevance of the study was discussed. Once the authors agreed on the articles to be included, the full text was read independently and the information obtained from the selected articles was organized according to the publication date, country, university major/degree, education level of participants, sampling type, sample size, and assessment level of the effectiveness of the Flipped Classroom implementation. These assessment levels were based on the modified Kirkpatrick[15] model, as follows: (1) Student perception; (2a) Attitude change; (2b) Knowledge and skills changes; (3) Behavior changes; (4a) Organizational practice changes; and (4b) Patient outcome changes. The authors compared their decisions regarding the included articles, and discrepancies were resolved through discussion. At the end of the process, the sample comprised 34 articles, which were included in the final analysis.

Since this work is based on a literature review, approval by an ethics committee is not required.

Results

General characteristics of the analyzed articles

As shown in Table 1, most of the articles were published in 2020 (29.4% and 2021 (23.5%), followed by 2018 (12.5%), 2019 (8.8%), 2016 (8.8%) and 2017 (5.9%). There were no papers published in the years 2012, 2014 and 2015. In geographical terms, most of the papers were published in the United States of America (n=8), Spain (n=3), Colombia (n=3), Chile (n=3), and Iran (n=3).

In terms of the Health Sciences training areas associated with the studies (Table 1), Medicine (50.0%) and Nursing (32.4%) were the most frequent. Most evidence was associated with the subjects of Anatomy (n=3), Physiopathology (n=3), Community Nursing (n=2), Adult Nursing (n=2), Radiology Practice (n=2), Histology (n=2), and Pharmacology (n=2).

The majority of participating students were in their third year of the training cycle (73.5%). Six articles did not provide information regarding this issue (Table 1).

Table 1. Main characteristics of the articles included in the quantitative synthesis

Publication year	Author	Country	Major/Specialization	Subject	Education level/semester	Sampling method	Sample size	Modified Kirkpatrick level[15]
2018	Domínguez, Sanabria[22].	Colombia	Medicine	Surgery	NS	Convenience	444	1a
2018	Fleagle TR, *et al*[23].	EEUU	Dentistry	Anatomy	First	Convenience	483	1a, 2b
2020	Busebaia TJ, John B[24].	Kingdom of Bahrein	Nursing	Pediatric nursing	Fourth	Convenience	26	1a, 2a, 2b
2022	Behmanesh F, *et al*[25].	Iran	Obstetrics	Principles and techniques in obstetrics	First	Convenience	34	1a, 2a, 2b
2021	Hernández-Guerra M, *et al*[26].	Spain	Medicine	Digestive tract diseases	Fourth	Convenience	404	1a, 2b
2016	Ferrer-Torregrosa J, *et al*[27].	Spain	Medicine	Anatomy	First	Single random	171	1a, 2b
2020	Shabani A, *et al*[28].	Iran	Medicine	Emergency medicine	NS	Single random	59	1a, 2b
2021	Wright M, *et al*[29].	EEUU	Medicine	Asthma	NS	Convenience	146	2b
2019	Graham KL, *et al*[30].	EEUU	Nursing	Internal medicine residency	NS	Convenience	63	1a, 2b
2022	Qutob H[31].	Saudi Arabia	Clinical lab technician	Hematology	Third	Convenience	54	1a, 2b
2020	Sánchez JC, *et al*[32].	Colombia	Medicine	Clinical physiology	Second	Convenience	75	1a, 2b
2017	Domínguez LC, *et al*[33].	Colombia	Medicine	Management of traumatized patient	Fourth	Convenience	75	1a, 2b
2019	Angadi N, *et al*[34].	India	Medicine	Pharmacology	Second	Single random	98	1a, 2b
2021	Aristotle S, *et al*[35].	India	Medicine	Histology	First	Convenience	150	1a, 2b
2021	Kim Y, *et al*[36].	South Korea	Nursing	Community health nursing I	Third	Single random	62	2a
2021	Joseph MA, *et al*[37].	Brazil	Nursing	Clinical examination	First	Convenience	112	1a, 2a, 2b
2020	Herrero JI, *et al*[38].	Spain	Medicine	Physiopathology	Third	Convenience	430	1a, 2b
2020	Vajravelu BN, *et al*[39].	EEUU	medical assistant	Genetics physiopathology	NS	Convenience	203	1a, 2b

