



Higher education dominance and siloed knowledge: a systematic review of flipped classroom research

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Abstract

This structured review examined (academic) publications on flipped or inverted classrooms based on all Scopus database ($n = 530$) references available until mid-June 2016. The flipped or inverted classroom approach has gained widespread attention during the latest decade and is based on the idea of improving student learning by prepared self-studies via technology-based resources ('flips') followed by high-quality, in-class teaching and learning activities. However, only a few attempts have been made to review the knowledge of the field of interest more systematically. This article seeks to address this problem and investigates what constitutes the research on flipped classrooms and, in particular, to examine the knowledge contributions with the field so far in relation to the wider research topic of educational technology. This review found that the current state of flipped classrooms as a field of interest is growing fast, with a slight conference preference and a focus on higher education and STEM (science, technology, engineering and math) area contributions, with the US as the predominant geographical context. It is concluded that studies on flipped classrooms are dominated by studies in higher education sector and are relatively local in character. The research tends not to interact beyond the two clusters of general education/educational technology and subject-specific areas. This implies that knowledge contributions related to the flipped classroom approach are relatively siloed and fragmented and have yet to stabilise. Academically and socially, the research is quite scattered, and only local evidence and experiences are available. The knowledge contributions within this field of interest seem to be anecdotal rather than systematically researched. To a large extent, the research lacks anchoring in, for example, learning theory or instructional design known from educational technology traditions and which would have helped much of the flipped classroom research to examine aspects of the flipped classroom approach more fully.

Introduction

The increase of user-generated and collectively shared knowledge content on the Internet has affected education and teaching in a variety of ways. One particularly popular approach for teachers to produce and share knowledge content as part of their professional practices is the so-called flipped or inverted classroom approach. The basic purpose of flipping the classroom, often ascribed to Bergmann and Sams (2012a, 2012b), is to reallocate activities traditionally conducted within the classroom, such as lectures, to educational resources that students engage with before attending class. This

reallocation is intended to free classroom time for creating meaningful learning situations for in-class interaction between students and teachers. For realising the flipped or inverted classroom approach, social media has become an important platform for sharing educational resources in the form of blog posts, YouTube videos or other media through social networking sites. Combined with the use of social networking to share educational resources with students, social media communities have also become important sites for mobilising educators within the flipped or inverted classroom movement through the sharing of experiences and resources (e.g., Cho, Ro, & Littenberg-Tobias, 2013; Duncan-Howell, 2010). The movement can both be characterised by its grassroots-level formation and by its teaching-practice orientation with a heavy focus on knowledge content development, epitomised by 'the flip' itself. In this paper, we review the existing research literature available on the flipped or inverted classroom as an approach and as a movement.

During our preliminary explorations of the literature, we noticed that the search for evidence of the effectiveness of and improvements engendered by the flipped or inverted classroom approach is becoming frequent. This is illustrated by several recent articles in international journals on higher education studies (Flores, del-Arco, & Silva, 2016; Kim, Kim, Khera, & Getman, 2014; Nouri, 2016; O'Flaherty, Phillips, Karanicolas, Snelling, & Winning, 2015; Park, Yu, & Jo, 2016; Westerman, Daniel, & Bowman, 2016). Based on this development, it is timely to systematically review this emerging field of research and, in particular, the field's contribution to shared knowledge on the flipped or inverted classroom phenomenon. By conducting a systematic review, our interest has been to explore the focus of the most-cited research and how research on the flipped or inverted classroom approach and movement as a field of interest is developing within the educational sector. As both advocates and critics continue to discuss the effectiveness of the approach, it is important to openly approach and scrutinise the knowledge claims of the field while providing a well-grounded and systematically mapped analysis of existing research.

As our review will show, a rich spectrum of local experiments and experiences on the approach have been reported in a wide array of publication forms. This variety informed our choice of research review methodology and our selection of the multidisciplinary abstract and citation database Scopus (www.scopus.com). The review covers all peer-reviewed publications on the topic of flipped or inverted classrooms published between the beginning of 2000 and mid-June 2016. As we will show, there was a considerable increase in research contributions in the period between 2012 and mid-June 2016 and in particular from the higher education area, with the term 'flipped classroom' becoming more common and the previously widespread term 'inverted classroom', used in the first publication on the topic (Lage & Platt, 2000, losing ground. Hereafter we will only refer to the term flipped classroom and assume that it also includes the term inverted classroom.

Only a few reviews of the research on flipped classrooms have been conducted so far (e.g., Bishop & Verlinger, 2013; O'Flaherty et al., 2015). In their recent paper from *Internet and Higher Education*, O'Flaherty et al.'s (2015) review offers one of the more recent and noteworthy accounts of the field of interest through

a scoping method focussed on explicitly identified higher education references. The review is mainly concerned with evidence of how the approach could be improved through 'the exploration of key aspects of the flipped class that influence its effectiveness and contribute to an improved student flipped learning experience' (p. 86). Their conclusion is that the current research lacks a shared conceptual framework for understanding learning (both in pre-class, post-class and face-to-face learning activities),

resulting in a lack of clarity and heavy content focus; an under-developed capacity to blueprint, that is, to translate conceptual frameworks into context-specific plans and a lack of understanding of how to design and support inquiry-based learning and metacognition in a flipped learning curriculum. (O'Flaherty et al., p. 94)

Thus, their review points to several problematic aspects of the current developments within the higher education research field, including a technology-driven orientation that neglects learning aspects and an insufficient capacity for developing shared knowledge and a conceptualisation of the approach. Our review complements this earlier scoping review with more current data and seeks to address the current state of research on the flipped classroom more comprehensively by conducting a systematic research review across the literature with the intention of generating a broader impression of the field of interest that can then be discussed in relation to higher education. As part of this review, we will first explore the knowledge base and claims made in the available research and then discuss the contributions and developments of this emerging field.

