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The link between flipped and active learning: a scoping review

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ABSTRACT

Flipped learning in higher education is becoming increasingly widespread. Although the number of flipped learning articles has increased since 2011, systematic reviews of flipped learning have been criticized for lacking a theoretical framework. The aim in this article is to explore the link between flipped learning and active learning: specifically, which theoretical frameworks are described. A scoping review was adopted as the research methodology. The selected studies indicate that this link between flipped learning and active learning is rarely explicitly addressed or operationalized. Approximately 65% of the 435 full-text articles retrieved do not explicitly connect their research to theory or a conceptual framework. The remaining 155 studies included for analysis refer to a mix of pedagogical terms or approaches. The theoretical and conceptual underpinnings are generally only vaguely described, with a few exceptions. The results indicate an eclecticism and a reluctance to connect flipped learning with a specific conceptual framework.

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Introduction

Technology and digitalization have brought about tremendous changes in classroom practices, compelling the academic world to think beyond the traditional style of mono-directional teaching and learning as acquisition or even consumption and reproduction (Lundin et al. 2018; Sfard 1998). One of the latest indications of such change is the idea – and broader acceptance – of flipped learning (FL) (Cheng, Ritzhaupt, and Antonenko 2019; Muldrow 2013). FL in higher education is becoming increasingly widespread as a new and innovative learning approach stemming from the pedagogical concept of active learning (Yang, Lin, and Hwang 2019). Although some of the practices of FL, also called 'inverted learning' (Lage, Platt, and Treglia 2000), have been in use for decades, in recent years it has been widely adopted by educators at all levels of education and across many disciplines (Gayathri and Vijayarani 2017; Steen-Utheim and Foldnes 2018; Yang, Lin, and Hwang 2019).

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The increased traction and implementation of FL in higher education may be explained by focused efforts to help students reach higher cognitive levels in their learning processes; increase student engagement; create a paradigm shift from teacher-centred to student-centred learning; help students develop lifelong learning skills; and ensure the development of skills desired by employers (e.g. 'twenty-first-century skills', which include critical thinking, collaboration and self-direction) (Framework for twenty-first Century Learning 2010; Overmyer 2015). In addition, higher education institutions are now receiving a new generation of students, the millennials, who were born between 1982 and 2002. These students are used to 24/7 connectivity and access, and the ability to capture, process, send and receive information through multiple devices – anytime, anywhere (Alario-Hoyos et al. 2019; Howe and Strauss 2003).

While there has been a significant increase in the literature on FL since 2011 (Lundin et al. 2018; Yang, Lin, and Hwang 2019), the field is still at an early stage, as many articles report results from first attempts at using FL (Låg and Sæle 2019). The design and methods of FL can vary widely from class to class, but a fundamental principle lies in the name: the structure of learning is flipped upside down, pushing passive learning out of the classroom while pulling in active learning during the time previously used for lectures. While this working definition captures the justification for using the terminology 'flipped', it also underlines the active learning component, as FL involves more than just shifting content delivery outside of class time (Bishop and Verleger 2013). The entire classroom experience is built around active learning experiences: here, understood as meaningful learning of educational objectives, not merely 'being active'. As there is a substantial body of literature related to the concept of active learning (Drake 2012), this provides indirect support for the utilization of FL.

Active learning was one of the two most frequently used keywords according to an analysis of the keywords of 149 articles about FL from 2000 to 2015 (Yang, Lin, and Hwang 2019). Recent systematic reviews have identified a variety of theoretical frameworks for FL e.g. personalization, higher-order thinking, self-direction, collaboration, problem-based learning, peer assisted learning, cognitive load theory and self-determination (Bishop and Verleger 2013; Cheng, Ritzhaupt, and Antonenko 2019; Koh 2019; Seery 2015). These conceptual frameworks typically argue for the positive impact of active learning and have strong theoretical underpinnings in constructivism. However, few studies have examined how active learning theories guide the development and evaluation of the flipped approach to learning (Abeysekera and Dawson 2015; Koh 2019).

Despite FL being widely adopted in higher education, systematic reviews of FL have been criticized for lacking a theoretical framework (Abeysekera and Dawson 2015). There is a call for stronger pedagogical theorization of its practice, and the need to establish a robust framework on how FL is implemented (Bishop and Verleger 2013; Koh 2019; Lundin et al. 2018; O'Flaherty and Phillips 2015; Seery 2015). Thus, this scoping review addresses the empirical literature on FL through the lens of active learning to help provide theoretical underpinnings for FL. We now examine the many conceptualizations and definitions of FL that provide a pedagogical framework; our aim in doing so is to amplify the understanding of FL, of which active learning is an important element.

Defining flipped learning

In the empirical literature, we find extensive variety in how FL is defined: for example, some underline the usage of digital technology while others focus on collaborative learning or group learning activities (Låg and Sæle 2019). Among its many definitions, FL is referred to as a pedagogical approach, instructional approach, teaching approach, learning technique, educational strategy, method, student-centred approach, active learning methodology, instructional model, active learning design, didactic methodology, hybrid teaching, active learning technique and holistic pedagogic scaffold (Ahmed 2016; Cheng, Ritzhaupt, and Antonenko 2019; Harris and Welch Bacon 2019; Koh 2019; Lin and Hwang 2019; Seery 2015; Yang, Lin, and Hwang 2019). Despite the lack of a universal definition of FL, the active learning component remains a common theme across the definitions used in FL research. For many years, educators have assumed – and also experienced – that active learning environments are generally more effective in students' learning processes than passive, lecture-dominated learning environments (Abeysekera and Dawson 2015; Prince 2004). FL restructures and reorders traditional lecture-based (LB) approaches by moving students, rather than teachers, to the centre of learning. In her classic article, 'From Sage on the Stage to Guide on the Side', King (1993) stresses the importance of the use of class time for the construction of meaning, rather than just the transmission of facts. King's early work is a momentum for an inversion in the classroom, from the traditional lecture-based approach to giving students time to engage in active learning. Research on active learning has shown that it contributes to student learning, achievement and engagement (Chaplin 2009; Freeman et al. 2007; Hake 1998; Knight and Wood 2005; Prince 2004). Thus, if FL leads to active learning, does the current evidence allow us to draw the conclusion that FL contributes to increased student learning?

From the literature reviews, we are still left with a rather opaque picture regarding the benefits of FL (Evans et al. 2019; Låg and Sæle 2019). The studies also largely lack anchoring in e.g. learning theory, and many contain methodological weaknesses (Evans et al. 2019; Lundin et al. 2018). Abeysekera and Dawson (2015) claim that the FL approach is 'under-evaluated, under-theorized and under-researched in general'. In a scoping review, O'Flaherty and Phillips (2015) identified several gaps in the literature that need to be addressed for effective implementation of FL in the curriculum transformation by educators. These include the underutilization of theoretical frameworks that enable a joint approach to pre-, face-to-face and post-learning activities – which in turn can result in heavy content focus and a lack of clarity.

Further, most FL designs are not described in a way that enables readers or researchers to determine the extent to which classroom activities and assessments align with evidence-based guidelines (Låg and Sæle 2019). Identifying what theoretical frameworks are being used in FL and obtaining related evidence-based quality indicators for FL could help us outline, quantify and reduce this distorting variation.

Aim and research questions

As a consequence of the concerns outlined above, the aim in this article is to explore the links between FL and active learning. With the above observations regarding the lack of

conceptualization around connections between FL and active learning, we ask the following research questions:

(1) What is the link between FL and active learning?
(2) To what extent is FL grounded in theory or theoretical frameworks, and how are these theories and frameworks described?
(3) Which subject specific fields are represented within the reviewed studies?
(4) Which methodologies are used in the reviewed studies?