				clinical medicine physical examination				
2022	Holm P, *et al*[40].	Iran	Nursing	adult and elderly nursing II	Second	Convenience	34	2a
2016	O'Connor EE, *et al*[41].	EEUU	Medicine	Radiology practice or elective in radiology	Third and fourth	Convenience	175	1a, 2b
2013	Missildine K, *et al*[42].	EEUU	Nursing	adult health	first and second	Convenience	589	1a, 2b
2020	Durfee SM, *et al*[43].	EEUU	Medicine	Práctica de radiología	NS	Convenience	111	1a, 2b
2021	Ñique C, Díaz-Manchay R.[44].	Peru	Nursing	Biochemistry	Second	Convenience	31	1a
2020	Reinoso-González, *et al*[45].	Chile	Kinesiology	Inclusive exercise and sports	Second	Convenience	73	1a
2019	Hechenleitner-Carvallo[46].	Chile	Nursing	Nursing process I	Second	Convenience	24	1a
2018	Park EO, Park JH[47].	South Korea	Nursing	adult nursing	First	Convenience	81	2b
2020	Zheng B, Zhang Y[48].	EEUU	Medicine	Anatomy	First and second	Convenience	146	1a, 2b
2016	Hanson J[49].	Australia	Nursing	Pharmacology	Second	Convenience	51	1a
2017	Cheng X, *et al*[50].	China	Medicine	Histology	First	Convenience	111	1a, 2b
2018	Chiu HY, *et al*[51].	Taiwan	Medicine	laparoscopic skills	Sixth	Single random	59	1a, 2b
2020	Wang X, Li J, Wang C[52].	China	Medicine	Medical statistics	Third	Convenience	88	1a, 2a, 2b
2021	Dong Y, *et al*[53].	China	Nursing	Community nursing	Third	Convenience	188	1a, 2b
2020	Burkhart SJ, *et al*[54].	Australia	nutrition	Basics in nutrition	Second	Convenience	144	1a, 2b
2021	Flores-Angulo C, *et al*[55].	Chile	Medicine	Morphofunctional pathology	Third	Convenience	39	1a

NS, not specified.

The sample size used in the studies varied from 24 to 589 participants. 17.7% of the papers had samples with less than 50 subjects, and the same percentage of studies had more than 200 participants (Table 1).

Methodological quality

There is a predominance of documents in which a sample selection was made for convenience (n=29). In contrast, 5 articles conducted a random assignment of the intervention, 4 of which were associated with Medicine and 1 to Nursing (Table 1).

Effectiveness assessment

As seen in Table 1 and based on the modified Kirkpatrick model, the effectiveness of the Flipped Classroom shows a predominance of studies that assessed both the perception of the intervention, in terms of satisfaction (88.2%), and the effect of the Flipped Classroom implementation on the knowledge and skills of the students (76.5%). 17.6% of the studies evaluated the effect of the Flipped Classroom on the attitude of students. There were no articles focused on determining changes in student behavior or changes in the organizational environment (levels 3, 4a and 4b).

Likewise, it is important to highlight that 29.4% of the studies assessed only one level of the Kirkpatrick model, whereas 58.8% of the articles assessed two (mostly 1a and 2b) and 11.8% of the articles assessed three (1, 2a and 2b) levels of the model (Table 1).

Students' perception of the Flipped Classroom (level 1a)

In 29.4% of the studies that assessed the effectiveness of the Flipped Classroom implementation in terms of student perception, did so only in the group exposed to this didactic model. In contrast, the remaining 70.6% of the studies carried out a comparative analysis in relation to a control group, which developed its training activities following a traditional approach. Surveys designed by each team were mostly used to collect information regarding student perception (83.3%)[23,25-28,30–35,37–39,41–43,46,48,49-51,53,55], followed by the use of previously published instruments, such as the *Dundee Ready Education Environment Measure* (DREEM)[22] and *Flipped Classroom Student Engagement Questionnaire* (FCSEQ)[54].