Aim and research questions

The overall aim of our systematic review is to investigate what constitutes the research on flipped classrooms and in particular to examine the knowledge contributions within the field so far and relate them to the wider research topic of educational technology in relation to higher education. The research questions that guided this review are as follows:

- How can the field of interest around the flipped classroom approach be described and problematised based on the most-cited publications?
 - What characterises the studies in terms of focus, setting (educational system, academic subject and country), methods and empirical data? How does the research interact?
 - What kind of knowledge is this field of interest aiming to develop?
 - What can be said of the current state of the field as an approach and a movement, and what future research is needed?

The questions can be classified into two areas of interest: one more descriptive-quantitative for mapping current research and one more epistemological-qualitative to understand the its knowledge foundations and developments of the field. Each of these areas of interest will be developed further in the remainder of this paper.

Methods and methodological approach

Our choice to conduct a systematic research review process is based on the need to develop systematic knowledge around the flipped classroom approach. The knowledge contributions of this emerging field of research are still in the making, and a systematic review should be of use for practitioners, scholars and stakeholders. One particular concern is how this field of interest is emerging and interacting within the wider research domains of educational technology. Earlier analyses of the research characteristics of educational technology, which include scientific areas such as educational science, cognitive psychology and computer science, also inform our analysis. Bulfin, Henderson, Johnson, and Selwyn's (2014) survey of methodological preferences based on 462 researchers showed that the research field of educational technology has a preference for descriptive and qualitative studies. Furthermore, Kalz and Specht's (2014) scientometric analysis of 3,476 scientific publications within technology-enhanced learning illustrates that disciplinary variety and a cross-disciplinary nature are common features. As part of our work, we also considered the impact of systematic, evidence-based research methodology, including how it has been criticised, e.g., in educational science (Biesta, 2007; Denzin, 2009; Hammersley, 2001). We agree with the critique that too much emphasis on the quantification of research and education performances for the purposes of comparability and impact for competitiveness is problematic, especially within fields characterised by a cross-disciplinary nature, local ideological education differences as well as commercial technology interests. However, taking this critique into account, we found it useful to combine quantitative selection principles with qualitative, in-depth analyses and a problematising stance towards reviewing in our analysis of the emerging research on the flipped classroom approach.

We have chosen to describe research on the flipped classroom approach as a field of interest, as the research currently has no stable disciplinary basis or established claims of validity (see, for example, Whitley, 2000). However, the research that has emerged to date socially and collectively shares rather similar views of the approach itself, the technology used and the need for recognition from practitioners. Based on these characteristics, we have chosen citation frequency as a selection instrument as the most-cited references are presumed to have a certain social impact. Citation frequency is thus not taken to be a proxy for quality but as an indicator of which texts are widely used in this emerging field of research.

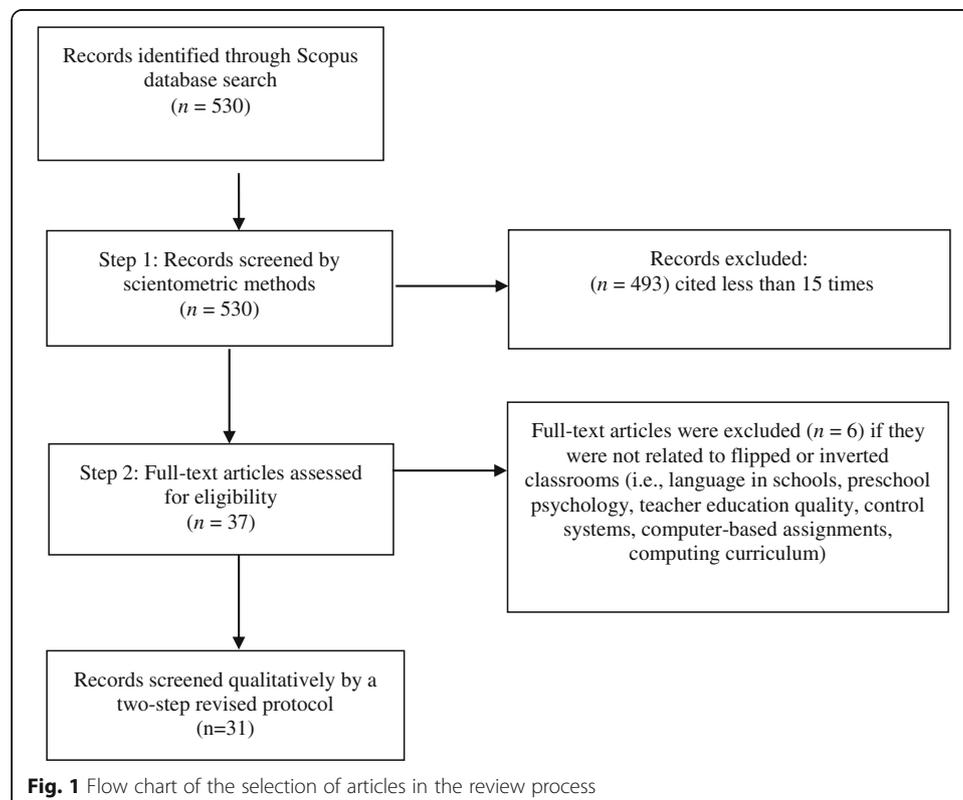
With our choice of methods and tools for the selection and analysis of data, the aim was to make the research process as transparent as possible in terms of systematic and conceptual positions. Consequentially, our review has been carried out following the nine tasks for systematic reviews suggested by Gough (2007, p. 218–219):