By responding to these questions, we aim to demonstrate how and to what extent the empirical literature approaches FL as a pedagogical principle and not merely as a decontextualized technique.

Theoretical framework

The term 'active learning' and the related idea of 'student-centred learning' became a notable interest among teachers, educational researchers, cognitive psychologists and instructional designers during the late 1970s and early 1980s (Bonwell and Eison 1991). Active learning can take many forms, follow different models and serve many different instructional goals. Many of the approaches have areas of overlap with each other and draw on similar pedagogies that focus on student-centred instruction and course learning objectives. Despite the reported benefits of active learning, the challenge for instructors is how to find time to incorporate these strategies into their courses without sacrificing content coverage (Crouch and Mazur 2001). This dilemma, together with the rise of digitalization in education, contributed to the development of the 'inverted' or 'flipped' learning approach (Bishop and Verleger 2013; Lage, Platt, and Treglia 2000). FL stresses the idea of active engagement over lectures in the classroom, which is strongly interconnected with learning approaches that have been referred to as active learning, student-centred learning and problem-based learning (Prince 2004). These approaches are grounded in a constructivist philosophy – one of the more influential paradigms in contemporary educational theory since Piaget (e.g. 1957) – which holds that knowledge cannot be 'transmitted', but requires the active construction of meaning by the learner. Aligning with constructivist philosophy, FL approaches learning as a learner`s active engagement with the content, the instructor and other students (Cheng, Ritzhaupt, and Antonenko 2019). While the assumption that learning requires active engagement is not new, nor especially revolutionary, our contemporary educational practices do not always reflect what we know about active learning.

However, from the empirical literature it is nearly impossible to understand what 'active learning' specifically entails, as the term is used to describe both methods and philosophies alike (Prince 2004). Though the term 'active learning' has never been precisely defined in educational literature, some general characteristics are commonly associated with the use of strategies promoting active learning in the classroom. One of the earliest definitions of active learning can be found in Bonwell and Eison's (1991) article, which has been cited over 7,500 times. The authors began their review of the literature on active learning by stating: 'Active learning is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do

meaningful learning activities and think about what they are doing' (Bonwell and Eison 1991, 2). Although we consider that to be a general description, we nevertheless find the definition appropriate and use it, ourselves, in this article. In 2004, Prince conducted another review of active learning, in its broadest sense. He concluded that there was extensive support for the effectiveness of active learning in the articles that he had analyzed; he also noted the difficulty in measuring its effectiveness due to the different definitions of and approaches to active learning across the literature. Prince (2004) describes active learning as activities that are introduced into a classroom, where the core elements are student activity and engagement in the learning process.

Relatedly, prior research suggests that students' knowledge, understanding and performance are improved via active learning (Freeman et al. 2014; Harris and Welch Bacon 2019; Lin and Hwang 2019). Despite these positive results, one obstacle with active learning is student resistance. Teachers implementing active learning techniques for the first time may face pushback from students unfamiliar with such an approach (Lambach, Kärger, and Goerres 2017). In addition, a recent study revealed that students prefer low-effort learning strategies – such as listening to lectures – despite performing better with active learning (Deslauriers et al. 2019).

Advocates of FL argue that the success of the model is due to its foundations in active learning pedagogy (Adams and Lenton 2017; Eichler and Peeples 2016; Jensen, Kummer, and Godoy 2015; Yang, Lin, and Hwang 2019). For instance, the difference in performance between flipped and traditional classrooms disappears when both use active-learning techniques (DeLozier and Rhodes 2017; O'Flaherty and Phillips 2015). Jensen, Kummer, and Godoy (2015) provide support for the hypothesis that the key to driving learning in the flipped setting is the inclusion of active learning. Moreover, research suggests that it is the presence of active learning, rather than the structure of the FL itself, that leads to higher student performance (Jensen, Kummer, and Godoy 2015). Some researchers even refer to FL as an instructional technique included in active learning pedagogy – see e.g. Harris and Welch Bacon (2019) and Yang, Lin, and Hwang (2019), or Alario-Hoyos et al.'s (2019) statement that '[t]he flipped classroom is a relatively new active learning strategy'.

This could add evidence in support of designing curricula that are grounded in active learning pedagogy. That is, discipline-based educational researchers should no longer focus on determining whether active learning strategies are more beneficial than traditional teaching methods, but should turn their attention toward investigating unresolved areas: for example, how active learning strategies facilitate learning in an FL intervention, or which student populations benefit most from which methods (Cheng, Ritzhaupt, and Antonenko 2019; Freeman et al. 2014; Leatherman and Cleveland 2019). However, as with any technique, active learning is not a panacea. Active learning techniques must be applied alongside consideration of the learning outcomes to make the learning process meaningful to the student (Drake 2012).

Taking into account the broader literature, however, there is a growing body of evidence supporting the argument that active learning is superior to the traditional lecture method (Bishop and Verleger 2013). The weight of this evidence led Freeman et al. (2014), who carried out a comprehensive meta-analysis comparing active learning to other lecture approaches, to conclude that it no longer makes sense to conduct studies using the traditional lecture method as a control (Freeman et al. 2014). They suggest that

it would be more productive to focus on using advances in educational psychology and cognitive science to drive changes in education, and to test which types of active learning are most efficient and suitable – not unlike what Prince did in 2004.

Given this lack of precision around the concepts related to FL and the connection between FL and active learning, we recognized that a systematic review aimed at a clear synthesis of a fragmented body of literature was unrealistic. As such, we opted for a scoping review as our methodology.

Methodology

Scoping reviews are an increasingly popular methodology for seeking and mapping the evidence in broad topic areas, one that is also relevant for both emerging and established fields. With regard to the latter, in established fields where there may be an abundance of evidence, scoping reviews can provide an understanding of the 'lay of the land' (Colquhoun et al. 2014). The approach for this scoping review is based on the five-stage framework of Arksey and O'Malley (2005), proposed as a guide for ensuring methodological transparency and reliability of findings (O'Flaherty and Phillips 2015). The five-stage framework consists of (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data and (5) collating, summarizing and reporting the results.

Identifying the research question

The research questions outlined in the introduction are aimed at exploring the link between FL and active learning and the characteristics of the research in this field: specifically, which theories or theoretical frameworks are described, and which subject fields and methodologies are represented.

Identifying relevant studies

Arksey and O'Malley (2005) suggest using broad search terms to obtain a comprehensive coverage of the relevant literature. Search terms were developed to capture literature that related to FL and active learning in higher education. The search string queried the databases for all results where the terms 'flipped' or 'inverted' occurred near terms like 'class', 'course' or 'learn' and in connection with different forms of active learning appearing in the title, abstract or keywords. 'Inverted' is often used interchangeably with the term 'flipped' and 'collaborative', while 'cooperative' and 'problem-based' are related to 'active learning'.

The literature searches were conducted in the Education Resources Information Centre (ERIC), Academic Search Premier, Web of Science and Scopus, which cover both field-specific and generic databases. The particular search string used in Scopus was TI (learn* N2 (active OR collaborative OR problem-based OR cooperative)) OR AB (learn* N2 (active OR collaborative OR problem-based OR cooperative)) OR KW (learn* N2 (active OR collaborative OR problem-based OR cooperative)) AND TI ((flipped OR inverted) N2 (class* OR course* OR learn*)) OR AB ((flipped OR inverted)

N2 (class* OR course* OR learn*)) OR KW ((flipped OR inverted) N2 (class* OR course* OR learn*)), and was limited to English and scholarly journals. No limits were set on publication date or study design. A similar search strategy was used in the other databases. The main search was conducted in February 2019, and this search was updated in December 2019.