The most frequently reported perceptions associated with a favorable assessment of the Flipped Classroom showed that this approach stimulates critical thinking[39,49,53], increases the interaction between participants[24,25,34] as well as promotes student participation[24,26,37,50], the development of generic skills[46,55], and the acquisition of knowledge[25,30,38], which results in a better academic performance[26,32]. On the other hand, some authors mention that students think that: (i) Flipped Classroom preparation requires a high effort[31,38,46]; (ii) involves reviewing a large amount of information[24] , and (iii) students think that this didactical strategy increases their stress and anxiety levels[32,44].

Changes in students' attitudes (2a)

All the studies that assessed the effectiveness of the Flipped Classroom implementation, in terms of changes in attitude, compared their findings to the attitudes observed in students following a traditional teaching model. The assessment of the students' attitudes was carried out mainly through the use of either questionnaires designed by the researchers[25,36,37], an adapted version of the *Motivated Strategies for Learning Questionnaire* (MSLQ) instrument, the *Self-Directed Learning Readiness Scale for Nursing Education (SDLRSNE)*[40] or verification lists[24]. The authors highlight an increase in student commitment[24], responsibility[36,37], academic involvement[36], self-confidence[52], and motivation[40,52], as the most important attitude changes related to the use of the Flipped Classroom.

Changes in knowledge and skills of students (2b)

In terms of the effectiveness of the use of Flipped Classroom in the training activities of the students, the majority of articles assessed specifically the acquisition of knowledge (84.6%), followed by those focused on both knowledge and skills (11.5%). Finally, only 3.8% of the articles analyzed the development of skills.

In terms of the instruments applied to assess the acquisition of knowledge, a majority of studies used theoretical exams based on multiple-choice questions[26,31,32,35,38,53] and questionnaires[24,25,39]. Generally speaking, these studies show that the Flipped Classroom implementation improves significantly the academic performance in both theoretical and practical subjects[23,24,26,29,42,53]. Regarding the latter, one article showed different results between new students and those who were taking the subject for a second time, concluding that only the former showed a significant increase in knowledge[32].

Finally, the acquisition of skills was assessed through instruments such as the *Critical Thinking Disposition Scale*[47] and a checklist adapted from the *Objective Assessment of Technical Skills* (OSATS)[51]. The results obtained in these studies showed an improvement in the development of technical skills specific to the field, as well as in general skills, including critical thinking[47], intellectual integrity[47], creativity[47], and teamwork[54].

Discussion

The education in the Health Sciences has experienced enormous changes in the last few years, which have led to the implementation of diverse models focused on the student, such as the case of the Flipped Classroom[19,56]. In addition, the COVID-19 pandemic, which started in 2020, has been perceived by the educational community as a challenge for the current learning methodologies. However this pandemic could also be seen as a catalyst for the transformation of the teaching strategies used[57]. Both elements have led to a growing body of knowledge associated with the use of the Flipped Classroom, which was observed in this literature review study and is consistent with previous reports[11,15,20].

Regarding the effectiveness of the use of the Flipped Classroom, the revised Kirkpatrick model has been applied in other studies related to the Health Sciences[15]. The first level of this model assesses the students´ responses regarding their learning experiences[16], which reflects their perceptions of the

quality of the training processes[58]. The analyzed evidence showed that the students perceive the Flipped Classroom as a favorable strategy in the majority of the cases, because of the learning environment it generates[22], as well as the perception of the improvement of skills, competencies and attitudes[24-26,30,32,37-39,46,49,50,53,55].

The aforementioned is favorable because of model's elements such as prior preparation of the classes, which increase the student's motivation to participate actively in the synchronized activities[59]. The previous findings support some of the advantages of the use of didactic strategies, which permit students to establish and develop essential aspects for their performance in the clinical settings[60],which is fundamental in the Health Sciences careers.