- (1) establishing the review question and protocols
- (2) defining studies to be included or excluded
- (3) articulating the search strategy and choosing information sources
- (4) screening the articles based on the inclusion/exclusion criteria
- (5) mapping the results of the search strategy in a flowchart
- (6) extracting relevant descriptive data from included studies
- (7) appraising the methodological quality of included studies

- (8) synthesising, either by aggregating or interpreting the contributions of the included studies
- (9) communicating and discussing the synthesis

With the review questions and protocols defined, we conducted a search for flipped classroom–related literature on June 22nd, 2016, in Elsevier’s Scopus database. Initially we tested both Scopus and Thomson-Reuters’s Web of Knowledge (now Web of Sciences and maintained by Clarivate Analytics) for comparisons based on similar search queries. Scopus was selected as it covers a wider array of peer-reviewed references and is more multidisciplinary in character (with scientific, medical, social sciences, the arts and humanities and technical literature included). The particular search string used in Scopus was ‘TITLE-ABS-KEY (flipped OR inverted) AND TITLE-ABS-KEY (classroom)’. This search term queried the database for all results where the terms ‘flipped classroom’ or ‘inverted classroom’ appear in the title, abstract or keywords of publications. The search produced 530 records consisting of journal articles and conference proceeding papers. In the flow chart shown in Fig. 1, the selection of records using the Scopus results has been described. Important aspects of the process will be discussed further.

In step 1, 530 publications were identified. While we did not examine the number of false positives produced by the search criteria for this step, such an examination was performed for the most-cited publications in step 2, and it is reasonable to assume that the false-positive rate of 16% identified for highly cited



publications is similar to the rate for the wider dataset. For the publications identified in step 1, both descriptive as well as aggregated analyses of co-occurrences of keywords and records were conducted to find relevant information about the dataset. For processing the data retrieved from Scopus, we used several tools, including Microsoft Excel for basic processing and sorting, and Elsevier's Mendeley as a reference manager tool. Co-occurrence analyses were conducted using VOSviewer (van Eck & Waltman, 2010) and Yasu Imao's CasualConc application (sites.google.com/site/casualconc/), and the results are presented in the step 1 subsection of the results section.

In step 2 of the review process, a further selection and extraction phase was conducted where 37 publications cited 15 or more times were selected for manual screening by a review panel based on an extended review protocol. All references were given an identification number from 1 to 37, where number 1 was the most cited. These identification numbers have also been used to identify the publications in the results section. There were 6 publications that were excluded (numbers 16, 21, 27, 34, 36 and 37) since they were determined to be unrelated to the flipped or inverted classroom approach during manual screening (a false-positive rate of 16%). The remaining 31 records are included in [Appendix 1](#), and the excluded false-positive publications are listed in [Appendix 2](#). The manual screening of the 31 records was based on a protocol-driven process, resulting in 2 protocols and adherent questions that formed the basis for the records listed in [Appendix 1](#). The results of step 2 are presented in the step 2 subsection of the results section.

In step 2, the 31 selected records were first classified based on the metadata of the author, year, title, source title, volume/issue/pages, citations, document type and URL. The publications were then distributed amongst a panel of research project team members for further examination based on a shared protocol. The protocol was iterated and is reported in [Appendix 1](#). The following questions were examined and reported first for each publication:

- What keywords are declared for the publication?
- Does the publication refer to a specific country, where is the study conducted?
- Did the publication undergo peer review or not?
- What type of publication is it (article, conference paper, editorial, etc.)?
- Which domain or educational sector does the publication concern?
- What is the character of the publication—practitioner report, academic contribution or other?
- What is the finding or conclusion of the publication, e.g., improving practice or learning?
- Based on the above, is the publication of high, low or medium relevance for the review?

The protocol was then expanded with the following questions:

- What are the aim/focus/research questions mentioned, with specific regard to the verbs used (develop, implement, evaluate, etc.)?

- Are pedagogical/learning theories mentioned, and, if so, are they implicit or explicit? Are theories robustly used, referenced and explained, or are more everyday, ad hoc buzzword orientations used?
- What is the quality of the method and references used? Is the quality low, medium or high? Lower quality is defined as, e.g., smaller populations, relying on local case studies/in-house experiences and no explicit methodology or theoretical base, and higher quality is defined as, e.g., the methods are explained, analytical tools are provided, methodological considerations are included and theoretical references are used.

This systematic review is a part of a larger research project on the flipped education movement (funded by the Swedish Research Council 2015–2017). In parallel to the review process, the project team gained insight into the field based on interviews, surveys and large-scale computational statistics on the approach and relevant social media communities. All five of the project members constituted a review panel for this systematic review and contributed to a protocol-driven, iterative process of reviewing. All protocols were synthesised, discussed and also refined to improve the design of the review throughout the process. In addition, to account for intersubjective validity and problems of bias, different members of the review panel examined a random sample of the records, and two panel members verified all excluded records. In the next section, the results of step 1 and step 2 of the review process are presented, followed by a discussion of the synthesis developed from the results of the process.