Study selection

The search strategy yielded 1301 records in total. Duplicates were removed, and 752 unique records remained. The articles were screened by title and abstracts in the review tool EPPI-Reviewer 4, and conflicts were subsequently discussed and resolved. Articles that did not concern active learning in flipped classrooms in higher education were excluded. In total, 435 articles remained, and their full texts were retrieved for screening. Of these, 280 were excluded mainly due to an absence of theory or a theoretical framework; a few articles were excluded due to having an incorrect context (e.g. primary or secondary education), language or publication type (e.g. conference proceedings and other non-refereed publications). The inclusion and exclusion criteria are listed in Table 1. Finally, 155 articles were included for analysis (see Table 2). The PRISMA flow diagram in Figure 1 depicts the article selection process (Moher et al. 2009).

Charting the data

The qualitative data analysis software NVivo 12 Pro was used to extract data from the 155 articles. Specifically, NVivo was used to map the overall findings of the articles, in addition to the methodological descriptions. The relationship between FL and active learning was examined by using the text search function in NVivo across the material. The following data were extracted from the included articles in a Microsoft Excel spreadsheet: authors, year of publication, the subject field of the population, methodology and pedagogical theory/theoretical framework (Table 2).

Collating, summarizing and reporting the results

The results were mainly summarized and reported by percentages and numbers (see Figure 2 for academic subject/field). The use of pedagogical theories or theoretical frameworks were categorized and captured in a figure to illustrate the relationships between the theories (Figure 3). The overall findings of the studies were then summarized.

Table 1. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Active learning in flipped classroom	Other teaching methods
Higher education	Other educational levels
Pedagogical framework or theory	Missing pedagogical theories
English language	Other languages
Peer-reviewed original research	Non-refereed publications

Table 2. Literature matrix.

Reference	Subject field	Theoretical framework/theory referred to	Study design
Al-rababah and Rababah (2017)	Language teachers	Constructivism, Reasoned action theory	Qualitative: interviews, N = 8
Alamri (2019)	Educational studies	Constructivism	Mixed: experimental, test, survey, interviews, N = 52
Alario-Hoyos et al. (2019)	Engineering	Active learning theory	Quantitative: test, N = 102
Alkhatib (2018)	Engineering	Constructivism, Bloom's taxonomy, Active learning theory	Mixed: test, survey, exam, N = 192
Angelini and García-Carbonell (2019)	Engineering	Simulation	Quantitative: experimental, test, N = 121
Asiksoy and Özdamli (2016)	Physics	ARCS motivation model	Mixed: experimental, self-evaluation, test, interviews, N = 66
Badia and Soria (2017)	Engineering	Bloom's taxonomy	Quantitative: test, survey, N = 19
Baharom et al. (2015)	Engineering	Bloom's taxonomy	Quantitative: test, exam, N = 47
Bakla (2018)	Language studies	Constructivism	Mixed: survey, interviews, N = 40
Balan, Clark, and Restall (2015)	Entrepreneurship	Team-based learning, Active learning theory	Qualitative: student evaluation, N = 60
Baytiyeh (2017)	Web-design course	Constructivism	Qualitative: survey, N = 20
Baytiyeh and Naja (2017)	Engineering	Constructivism	Mixed: survey, test, exam, N = 45
Bernal (2017)	Engineering	Constructivism	Qualitative: observations, interviews, focus groups, survey N = 189
Bingen et al. (2019)	Nursing	Self-regulated learning	Qualitative: focus groups, reflection notes, N = 192
Blau and Shamir-Inbal (2017)	Educational studies	Bloom's taxonomy, Self-regulated learning theory	Qualitative: reflection notes, N = 36
Bohaty, Redford, and Gadbury-Amyot (2016)	Dentistry	Constructivism, Active learning theory	Mixed: survey, exam, N = 212
Bokosmaty, Bridgeman, and Muir (2019)	Chemistry	Social constructivism, Cognitive load theory	Mixed: survey, N = 1670
Brown, Danvers, and Doran (2016)	Accounting	Constructivism, Active learning theory	Quantitative: survey, N = 93
Buil-Fabrega et al. (2019)	Business and Social Sciences	Constructivism	Mixed: survey, N = 154
Burke and Fedorek (2017)	Criminology	Constructivism	Quantitative: survey, N = 92
Butzler (2016)	Chemistry	Self-regulated learning	Mixed: survey, N = 197
Çakiroglu and Öztürk (2017)	Programming	Self-regulated learning, Problem-based learning	Qualitative: observation, discussion messages, interviews, N = 30
Canelas, Hill, and Novicki (2017)	Chemistry	ICAP theory (Interactive, Constructive, Active and/or Passive learning)	Mixed: survey, exam, student evaluation, N = 567
Chen and Hwang (2018)	Marketing	Social constructivism, Social cognitivism	Quantitative: quasi-experimental, N = 85
Chen, Chen, and Chen (2015)	Statistics	Social learning theory	Mixed: survey, interviews, N = 45
Chen, Hwang, and Chang (2019)	Technology	Bloom's taxonomy, Reflective thinking	Quantitative: quasi-experimental, survey, N = 38
Chew, Jones, and Wordley (2018)	Engineering	Sociocultural, Behaviourism, Pedagogy of the oppressed	Mixed: survey, interviews, N = 91
Chiang and Wang (2015)	Engineering	Active learning theory	Quantitative: test, survey, N = 32

(*Continued*)

Table 2. Continued.

Reference	Subject field	Theoretical framework/theory referred to	Study design
Chis et al. (2018)	Programming	Constructivism, Self-directed learning theory	Quantitative: survey, test, N = 53
Christiansen et al. (2017)	Chemistry	Cognitive information processing theory	Quantitative: survey, N = 12
Clark et al. (2018)	Engineering	Connectivism, Social development learning, Cognitive Apprenticeship	Mixed: survey, focus groups, N = 506
Conner et al. (2014)	Agriculture teachers	Social constructivism, Bloom's taxonomy	Qualitative: focus groups, N = 32
Covill and Cook (2019)	Health sciences	Self-determination, Cognitive load	Quantitative: survey, N = 152
Das et al. (2019)	Business	Design thinking approach	Mixed: reports, observations, N = 334
Day (2018)	Physical Therapy	Active learning theory	Quantitative: quasi-experimental, test, exam, N = 217
Dehghanzadeh and Jafaraghaee (2018)	Nursing	Social constructivism, Self-regulated learning theory	Quantitative: quasi-experimental, test, N = 85
de Novais, Silva, and Jorge Muniz (2017)	Logistics Technology	Constructivism, Active learning theory	Qualitative: survey, N = 37
Deri, Mills, and McGregor (2018)	Chemistry	Constructivism	Quantitative: exam, N = 5532
Engbers (2019)	Public administration	Problem-based learning	Quantitative: student evaluation, N = 198
Eryilmaz and Cigdemoglu (2019)	Language studies	Constructivism	Quantitative: experimental, test, exam, N = 57
Fan (2018)	Language studies	Constructivism	Mixed: survey, interviews, N > 1000
Fauzi and Hussain (2016)	Communication studies	Learning styles	Qualitative: observation, N = 24
Fidalgo-Blanco, Sein-Echaluce, and García-Peñalvo (2018)	Information Technology	Bloom's taxonomy	Mixed: quasi-experimental, survey, N = 112
Finne (2018)	Operations management	Bloom's taxonomy	Mixed: survey, test, N = 375
Foldnes (2016)	Business	Cooperative learning	Quantitative: experimental, test, exam, N = 1569
Ford (2019)	Pharmacy	Cooperative learning	Quantitative: test, N = 633
Foster and Stagl (2018)	Economics	Transformative learning, Active learning theory	Quantitative: survey, exam, N = 33
Galway et al. (2014)	Public Health	Bloom's taxonomy, Transformative learning	Mixed: survey, exam, focus groups, N = 11
Garnjost and Lawter (2019)	Management	Constructivism	Quantitative: survey, N = 303
Giuliano and Moser (2016)	Pharmacy	Constructivism	Quantitative: quasi-experimental, survey, N = 82
Halili et al. (2019)	Educational studies	Learning-styles	Quantitative: survey, N = 52
Harrison et al. (2017)	Mechanics	Active learning theory	Quantitative: observation, N = 59
He et al. (2019)	Chemistry	Active learning theory	Quantitative: experimental, test, exam, N = 587
Ho (2019)	English	Academic engagement	Mixed: experimental, survey, narratives, focus groups, N = 50
Hu et al. (2019)	Medicine	Bloom's taxonomy	Quantitative: survey, test, N = 74
Huguet et al. (2020)	Arts, technology, engineering, geoscience	Active learning theory	Mixed: focus groups, survey N = 267
Hung (2015)	Language studies	Bloom's taxonomy, Active learning theory	Mixed: quasi-experimental, survey, test, interviews, N = 75

(*Continued*)

Table 2. Continued.