In contrast, there are certain aspects that reduce the satisfaction perceived with the use of the Flipped Classroom. The first element that was identified through the analysis of the selected articles was the increase in students' workload[31,38,46], which is related to the content prior to the synchronized activity, such as the review of the instructional materials including scientific articles, videos, and presentations, which increase the time demands associated with class preparation.

It is fundamental to consider the characteristics of the students to plan and distribute appropriately the workload in the semester, having in mind the diversity of the learning styles and study habits[61]. Another aspect associated with the unfavorable perception of this method is the stress caused by its implementation[32,44], which in the literature has been associated with the lack of adequate preparation for its use[59]. In relation to this last point, it is important to consider that the professors who teach students in these careers are individuals who focus on field work, where practical skills have more value than pedagogical abilities[62]. Although teaching experience may not be required in hiring practices at higher learning institutions[63], pedagogical training should be provided in order to improve the education of students without generating excessive workload.

In terms of attitudes (level 2a of the Kirkpatrick model), the effectiveness of the Flipped Classroom is reflected in greater commitment, participation, confidence, and motivation in students[36,40,52]. This is promoted, at least in part, by the use of technological tools, which must be consistent with their goals[60]. Likewise, the students' empowerment is a central aspect of the Flipped Classroom since it allows them to take charge and be responsible for their learning[64], which is an element that have been reported by two of the studies included in the current literature review[36,37].

Regarding the assessment of the level 2b of the Kirkpatrick model, which refers to the cognitive changes and development of student abilities as indicators of the effectiveness of the Flipped Classroom, the results obtained indicate that this aspect is assessed most frequently in the analyzed studies. Probably this is due to the fact that part of the development of each course's evaluative instruments are traditionally used to determine the success of learning methods such that the grades constitute a common way to assess academic performance of the students[65].

Although the reviewed articles show a positive effect of the use of Flipped Classroom on the academic performance and this finding is partially consistent with what has been reported in the literature. For instance, some groups have reported conflicting evidence regarding this improvement[60], highlighting the importance of the contextual variables for the success of this didactic model, which involves social, economic, and academic aspects, among others.

In terms of the development of skills associated with Flipped Classroom, it is observed that the acquisition of both technical skills required in their respective disciplines[25,51] as well as other general ones such as critical thinking[47], whose importance in health related professions has been recognized in the literature[56,66].

The articles analyzed in this study (Table 1) show a predominance of studies being conducted in Medicine and Nursing careers. Although this reflects the importance of the use of Flipped Classroom in teaching-learning processes of the students from these fields, it also shows the need to extend the implementation of this didactic model to other areas of the Health Sciences.

The analysis of the methodological quality of the studies reveals the predominance of studies that used convenience sampling methods (Table 1), which does not ensure an accurate representation of the population. This concern is more evident when working with small samples, which makes it difficult to extrapolate the results to other settings[67].

Conclusions

Based on the results obtained in this literature review, it can be suggested that the Flipped Classroom is an effective didactic method for the undergraduate Health Sciences students to achieve attitudes, knowledge, and skills. Therefore and depending on the context, its implementation could be useful for students returning to face-to-face activities as well as for those completing courses taught in a virtual learning modality[57].

Some limitations of this study include a language bias, since only articles in English and Spanish were included. Secondly, it must be highlighted that the information analyzed is restricted to undergraduate Health Sciences programs, this way excluding the study of other training fields or Health Sciences graduate programs. Finally, with the goal of leading to a better generalization of the conclusions, it is necessary to either carry out studies or report results in other university programs within the same area.

Future studies should consider the effectiveness of this didactic strategy based on the more complex levels of the modified Kirkpatrick model, as well as an analysis of the effects of this methodology at an institutional level, or in the long term through repeated measurements of each cohort of students over time.

Acknowledgments: The authors thank the guidance provided by Dr. Natalia Herrera (Professor of the Department of Nursing - Health Sciences, University of Tarapaca) for the structuring and development of this work. Likewise, two authors (D.N. and M.A.) thank the Research Department of the University of Tarapaca for its support through Scientific and Technological Research Grant (UTA MAYOR, No. 7726-22).

Conflict of interests: None declared by the authors.

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