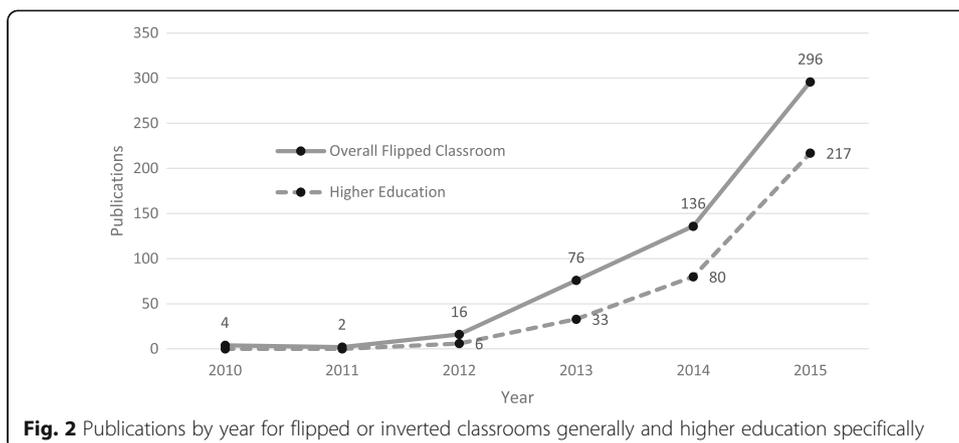
Results

The results of this systematic review will be presented under two headings referring to the two steps in the review process. First, we provide a descriptive-quantitative mapping and aggregation of the current research based on the 530 most-cited publications from step 1 in the review. Second, we present descriptive-quantitative data from step 2, mapping the flipped classroom research based on those 31 publications cited 15 or more times due to our interest in the most used publications in the field. Included here are analyses of the types of knowledge contributions made in the reviewed literature with regard to overall research characteristics as well as the epistemological basis for the field of flipped classroom research.

Step 1: Characteristics of the flipped classroom field of interest

To provide a context for flipped classrooms as a field of interest, some basic characteristics of the sample of the 530 most-cited publications are presented. The first characteristic concerns a substantial growth of publications starting in 2011 (Fig. 2). Here, we have not taken the 16% of publications that were false positives into account, as the aim of this part of the results is to characterise the emerging field of interest in relative terms.

Figure 2 shows that the rate of academic publications concerned with flipped classrooms increased substantially between 2011 and the end of 2015. This period started



with two publications in 2011, followed by 16 publications in 2012, 76 publications in 2013, 136 publications in 2014, and 296 publications in 2015. This substantial increase in the number of academic publications concerned with flipped classrooms indicates, we will argue, an emerging movement of the flipped classroom as a field of interest. This is underscored in relation to higher education, where the proportion of those publications with ‘higher education’ in the title, keywords or abstract within the overall corpus is significant. In 2012, higher education publications represented 38% of the total number, while by 2015 they represented 73%. This indicates a particularly strong growth of interest in relation to higher education and suggests that higher education has come to dominate the scientific discourse around the flipped classroom phenomenon.

Geographically, the research on flipped classroom is dominated by publications from the United States. Despite some contributions from countries such as India and Malaysia, the Global South is generally underrepresented in our corpus, and largely English-speaking countries dominate (see Table 1).

Similar distributional patterns are seen in the research review by O’Flaherty et al. (2015), but our data highlights the relatively low number of contributions from European countries. While much of the U.S. dominance in publications could be accounted for by a general Anglo-Saxon dominance in academic publishing, it should also be noted that the flipped classroom approach was first popularised in secondary education

Table 1 Publications by country of first-author affiliation

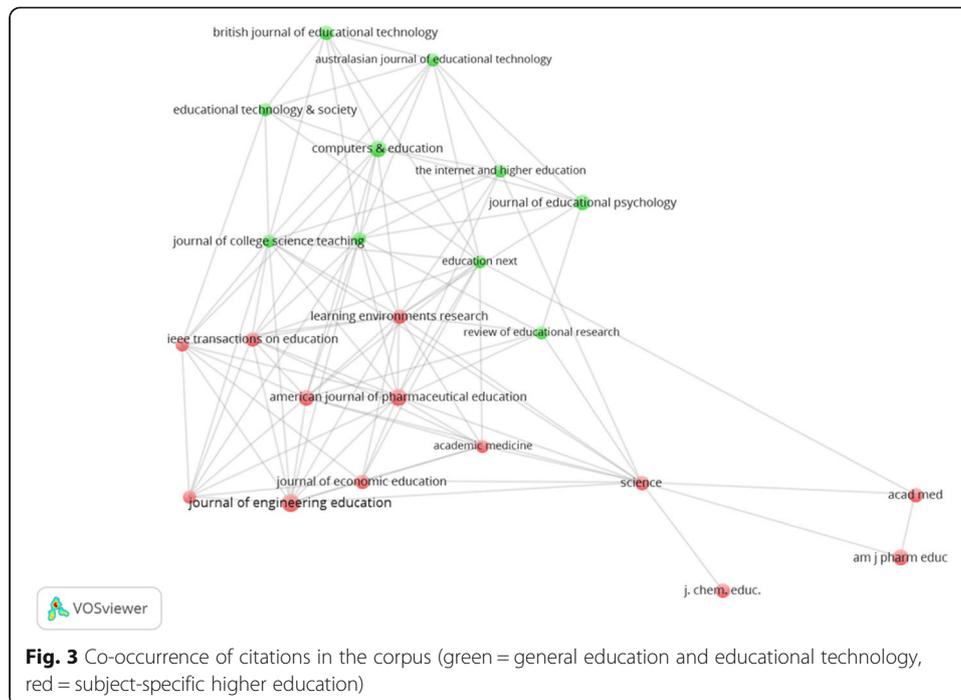
United States (321)	Norway (9)	Finland (4)	Qatar (3)	Switzerland (2)	Iran (1)
Australia (31)	India (8)	Greece (4)	Saudi Arabia (3)	Austria (1)	Oman (1)
China (26)	Malaysia (7)	South Korea (4)	Sweden (3)	Bahrain (1)	Poland (1)
Canada (17)	Japan (6)	Turkey (4)	Thailand (3)	Chile (1)	Russia (1)
United Kingdom (16)	Spain (6)	Denmark (3)	Israel (2)	Colombia (1)	Saint Kitts and Nevis (1)
Germany (14)	Brazil (5)	France (3)	The Netherlands (2)	Croatia (1)	Sudan (1)
Taiwan (14)	Hong Kong (5)	Ireland (3)	Puerto Rico (2)	Egypt (1)	Undefined (8)
Italy (10)	Singapore (5)	New Zealand (3)	South Africa (2)	Indonesia (1)	