Reference	Subject field	Theoretical framework/theory referred to	Study design
Hwang and Chen (2019)	International food culture	Bloom's taxonomy	Mixed: quasi-experimental, survey, test, observation, N = 72
Jensen et al. (2018)	Biology	Constructivism, Motivational theory	Quantitative: quasi-experimental, test, N = 657
Jensen, Kummer, and Godoy (2015)	Biology	Constructivism	Quantitative: quasi-experimental, test, exam, N = 108
Jones et al. (2019)	Geology	Self- regulation	Quantitative: exam, N = 355
Joseph and Joy (2019)	Engineering	Social constructivism	Quantitative: survey, N = 250
Jovanovic et al. (2019)	Engineering	Self-regulation	Quantitative: exam, N = 1147
Juárez and Herrera (2019)	Design/ engineering/ architecture	Learning-styles	Quantitative: test, N = 460
Kantanen et al. (2019)	Business	Communication in the disciplines, Collaborative inquiry	Mixed: survey, exam, student evaluation, N = 51
Kaw et al. (2019)	Engineering	Active learning theory	Mixed: student metrics, focus groups, N = 146
Kay, MacDonald, and DiGiuseppe (2019)	Computer programming	Active learning theory	Mixed: survey, test, N = 103
Kenwright et al. (2017)	Medicine	Constructivism	Mixed: survey, focus groups, N = 75
Khanova et al. (2015a)	Pharmacy	Bloom's taxonomy, Constructivism	Mixed: survey, N = 134
Khanova et al. (2015b)	Pharmacy	Social constructivism, Self-regulated learning	Qualitative: student evaluation, N = 6010
Kim (2017)	Language studies	Community of inquiry	Quantitative: quasi-experimental, survey, N = 45
Kühl et al. (2019)	Medicine	Collaborative learning	Quantitative: experimental, survey, test, N = 196
Kwon and Woo (2018)	Business	Constructivism, Active learning theory	Quantitative: experimental, survey, N = 157
Lally and Forbes (2019)	Engineering	Constructivism	Mixed: test, interviews, N = 91
Lambach and Kärger (2019)	Political Science	Bloom's taxonomy	Quantitative: survey, exam, N = 87
le-Roux and Nagel (2018)	Economics	Constructivism, Community of inquiry	Mixed: survey, N = 30
Leatherman and Cleveland (2019)	Sophomore-level genetics	Cognitive load theory	Mixed: survey, exam, N = 131
Lee, Lee, and Kovel (2016)	Construction management	Theory of multiple intelligences	Quantitative: experimental, test, N = 52
Lee and Bonk (2019)	Education	Collaborative learning	Quantitative: survey, N = 30
Lento (2016)	Accounting	Cognitive multimedia learning, Bloom's taxonomy, Active leaning theory	Quantitative: quasi-experimental, test, survey, N = 189
Lento (2017)	Accounting	Variation theory	Mixed: survey, N = 148
Lewis, Chen, and Relan (2018)	Medicine	Constructivism	Mixed: survey, N = 200
Long, Cummins, and Waugh (2017)	Teachers in various studies	Technological pedagogical content knowledge	Qualitative: interviews, N = 8
Long, Cummins, and Waugh (2020)	Instructors' mathematics	Technological pedagogical content knowledge	Qualitative: interviews, N = 3
Long, Logan, and Waugh (2016)	Engineering	Constructivism	Quantitative: survey, N = 55
Lucke, Peter Dunn, and Christie (2017)	Engineering	Metacognition	Mixed: survey, exam, observation, student metrics, N = 44

(*Continued*)

Table 2. Continued.

Reference	Subject field	Theoretical framework/theory referred to	Study design
Lumpkin and Achen (2015)	Economics	Constructivism	Mixed: survey, observation, N = 46
Maheshwari and Seth (2019)	Management	Active learning theory	Mixed: experimental, test, survey, N = 80
Matthew et al. (2019)	Veterinary	Active learning theory	Mixed: survey, N = 165
McCallum et al. (2015)	Various courses	Student involvement theory	Mixed: survey, focus groups, N = 60
McCubbins, Paulsen, and Anderson (2018)	Agriculture	Constructivism, Behaviourism	Mixed: survey, test, focus groups, N = 121
McLaughlin et al. (2013)	Pharmacy	Constructivism, Bloom's taxonomy, Transactional distance theory	Mixed: survey, N = 22
Mooring, Mitchell, and Burrows (2016)	Chemistry	Social constructivism, Cognitive load theory	Quantitative: experimental, survey, N = 432
Moraros et al. (2015)	Public Health	Constructivism, Social learning theory	Quantitative: survey, N = 67
Morosan, Dawson, and Whalen (2017)	Information Technology	Constructivism	Mixed: observation, N = 230
Motameni (2018)	Marketing	Bloom's taxonomy	Quantitative: experimental, test, exam, N = 167
Mulcare and Shwedel (2017)	Political Science	Bloom's taxonomy	Quantitative: test, N = 56
Munir et al. (2018)	Engineering	Bloom's taxonomy	Quantitative: survey, N = 25
Narendran et al. (2018)	Business	Self-determination theory	Qualitative: observation, interviews, N = 9
Ng (2019)	Education	Self-regulated learning	Quantitative: test, N = 16
Notaros et al. (2019)	Engineering	Active learning theory	Quantitative: test, N = 83
Oliván Blázquez et al. (2019)	Social work	Active learning theory	Quantitative: experimental, exam, survey, N = 110
Osman, Jamaludin, and Fathil (2016)	Polytechnics	Cognitive multimedia learning	Quantitative: survey, N = 32
Overmyer (2015)	Mathematics	Collaboration, self-direction	Quantitative: quasi-experimental, exam, N = 301
Pejuan and Antonijuan (2019)	Engineering	Self-directed learning	Quantitative: survey, N = 268
Peters et al. (2019)	Mathematics	Team-based learning	Quantitative: test, N = 671
Porcaro et al. (2016)	Medical laboratory scientist	Constructivism	Mixed: survey, exam, N = 65
Prashar (2015)	Operations management	Constructivism, Bloom's taxonomy	Mixed: quasi-experimental, survey, focus groups, N = 50
Price and Walker (2019)	Business	Bloom's taxonomy	Quantitative: quasi-experimental, survey, exam, N > 1000
Qiang (2019)	Mathematics	Cooperative learning	Quantitative: experimental, test, N = 242
Raman (2015)	Chemistry	Constructivism, Theory of perceived attributes	Quantitative: survey, N = 113
Ramlo (2015)	Physics	Constructivism	Mixed: consensus statements, N = 21
Rau et al. (2017)	Chemistry	Constructivism	Mixed: quasi-experimental, survey, test, observations, N = 413
Reddan, McNally, and Chipperfield (2016)	Sports Coaching	Bloom's taxonomy, Self-directed learning	Mixed: survey, N = 35
Riddell et al. (2017)	Medicine	Social constructivism	Quantitative: experimental, test, exam, N = 73
Robert et al. (2016)	Chemistry	Constructivism	Quantitative: exam, N = 2000
Rodríguez et al. (2019)	Medicine	Active learning theory	Qualitative: survey, exam, observation, N = 93

(*Continued*)

Table 2. Continued.