by two teachers, Bergmann and Sams (2012a, 2012b), both of whom are active within the U.S. educational context. Similarly, as the second-most prolific country, Australia's educational context has a strong tradition of technology-based and student-centred education forms that may well set the stage for strong engagement with the flipped classroom approach.

Overall, within the corpus, conference papers are the dominant form of publication, accounting for 55% of publications with journal articles making up the remaining 45%. However, this trend appears to be shifting, with a decrease in the relative dominance of conference papers in 2014 and 2015. The early dominance of conference papers over journal articles may be partly due to the flipped classroom being a rather new field of interest, where conference papers are used as a format for sharing preliminary results. Within our corpus, the most common publication venue is the proceedings of the American Society for Engineering Education's (ASEE's) *Annual Conference and Exposition* with 84 publications. The second-most common publication venue is the proceedings of the *Frontiers in Education Conference* of the Institute of Electrical and Electronics Engineers (IEEE) with 33 publications. This suggests that both ASEE's *Annual Conference and Exposition* and IEEE's *Frontiers in Education Conference* are publication venues used by researchers and practitioners to channel preliminary results to the engineering education community. It is not until the third-most common publication venue, *PRIMUS: Problems, Resources and Issues in Mathematics Undergraduate Studies* with 24 publications, that a journal appears. To sum up so far, the flipped classroom as a field of interest is currently engaged with sharing experiences and methods about the flipped classroom approach by providing preliminary results in conference proceedings and in journal articles, the former of which are slightly predominant. What is interesting is that such sharing of experiences and methods seems to be carried out within specific subject fields or educational domains, predominantly higher education, along with specific subject areas, such as engineering education, computer science and mathematics education.

The majority of the publications in our corpus are associated with a particular subject area, distributed as follows: social sciences (329 publications, 62% total), computer science (199 publications, 38% total), engineering (162 publications, 31% total), medicine (47 publications, 9% total) and mathematics (35 publications, 7% total). This implies that the most-cited publications related to flipped classrooms can be located in well-defined subject areas, and as illustrated before, commonly within the STEM (science, technology, engineering, mathematics) areas.

Based on co-occurring citations, that is, the interaction of publications as they refer to each other, we can see the dominance of STEM areas again, particularly engineering, natural science and medicine. Within the data, two strong clusters are formed: one in the subject-specific higher education domain (marked in red in Fig. 3) and another representing the domains of general education and educational technology (marked in green in Fig. 3). Within the educational technology domain, three journals dominate: *Computers & Education*, *Educational Technology & Society*, and *British Journal of Educational Technology*. Closely following these are the



Internet and Higher Education and the *Australasian Journal of Educational Technology*. Again, the growing importance of journal publications within this field is made visible. Generally, there is a relatively low degree of interaction within the field as a whole, with the exception of some parts of the subject-specific areas and among certain conference publication venues. This suggests that much of the research discourse on flipped classrooms is constrained to clusters and in particular subject-specific silos, most often within the STEM higher education area (Fig. 3). The source data and co-citations within these fields suggests that studies on the flipped classroom phenomenon remain relatively local in character and tend not to refer to publications outside of their respective field clusters or get cited outside of those clusters. Only parts of the subject-specific domain show a strong discourse of internally citing earlier studies. This lack of interaction between fields, visible in Fig. 3, implies that the knowledge contribution of the flipped classroom as a field of interest has yet to stabilise. Academically and socially, the research is characterised by a low degree of interaction and a significant divide between the general education/educational technology areas and subject-specific domains.

To summarise this first result section based on descriptive-quantitative data from our corpus of the 530 most-cited publications, the current state of the flipped classroom as a field of interest can be described as growing fast with a slight preference for conference proceedings and a predominance of STEM and medical contributions. Furthermore, as the field of flipped classrooms seems to be fragmented with low interactivity, it also reflects trends in research within the wider field of educational technology. As argued by Selwyn (2012), research on educational technology is constituted by 'different tribes', each with a 'particular interest and motives for studying technology and education' (p. 213). Such tribal work leaves little

‘collective impetus for making the field anything more than the sum of its parts’ (p. 213). In the context of the flipped classroom, such isolated tribes and local subject area studies are manifested in the evident lack of interaction between subject fields. The data shows that the focus of most studies on flipped classrooms is subject-specific instructional designs.

Step 2: Mapping flipped classrooms as a field of interest

In this section, we present those 31 publications cited 15 or more times in our corpus of 530 records from step 2. First, 37 publications were selected on the basis that they had received 15 or more citations. Six of these publications were identified as false positives that did not actually address the flipped classroom approach, resulting in a selection of the 31 most-cited publications on flipped classrooms. This list of most-cited publications confirms the predominance of American researchers as 30 of the 31 records has a first author affiliated with a U.S. institution. All published by U.S.-based researchers, the top 6 publications were cited 50 or more times. These publications are presented in Table 2.

The six most-cited studies use a variety of concepts to describe the teaching strategies employed, and most of them combine the concepts in their definitions. The most common concepts used are *the flipped classroom approach* (Mason, Shuman, & Cook, 2013; McLaughlin et al., 2014; Prober & Khan, 2013; Strayer, 2012; Tucker, 2012) and *the inverted classroom* (Gannod, Burge, & Helmick, 2008; Mason et al., 2013; Strayer,

Table 2 Location, publication type, publication source’s impact factor and number of citations of the 6 most-cited publications in the field of flipped classrooms

(Study number) author details	Year	Type of publication	Title	No. of citations	Publisher	First author location
(1) Strayer	2012	Article	How learning in an inverted classroom influences cooperation, innovation and task orientation	142	Learning Environments Research	US
(2) Tucker	2012	Note	The flipped classroom: Online instruction at home frees class time for learning	121	Education Next	US
(3) McLaughlin et al.	2014	Article	The flipped classroom: A course redesign to foster learning and engagement in a health professions school	84	Academic Medicine	US
(4) Mason, Shuman & Cook	2013	Article	Comparing the effectiveness of an inverted classroom to a traditional classroom in an upper-division engineering course	81	IEEE Transactions on Education	US
(5) Gannod, Burge & Helmick	2008	Conference paper	Using the inverted classroom to teach software engineering	71	International Conference of Software Engineering	US
(6) Prober & Khan	2013	Article	Medical education reimagined: A call to action	50	Academic Medicine	US

2012). Some studies specifically acknowledge *active learning* (Mason et al., 2013; McLaughlin et al., 2014), and one study also names *blended learning* (Strayer, 2012). These two concepts can also be found in a wide range of studies across the whole corpus.

In the six most-cited studies, the flipped approach is generally defined as a strategy that 'relies on technology to introduce students to course content outside of the classroom so that students can engage that content at a deeper level inside the classroom' (Strayer, 2012, p. 171). The core idea is to 'flip the common instructional approach', enabling the classroom to be a place 'to work through problems, advance concepts, and engage in collaborative learning' (Tucker, 2012, p. 82) by mixing 'the use of technology with hands-on activities' (Gannod et al., 2008, p. 777). These definitions rest on the assumption that flipped teaching alters traditional instruction so that deeper levels of learning can take place in class rather than rely on homework (Gannod et al., 2008; Mason et al., 2013; McLaughlin et al., 2014; Prober & Khan, 2013; Strayer, 2012; Tucker, 2012). The most common advantages expressed in the six most-cited publications are that the flipped classroom approach focusses student-centred and collaborative, problem-based learning activities, thus enabling teachers to spend more time identifying student problems and knowledge gaps (Mason et al., 2013; McLaughlin et al., 2014; Prober & Khan, 2013; Strayer, 2012). They also indicate that the approach allows teachers to cover more course material (Mason et al., 2013) and engage directly with students when they are involved in in-depth learning activities (Gannod et al., 2008; Prober & Khan, 2013; Strayer, 2012). Moreover, the publications suggest that the approach makes it possible to foster a 'shared responsibility between students and instructors' (McLaughlin et al., 2014, p. 242), and overall, optimising classroom time is often specifically emphasised (Gannod et al., 2008; Mason et al., 2013; McLaughlin et al., 2014; Tucker, 2012). The flip is usually referred to as a video clip (Gannod et al., 2008; Mason et al., 2013; Tucker, 2012), but other interactive technologies or materials such as textbooks and handouts are also mentioned (McLaughlin et al., 2014; Prober & Khan, 2013; Strayer, 2012). The main advantage of using video clips to flip the classroom is described as enabling students to watch content as many times as needed (Prober & Khan, 2013).

Most of the six most-cited publications focus specifically on the opportunities created by implementing the flipped classroom approach. However, there are some exceptions, with some results showing that students were less satisfied with how classroom structures oriented them to the learning content of the tasks in a course using the flipped classroom approach (McLaughlin et al., 2014). Even if they collaborated more, the students also reported having to adjust to different ways of orienting to the learning activities, including flips, mini-lectures, collaborative work and discussions with the teachers, whereas in the traditional classroom, the structure supporting the learning tasks was well established (Strayer, 2012). For the flipped classroom approach to be successful, it is argued that it is important to rigorously structure classroom activities and flips so that they coherently support one another. If the flip and the classroom activities are not carefully aligned, flips may instead become a barrier to the students' learning (Strayer, 2012).

Across the six most-cited studies, the flipped classroom approach is also discussed in terms of a potential solution for teachers to respond to the increasing pressure to implement and use digital technologies in their teaching (Tucker, 2012). In one publication, the pros and cons of using video clips produced by private companies are discussed (Tucker, 2012), and the novelty of the flipped classroom approach is also questioned when it is argued that teachers have a tradition of asking students to prepare before class by, for example, doing readings (Strayer, 2012; Tucker, 2012). Instead, the novelty of the flipped classroom approach is described as ‘the regular and systematic use of interactive technology in the learning process’ (Strayer, 2012, p. 172). Furthermore, the stability of the approach is also considered in the publications as formal schooling and higher education has a long history of implementing instructional approaches that are later abandoned, indicating that ‘there’s a real danger that flipping, a seemingly simple idea that is profound in practice, may be reduced into the latest educational fad’ (Tucker, 2012, p. 83).