Reference	Subject field	Theoretical framework/theory referred to	Study design
Romero-García, Buzón-García, and Touron (2019)	Education	Bloom's taxonomy, cooperative learning	Quantitative: quasi-experimental, survey, N = 173
Røe et al. (2019)	Physiotherapy	Collaborative learning	Quantitative: exam, N = 54
Sánchez-Azqueta et al. (2019)	Physics	Active learning theory	Quantitative: survey, N = 40
Sankey and Hunt (2014)	Various courses	Constructivism	Qualitative: interviews in 3 case studies
Schneider and Blikstein (2016)	STEM	Constructivism	Mixed: experimental, test, video, N = 27
Schwarzenberg et al. (2018)	Programming	Constructivism, Self-determination theory	Quantitative: quasi-experimental, survey N = 422
Shatto, L'Ecuyer, and Quinn (2017)	Nursing	Cognitive educational theory	Mixed: survey, N = 47
Shattuck (2016)	Chemistry	Online collaborative leaning theory	Mixed: survey, test, exam, focus groups, N = 54
Shen (2018)	Information literacy	Online collaborative leaning theory	Qualitative: interviews, N = 5
Skagen et al. (2018)	Chemistry	Social constructivism	Mixed: survey, reflections, interviews, N = 75
Sletten (2017)	Biology	Self -directed learning theory	Quantitative: survey, exam, N = 76
Smith, Grundmann, and Li (2018)	Pharmacy	Social cognitive theory, Pedagogy of the oppressed	Quantitative: survey, N = 208
Steen-Utheim and Foldnes (2018)	Mathematics	Social constructivism	Qualitative: interviews, N = 235
Stover and Holland (2018)	Nursing	Constructivism	Mixed: survey, exam, N = 291
Stover and Houston (2019)	Business	Social constructivism	Mixed: survey, exam, N = 87
Strayer (2012)	Mathematics	Learning environment theories	Mixed: survey, observations, interviews, focus groups, N = 50
Su and Chen (2018)	Educational studies	Constructivism, Metacognition	Quantitative: survey, N = 54
Sun, Xie, and Anderman (2018)	Mathematics	Self-regulated learning theory	Quantitative: survey, observations, N = 151
Tanner and Scott (2015)	Information technology	Theory of coherent practice	Qualitative: survey, N = 247
Teng (2017)	Language Studies	Constructivism	Mixed: survey, interviews, N = 90
Thongmak (2019)	Information technology	The technology acceptance model (TAM) and expectation-confirmation model (ECM)	Quantitative: experimental, survey, N = 46
Tomas et al. (2019)	Education	Active learning theory	Mixed: survey, N = 171
Tonkin, Page, and Forsey (2019)	Language studies	Cognitive load theory	Mixed: survey, interviews, focus groups, N = 70
Torío (2019)	Engineering	Collaborative learning	Quantitative: survey, N = 17
Turner and Webster (2017)	Engineering	Metacognition	Mixed: survey, N = 27
Turra et al. (2019)	Engineering	Social constructivism	Quantitative: survey, N = 76
Urfa and Durak (2017)	Information technology	Diffusions of innovation theory	Mixed: observations, interviews, focus groups, N = 24
van Vliet, Winnips, and Brouwer (2015)	Medicine	Metacognition	Quantitative: survey, test, exam, N = 170
Vercellotti (2018)	Language studies	Sociocultural learning theory	Quantitative: experimental, survey, N = 29
Wang and Zhu (2019)	Chemistry	Self-regulated learning	Mixed: quasi-experimental, survey, interviews, N = 73

(*Continued*)

Table 2. Continued.

Reference	Subject field	Theoretical framework/theory referred to	Study design
Wang, Wang, and Xing (2019)	Language studies	Active learning theory	Mixed: survey, observations, focus groups, N = 21
Weaver and Sturtevant (2015)	Chemistry	Self-motivation theory	Quantitative: survey, exam, N = 164
White et al. (2017)	Pharmacy	Social constructivism	Mixed: survey, exam, N = 147
Williams, Horner, and Allen (2019)	Business	Active learning theory, deep learning	Mixed: survey, N = 126
Wood et al. (2018)	Physics	Sociocultural learning theory	Qualitative: video lecture recording, dialogue, 2 case studies
Yamarik (2019)	Economic	Bloom`s taxonomy	Quantitative: quasi-experimental, survey, N = 122
Yao and Collins (2018)	Various	Constructivism	Qualitative: interviews, N = 24
Yong, Levy, and Lape (2015)	Mathematics	Metacognition	Mixed: survey, N = 176

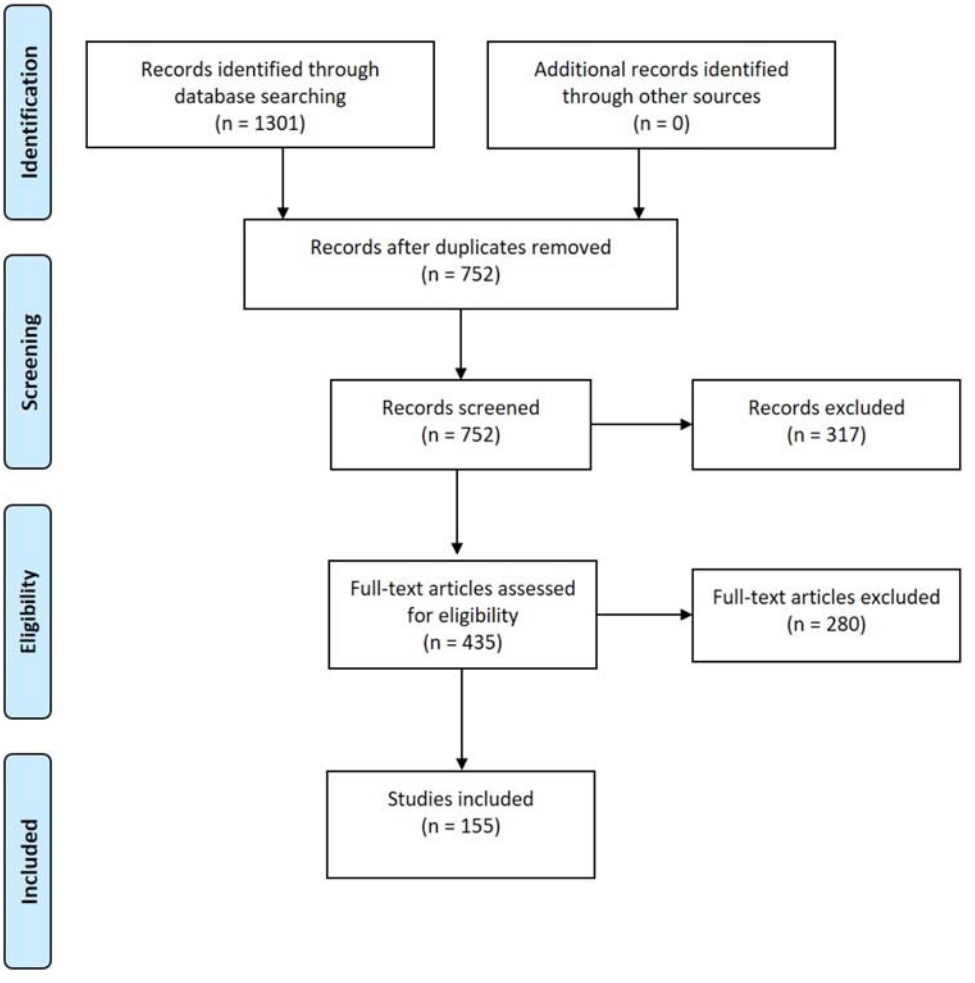

Figure 1. PRISMA flow diagram.