As Table 2 shows, 4 of the 6 most-cited publications are journal articles. Among the 31 most-cited publications, 26 of the publications are journal articles, and only 4 are conference papers. This is in contrast somewhat to the slightly stronger conference paper discourse identified in step 1 of the review. Still, the second-most-cited publication in the field of flipped classrooms is a conference note on the development of the approach (Tucker, 2012). Although conference publications have high status in some disciplines, such as computer science, there is a clear preference for citing journal articles over conference papers in the field of flipped classrooms. An explanation for this can be that a journal article is often a more recent but also a more authoritative record of a study that has been validated by a more elaborate peer-review system. Of the 26 journal articles among the 31 most-cited publications (see Appendix 1), 4 were published in the *American Journal of Pharmaceutical Education* (10, 15, 16, 25), 3 in *Academic Medicine* (4, 7, 12), 2 in *Phi Delta Kappan* (23, 29), 2 in *Computers & Education* (31, 36), 2 in *Internet and Higher Education* (19, 28). The remaining 13 articles were published in 13 different journals. This shows that a significant proportion of the most-cited journal articles were published in well-established, high-ranked journals. In particular, it suggests that medical and pharmaceutical education is influential as empirical contexts within the field of flipped classroom research, with educational technology journals beginning to gain some influence. This differentiation between subject-specific areas and more general and educational technology-based fields further adds credence to the perception that the field of flipped classroom research is rather siloed and fragmented and therefore still evolving.

While they are fragmented in terms of the subject area of interest, the most-cited publications are relatively homogenous when it comes to educational level of interest. Publications addressing higher education contexts make up 25 of the 31 most-cited publications, compared to only 4 publications addressing K–12 schools (13, 20, 22, 28). This is an interesting finding since the flipped classroom approach is regarded to have first emerged within K–12 educational contexts (Ash, 2012). As will be discussed in the next section, many of these higher education publications rely on local case studies and aim to improve practice and student outcomes.

Types of knowledge contributions based on flipped classrooms and their epistemological basis

This section details an epistemological-qualitative analysis to understand the knowledge foundations of flipped classrooms as a field of interest. In this analysis, we have coded the subset of the 31 most-cited publications (see [Appendix 1](#)) with regard to the types of knowledge contributions made. These relate to the following research characteristics: focus, methods, data, theory use, conclusions and the type of text contribution (note that the same publication can appear in more than one category). The results of this analysis are presented in [Table 3](#).

As already established, 25 of the 31 records are from the higher education sector, leaving only 6 of the records from other educational areas (2, 7, 13, 20, 22, 28). The character of most of the publications is that they are locally situated in terms of their sample or case. In addition, 26 of the 31 publications (all but 2, 7, 13, 20, 22, 28) are based on teachers reporting their own practices and the context of a single higher education course or classroom experience or, similarly, a specific curricular aspect within a disciplinary subject area. The number of (mostly student) respondents in empirical studies varies but is most commonly between 20 and 40 for a smaller higher education course, with a few examples having over 500. Such small sample sizes for local case studies might not be a problem if the flipped classroom approach used in these studies was fully theorised and operationalised in terms of a specified design (e.g., of content, pedagogy, technology use, etc.). However, basic descriptions are often lacking, making high-quality empirical research characteristics rare amongst the 31 most-cited publications. Commonly, the flipped classroom approach is taken for granted as effective in improving student learning, and the experimental setting or flipped classroom approach used is not fully described. Added to this, the choice of methods is generally inappropriate for showing improved student learning or making in-depth qualitative analyses of whether learning occurred. A considerable number, 19 records, makes use of comparisons of student results or motivation changes within small sample settings. In 16 references, basic survey data, like course questionnaires or examples from students' pre- and post-tests, are often compared over two courses or between two courses

Table 3 Types of knowledge contributions based upon review sample ($N = 31$)

Type of knowledge contribution	Characteristics	Quantity	Studies (identified by the previous numbering, see also Appendix 1)
Studies that are local in character	Studies of local course experiments, subject-specific areas, case studies, etc.	26	1, 3–10, 12, 14, 15, 17–20, 22–26, 31–33, 35
Claims of improved student learning and/or student motivation	Argue that Flipped classrooms enhance student learning or motivation, often by comparing with a traditional teaching approach	19	3, 4, 6–10, 12, 14, 15, 17, 19, 20, 23–26, 28–33, 35
Comparisons of Flipped classrooms/Inverted classrooms to other forms provided	Comparing Flipped classrooms/Inverted classrooms (mainly) to traditional forms of teaching	16	3–5, 7–10, 14, 15, 23, 25, 26, 30, 32, 33, 35
Opinion-based or reflection-based arguments around flipped classrooms	Typically editorials, reflections or opinion sections	4	2, 11, 13, 28
Learning/educational theories are explicit	Theoretical approach or understanding is explicit and referenced	11	1, 3, 6, 9, 18, 23, 24, 29, 31, 33, 35