Results

Approximately 65% of the 435 articles retrieved in full text did not connect their research to theory or a theoretical framework. In the remaining 35% of the 435 articles, there were some cases for which it was difficult to determine which theoretical framework or methodology was used. Across the articles, the description of these elements varied from one sentence – e.g. 'the flipped classroom has underpinnings in both the constructivist and social learning theory' (Moraros et al. 2015, 15) – to entire sections (e.g. Blau and Shamir-Inbal 2017). The most frequently theoretical framework referred to was constructivism; 68% of the 155 included articles referred to constructivism and related perspectives invoking active learning as a theoretical concept. Active learning and similarly specific terms were explicitly mentioned in 23% of the articles. We classified 25% of the articles under 'instructional design models' or 'other', while Bloom's taxonomy was mentioned in 14% of the articles (Figure 3). The included articles were primarily published in

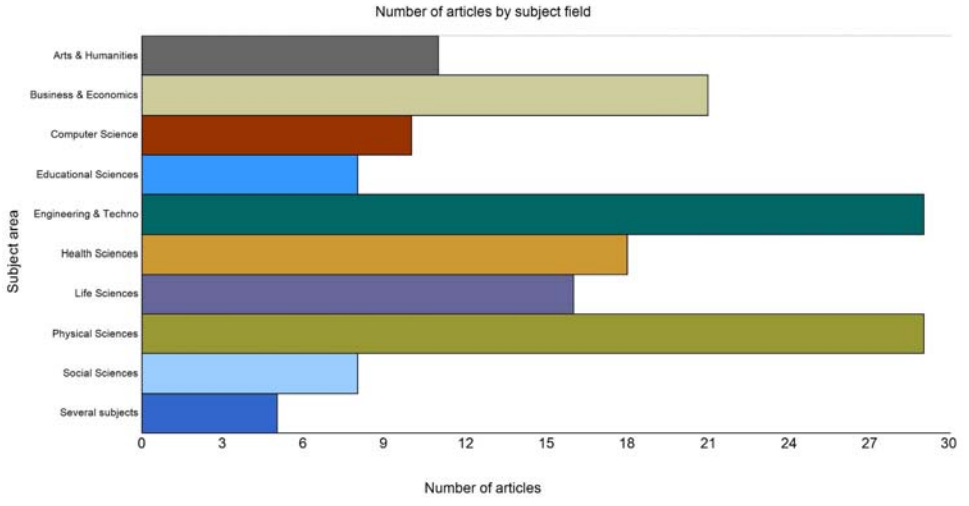

Figure 2. The subject area of the flipped classroom interventions.

Figure 3. Theoretical frameworks reported in the included studies.

subject-specific journals (e.g. engineering, chemical or pharmaceutical journals) but also in some journals focused on pedagogy and research in higher education.

FL has been used as an approach to teaching in a wide variety of academic subject areas. Figure 2 shows this variety based on an analysis of the included articles in this study. The most common subject area for FL is the STEM subjects: engineering, technology, and the physical sciences (e.g. physics, chemistry and mathematics). These are followed by subjects relating to business and economics, and in the health sciences and life sciences (biology, pharmacy and agriculture). Common across these subjects is their preference for numbers, formulas, models and hard facts, while 'softer' subjects – such as

those in the social sciences and the arts and humanities – are less represented in the reviewed articles.

A quantitative study design was the most common methodology used, accounting for 46% of the included studies. Qualitative studies accounted for 14%, and mixed (qualitative and quantitative) methods were used in 40% of the included articles. About 25% of the studies used either a quasi-experimental (e.g. Rau et al. 2017; Schwarzenberg et al. 2018) or an experimental study design (e.g. Foldnes 2016; He et al. 2019) with pre-tests and/or post-tests to measure the effect of FL compared to traditional teaching. Test scores and grades were compared across the intervention group and the control group. Surveys collecting quantitative and, in many cases, qualitative data were another frequently used methodological instrument (e.g. Bokosmaty, Bridgeman, and Muir 2019; Lewis, Chen, and Relan 2018). The quantitative questions typically measured learning outcomes, and the qualitative open-ended questions captured students' attitudes and preferences regarding the FL intervention. The qualitative studies were mainly based on various types of interviews (e.g. Bingen et al. 2019; Steen-Utheim and Foldnes 2018).

Most of the studies that quantified the effectiveness of FL reported higher grades and diminished failure rates in the FL group (e.g. Mooring, Mitchell, and Burrows 2016; Røe et al. 2019). Test scores were significantly higher with regard to critical thinking (e.g. McCubbins, Paulsen, and Anderson 2018; van Vliet, Winnips, and Brouwer 2015), teamwork (e.g. Huguet et al. 2020; Morosan, Dawson, and Whalen 2017) and learning motivation (e.g. Lucke, Peter Dunn, and Christie 2017; Su and Chen 2018). A few studies were inconclusive with regard to learning outcomes (e.g. Covill and Cook 2019; Garnjost and Lawter 2019).

The qualitative data mainly demonstrated higher satisfaction with FL (Hung 2015; Teng 2017), increased engagement (e.g. Fauzi and Hussain 2016; Steen-Utheim and Foldnes 2018), enhanced learner empowerment (e.g. Fauzi and Hussain 2016; McLaughlin et al. 2013) and increased interaction between students and/or students and faculty (e.g. Al-rababah and Rababah 2017; Matthew et al. 2019).

However, some studies point to the challenges of adapting to an active learning style, especially as it is more time consuming and demanding (e.g. Bingen et al. 2019; Røe et al. 2019). In addition, studies suggest that students need to learn strategies for active learning (Balan, Clark, and Restall 2015; Butzler 2016), including how to prepare at home (Burke and Fedorek 2017; Harrison et al. 2017).

As can be seen in Figure 3, FL is related to several different theories, conceptual frameworks and approaches in the reviewed articles. The categorization scheme depicted in Figure 3 was inductively constructed from the selection process described above and in Figure 1, but also with a view to a series of well-established theoretical perspectives. However, these perspectives rarely come across as clear-cut or fully applied. For example, some of them mention constructivism very briefly, while others mention connectivism and relate it to constructivism but without further explanation. In addition, none of the selected articles refer to cognitivism specifically, but to perspectives originating from cognitivism – such as self-regulated learning (SRL). Some studies have entire sections devoted to learning theory, while others offer only two sentences. Under the category 'other', we have subsumed approaches used in the articles that do not adhere to more well-established theoretical perspectives; one example is Bloom's taxonomy,

which emerged as one of the three most frequently used approaches in the articles. In addition, among the most widely used approaches under constructivism, we find the notion of 'active learning', with its subcategories of problem-based, collaborative and cooperative learning – in accordance with Prince's (2004) definition. Finally, we grouped any approaches that could be classified under the instructional design model (Carr-Chellman and Reigeluth 2009).

The above results reflect a complex and diverse landscape with regard both to how FL has been perceived and how it has been studied. In the following, we seek to relate this complexity to the research questions in order to distil principles underlying FL and how it connects to active learning.

Discussion

Active learning

Our first research question queried the link between FL and active learning. The selected studies indicate that this link is rarely explicitly addressed or operationalized. Active learning, with its three subcategories of problem-based, collaborative and cooperative learning, is mentioned in 23% of the articles in our review. Few studies explicitly define their definition of active learning. Most describe active learning in very general terms, sometimes only 'namedropping' it (see, for example, McLaughlin et al.'s [2013] and Day's [2018] frequently cited articles). The notion of active learning seems to be taken for granted as being positive for learning; moreover, many studies convey more of an intuitive understanding of active learning than a shared definition, as exemplified by the following excerpt: 'An effective way to achieve excellent learning results is individual one-on-one tutoring (Bloom [1956] 1984), which is characterised by rich instructor–student interaction and active learning' (Finne 2018, 6). The term 'active learning' occurs 13 times in this article, but is never clearly defined.

However, there are some exceptions. Some articles refer to empirical literature on active learning, e.g. Alkhatib (2018), Harrison et al. (2017), Lumpkin and Achen (2015) and Foster and Stagl (2018). The latter article contains a theoretical section concerning a pedagogical model based on three contemporary theories of learning: (1) student-centred learning, (2) active learning and (3) transformative learning. Further, the authors argue that these theories have roots in constructivism or social constructivism, with a view toward the 'zone of proximal development' (Vygotskij 1978). They present a conceptual framework for the design, implementation and evaluation of FL, entitled the 'inverted classroom model'. Moreover, they define active learning following the broad, but widely accepted, definitions of Prince (2004) and Bonwell and Eison (1991) – we found that other articles also base their definition of active learning on the same. For example, Hung (2015, 82) states the following: 'Conceptually, active learning is an umbrella term that involves students in doing things and thinking about the things they are doing'. This definition links active learning to an assortment of learning methods and activities, instructional strategies and any approach with the goal of activating the students in the learning process. Examples of these approaches found in the review articles include collaborative learning, cooperative learning, problem-based learning and team-based learning.

Theoretical framework

Our second research question queried the extent to which FL is grounded in theory or theoretical frameworks. All research articles should have a valid theoretical framework to justify the importance and significance of the work (Lederman and Lederman 2015). Approximately 65% of the 435 full-text articles retrieved do not connect their research to theory or a theoretical framework. Of the remaining 35%, the theoretical and conceptual underpinnings are vaguely described, with a few exceptions. Thus, it was challenging to identify the inner logic amidst the theoretical diversity of the studies reviewed.

In the following sections, we have classified studies such that their conceptual underpinnings correspond to well-established theoretical categories. This should not be seen as an exercise of 'forced matchmaking' but rather as an overview of where studies of FL turn to increase their explanatory power. As a result, not all categories would qualify as theoretical frameworks, per se – e.g. Bloom's taxonomy (see below) – but have been subsumed under this term, as they inductively emerge when examining the studies' conceptual references.

Constructivism

In total, 68% of the 155 included articles refer to constructivism and other perspectives originating from constructivism. Constructivism emphasizes active learning by placing students at the centre of the learning process, replacing passive listening with active participation (King 1993). As its name suggests, constructivism understands knowledge to be constructed rather than 'given' or discovered. As a result, learning becomes a matter of restructuring pre-existing modes of thinking rather than accumulating information. Teaching involves the facilitation of this thinking, not the imparting of facts. Further, constructivism posits that making use of communication and interactive activities in which learners play engaged and active roles can motivate learning more effectively than activities in which learners are inactive (Olusegun 2015).

Such constructivist fundamentals can be traced in excerpts such as this one:

> The basis of flipped learning is active learning and builds on constructivism (…). It embraces problem-based learning, peer-assisted learning, cooperative learning, and collaborative learning under active learning (…). After all, flipped learning, which stresses the instructor's role as a coach, is a pedagogical option to provide opportunities for interactive and dynamic engagement in the learning process. (Kwon and Woo 2018, 3)

Many articles only briefly describe or do not explicitly explain or define constructivism using references to the literature, as we see in this article: 'The flipped model employs a constructivist approach to learning. In this approach, students learn by experiencing and are responsible for building their knowledge' (Giuliano and Moser 2016). Even in a highly cited article by Jensen, Kummer, and Godoy (2015, 1), there is a lack of a clear definitions; the authors state only, 'We conclude that the flipped classroom does not result in higher learning gains or better attitudes compared with the nonflipped classroom when both utilize an active-learning, constructivist approach'.

Social constructivism

In our review, we found 11% of the 155 included articles refer to social constructivism and other perspectives originating from social constructivism as a theoretical framework (e.g. social development theory). Within the constructivist family, there are several differing positions, of which social constructivist is one. Social constructivism does not take individual cognition as its point of departure but rather posits that knowledge is constructed socially by engaging in interactions.

One example of how this perspective is reflected in the articles we reviewed can be found in Khanova et al. (2015b, 1039), who write:

> This pedagogical approach is underpinned by a combination of self-regulated and socio-constructivist learning theories. The former views students as active constructive participants in the learning process, whereas the latter emphasises the role of learning interactions, such as classroom discussions, in developing higher-order cognitive skills like reasoning and problem solving.

Another example is Dehghanzadeh and Jafaraghaee's (2018, 152) assertion that

> FC is based on the self-regulated and socio-constructivist theories of learning. The self-regulated learning theory considers the learner as an active participant in the process of learning while the socio-constructivist theory puts greatly values the role of classroom discussions and interactions in promoting higher-order cognitive skills.

Cognitivism

In our study, 21% of the 155 included articles refer to theories that originated from cognitivism, such as cognitive load theory and self-determination theory, SRL: these share fundamental assumptions about knowledge as a result of processes of acquisition and developing mental structures, often connected to problem solving. None of the articles refer explicitly to cognitivism or similar terms. For example, SRL – a conceptual framework that includes the cognitive, metacognitive, behavioural, motivational and emotional/affective aspects of learning – is referred to in 5% of the reviewed studies. However, in the articles we reviewed, SRL can be seen as an umbrella term capturing numerous cognitive variables influencing learning (e.g. self-efficacy, volition and cognitive strategies) (Panadero 2017). In these articles, SRL, students' motivation, and learning are treated as interdependent processes that cannot be understood apart from each other. For example, in Blau and Shamir-Inbal (2017, 72), we find the following: 'Self-regulated learning (SRL) refers to one's ability to monitor his or her learning and think meta-cognitively, motivationally, and behaviourally'. This same study claims that all SRL is determined by external rewards or punishment – not unlike mechanisms we know from behaviourism. FL poses higher demands on the self-regulation of students than in traditional models of content delivery. In practice, for students this means well-defined SLR outside the classroom, often assisted by technology (Blau and Shamir-Inbal 2017). Notably, it is critical for teachers to use proper methods to keep students on the right track prior to class, with regard to learning: this can be done e.g. through pre-class assignments and online quizzes (Cheng, Ritzhaupt, and Antonenko 2019). In this context, then, SRL becomes especially relevant with its

emphasis on students' control of their learning environments as part of their cognitive efforts to reach educational goals.

Bloom's taxonomy

In our study, 14% of the 155 included articles refer to Bloom ([1956] 1984) taxonomy. This taxonomy is a hierarchical classification of the different levels of knowledge in the learning process and, as noted in the introduction to this section, does not strictly qualify as a conceptual framework or 'theory' (although it often resonates with cognitive assumptions). After being revised in 2001, the taxonomy proposes the following levels in the cognitive domain: (1) remembering, (2) understanding, (3) applying, (4) analysing, and (5) evaluating information and knowledge (Krathwohl 2002). The taxonomy is hierarchical, because each level is based on the previous one and can be reinforced and developed through social interaction and students' active learning. To be able to apply knowledge (Level 3), a student must have both the necessary knowledge (Level 1) and understanding (Level 2). Blau and Shamir-Inbal (2017, 79) provide an example of how Bloom's taxonomy is used as a framework in the studies we reviewed: 'This study suggests a re-designed model of flipped learning and discusses the added value of technologies in promoting higher order thinking skills presented in Bloom's taxonomy, such as applying, analysing, evaluating, and creating during both in- and out-of-class learning'.

It would seem that a number of the studies in our analysis found Blooms' taxonomy relevant to FL, in that the transmission of knowledge is obtained independently and outside of class, while the assimilation of knowledge – which requires greater critical reasoning – occurs during class under the guidance of teachers or peers. The higher the level, the more assimilation is required; the lower the level, the more transmission of information occurs through largely independent assimilation (Lambach, Kärger, and Goerres 2017; McLaughlin et al. 2013; Moraros et al. 2015; Reddan, McNally, and Chipperfield 2016).

Some educators claim that the use of FL in education corresponds directly to the objective embedded in Bloom's taxonomy; that is, to help students develop higher-order thinking skills by way of flipped instruction, which is assumed beneficial for both lower- and higher-order skills development (Ahmed 2016).

Flipped learning in subject-specific fields

In our review, FL approaches are described across a wide range of disciplines in which STEM subjects most commonly employ FL (see Figure 3). Similar findings are described in Lundin et al.'s (2018) systematic review. This contrasts with a new meta-analysis of FL, however, which found that most of the FL studies are connected to health professions (Låg and Sæle 2019).

The 'lecture-based' and 'teacher-centred' approaches are a 'signature pedagogy' of many STEM disciplines and fields (Freeman et al. 2014; Winberg et al. 2019). Mason, Shuman, and Cook (2013) claim that although there is a pressing need to reorganize engineering education, for example, the traditional lecture style of teaching remains the norm in college courses around the world. Students are familiar with this method

and are generally comfortable in the traditional classroom. On the other hand, because FL emphasizes active participation during class, it is argued that STEM-based subject areas, which often involve the application of concepts, labs and problem sets, may be well-suited to this method. Freeman et al. (2014) conducted a comprehensive meta-analysis (225 studies) of STEM courses, comparing traditional lecturing versus active learning, and found that the average examination score improved in active learning sessions.

In addition to STEM-based subjects, many of the reviewed articles originated from the health sciences. Similar findings are described in a meta-analysis of FL (Låg and Sæle 2019). The same article claims that most meta-analyses of flipped classroom studies are limited to the medical and health professions disciplines. The flipped learning approach has grown rapidly and is now widely used in health professions education (Hew and Lo 2018). The results of a systematic review (Betihavas et al. 2016) indicate the potential for flipped learning to transform nursing education, provide a student-centred approach and offer increased opportunities for students to develop critical thinking skills.

Methodological aspects in the studies

In the reviewed studies, we also found a wide variety of research designs and methodological approaches. Quantitative study design accounted for 46% of the included studies, qualitative studies for 14% and mixed-methods for 40%. This is consistent with findings from Steen-Utheim and Foldnes (2018), who found that mixed methods are one of the most widely used methods for studying FL after quantitative methods; the authors also conclude that there is a lack of in-depth qualitative research on students' perceptions of FL.

Several authors have noted the lack of a rigorous evaluation of FL (Låg and Sæle 2019). However, to objectively measure the effect of FL, a controlled experimental study design with pre-test and post-test is considered the gold standard (Bishop and Verleger 2013). About 25% of our 155 studies has an experimental or quasi-experimental design. Yet, some of the studies are based on a post-test only and several are small scale studies with $N < 100$. Foldnes (2016) may be considered as one of the more robust studies, which is an experimental study running throughout one semester and with pre-test, post-test and exam scores. Student performance was measured across ten classes in six campuses in the largest cities in Norway ($N = 1569$). Test and exam scores highly increased with collaborative and active learning elements. Although there may be scant evidence as to the FL approach being more 'effective' or producing better results than lecture-based teaching, there are strong indications that active learning leads to better student performance (Låg and Sæle 2019). As the FL approach prioritizes the active student, one can argue that FL interventions are conducive to improved student performance.

Five years after O'Flaherty and Phillips (2015) claimed that FL is under-theorized, we still find a lack of consistent and articulated theoretical perspectives and a multitude of analytical approaches. We found few articles that explicitly invoked a theory in terms of explanatory power or specific references to a body of conceptually oriented literature. Most of the studies refer to a mix of pedagogical terms or approaches (e.g. transformative

learning, self-determination theory and online collaborative learning) without describing or theoretically differentiating them fully. For example, a very influential experience is reported in Bergman and Sams' account of the use of FL in their chemistry class; although they demonstrated a positive effect, the data was mostly anecdotal (Tucker 2012). This eclecticism and reluctance to connect FL with a specific paradigm correspond with findings from other reviews on FL (Cheng, Ritzhaupt, and Antonenko 2019; Lundin et al. 2018). The lack of applied theoretical frameworks in the FL literature can also be understood within the context of FL's emergence from classroom practice as a cluster of techniques that worked well, rather than a conceptualization resulting from scientific educational research (Seery 2015).

To summarize, our analysis has shown that interest in FL has grown in recent years, perhaps due to an increased interest in active learning and the ways FL can support and sustain this pedagogical principle when operationalized. However, as the phenomenon of FL has continued to make an impact across several disciplines, it has become important to identify its conceptual underpinnings and the basis on which its claims for success are made. As with the connections between FL and a diversity of conceptual frameworks, methodologies also reflect a 'multi-paradigmatic' approach depending on whether studies aimed to e.g. measure effects or examining students' perceptions. Our scoping review also indicates that diversity is utilized in order to better capture an emergent and not yet 'stable' phenomenon. However, it might also reflect researchers' sheer uncertainty as to how best to examine the phenomenon. Regardless, our scoping review reflects a situation where a plethora of conceptual and analytical approaches exist and where such approaches are only rarely argued or elaborated. Thus, FL might run the risk of being reduced to a 'technique' or a 'universal tool', instead of potentially becoming a generative concept for educational development.

Limitations

An initial literature search proved that there is a considerable amount of research on FL. We limited our search to FL related to specific forms of active learning in order to examine to what extent and how this relationship FL was conceptualized. The searches were further restricted to four of the largest and most important databases: our aim here was not to be exhaustive, but rather to obtain a broad overview of the research field. Our main interests were the theoretical and methodological framework(s) used; however, it proved challenging to identify the use of these frameworks in several of the articles. We also discussed where to draw the line for inclusion and exclusion with regard to theoretical description(s): we opted to include even very short descriptions. Despite these limitations, we are confident that the number of articles included provide a representative view of the theoretical and methodological challenges of this research field.

Conclusion

One conclusion that can be drawn from the present study is that, although the number of FL articles has seen rapid growth since 2011, we still find a lack of principally applied theoretical perspectives and/or conceptual frameworks. Approximately 65% of the 435

full-text articles retrieved do not make such connections explicit. For the remaining 35%, the theoretical and conceptual underpinnings are generally only vaguely described in the screened corpus, although with a few exceptions. In sum, the reviewed literature reflects a 'multi-paradigmatic' approach. We propose that the popularity of FL could be explained by and accounted for by such a pragmatic but unprincipled approach. Our scoping review seems to indicate that, in the surveyed literature on FL, theoretical and methodological eclecticism and diversity are favoured as better capturing an emergent and not yet 'stable' phenomenon.

As previously emphasized, research is important for robust knowledge development, and convincing research applies – or is influenced by – a scientifically grounded paradigm. As we have found eclecticism and a reluctance to connect FL with elaborated theoretical perspectives or established paradigms, we propose that further development of FL as an instructional methodology would benefit from the use of more principled views on learning and instruction. In this case, it would involve robustly establishing the connections between a pedagogical principle (active learning) and a didactic principle (flipped learning).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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