(based on simple dichotomies of traditional versus flipped approaches). This methodological trend is often accompanied with the dismissal of traditional teaching as unsuccessful with the flipped classroom positioned as a solution. Thus, an argument regularly used in the 31 most-cited publications is that the flipped classroom approach improves student learning, but this claim is mainly evidenced by improved student test results or student self-reports of increased motivation. This suggests that the mainly positive results reported in the research may be an effect of the bias of self-reported studies undertaken by teachers themselves but may also be related to the rhetorical conviction and current hype around the flipped classroom approach. Only 4 of 31 references (2, 11, 13, 28) are opinion or reflection papers, but opinion-based arguments around the flipped classroom approach are also common within the overall sample. These arguments tend to describe the flipped classroom approach uncritically, without scientific consideration of empirical design or reference to earlier research. It should be noted that rather than explicitly using and referring to educational or learning theories, most studies instead refer to a mix of pedagogical terms or strategies (e.g., active, blended, inquiry-based, problem-based, flipped, student-centred learning, etc.) without describing or theoretically distinguishing them fully. Equally, these pedagogical terms or strategies are generally not considered in relation to the context in which a study was conducted, developed or reported. Empirically and theoretically, many of the most-cited flipped classroom studies do not draw on systematic or existing resources from other research or on related fields such as educational technology. Only one study explicitly stated the theoretical aim of developing the field of flipped classrooms (29).

Discussion and conclusions

In this article, we investigated the current state of research on the flipped classroom approach based on the most-cited publications selected from a multidisciplinary database search and systematic review process. Our focus concerned research characteristics (focus, setting, methods and empirical data), knowledge contributions and how the research on flipped classroom as a field of interest interacts. Our aim was to describe and problematise the current research by relating it to the wider field of educational technology to discuss the kinds of future research needed. The research questions we asked were as follows:

- How can the field of interest around the flipped classroom approach be described and problematised based on the most-cited publications?
 - What characterises the studies in terms of focus, setting (educational system, academic subject and country), methods and empirical data? How does the research interact?
 - What kind of knowledge is this field of interest aiming at developing?
 - What can be said of the current state of the field as an approach and a movement and what future research is needed?

The current state of flipped classroom studies as a field of interest can be described, based on our analysis, as growing fast, with a slight conference

preference and a focus on higher education and STEM area contributions, with the US as the predominant geographical context. It should be noted, however, that our systematic review was conducted based on database searches and citations of scientific publications in the English language, introducing a strong bias for certain geographical areas. Developments around flipped classrooms, especially outside the practices of higher education, are also taking form in other languages and in other, presumably faster, more ephemeral and more dispersed media than the ones examined. In particular, as social media and other user-generated forms of knowledge-sharing arenas that cut across national- and cultural-specific boundaries characterise both the instructional approach and how it has spread internationally, such media and sharing practices should be of significant interest for further developing a deeper understanding of how the movement of flipped classroom is emerging socially and technologically. Ideologically, it connects to strong societal and educational discourses of opening and making learning resources more accessible, re-usable and sustainable.

Based on the source data and co-citations in our corpus of scientific publications, we conclude that studies on flipped classrooms are dominated by higher education sector studies and are relatively local in character. The research tends not to interact beyond the two clusters of general education/educational technology and subject-specific areas. This implies that knowledge contributions related to the flipped classroom approach are relatively siloed and fragmented and have yet to stabilise. Since our review was conducted, some systematic reviews have been published and compiled in special issues, indicating that the instructional approach and research designs around flipped classroom studies are gaining interest (see e.g. Song, Jong, Chang, & Chen, 2017; Stöhr & Adawi, 2018) which testifies to an expanding research field. However, as a future field of research, its potential lies in a stronger alignment and interaction between such disciplinary fields as educational science, educational technology and subject-specific didactics so that results and research designs can be compared and developed. Based on our qualitative, protocol-based screening, it was shown that academically and socially, the research, as a movement, is quite scattered, and only local evidence and experiences are available. Small-size, local case studies and simple designs combined with empirical data, such as course questionnaires and student pre- and post-test results, constitute a large part of the research. Systematic evidence on the effectiveness of the approach as well as qualitative analyses of actual student learning based on empirical data is still rare. This is similar to the conclusion in the review by O'Flaherty et al. (2015, pp. 93-94), which stated that robust evidence on the effectiveness of the flipped classroom approach based on long-term or empirical validation is lacking and that better indicators for student engagement and conceptual use are needed. Our review complements the review by O'Flaherty et al. (2015) by more comprehensively conducting a systematic review across the literature and thus generating a broader impression of the field of interest. In doing so, our conclusion is that there is commonly a mismatch between the models of instruction and research methodology used that is visible in the discrepancy between espoused and applied learning theories in research designs.

Based on the full Scopus corpus of 530 records, we examined the co-occurrence of keywords amongst the author-selected keywords for each publication and found that active learning and blended learning stood out as specifically interesting with regard to our research questions concerning what kinds of knowledge the research on flipped classroom produces. The two themes are commonly regarded as operating on somewhat different levels. First, blended learning is a theme that considers education to be designed on a system level, whereas active learning considers education to be mediated by human practices. Examples from publications on flipped active learning show how constructivist and behaviourist learning theories are simultaneously used and how discovery-based learning instruction models are combined with a behaviouristic-experimental learning theory methodology. There is a notable absence of approaches to learning in theory, instructional models and methodology that explore more situated, observation-based aspects of the flipped classroom approach. The fact that active and blended learning as significant co-occurring keywords in the corpus implies that many studies are concerned with either system-organisational aspects or the social micropractice of the flipped classroom approach. This reflects the common understanding of the flipped classroom approach as reallocating education activities before class and creating meaningful interactive learning situations in class. However, as the theoretical and conceptual underpinnings are generally vague in the screened corpus, these aspects need further attention from future research.

To conclude, rigorous and empirically well-grounded studies currently seem to be rare in the research on flipped classrooms. Very few studies can make generalisable or transferrable knowledge claims and thereby contribute to the development of the field of interest around flipped classrooms. Therefore, it is difficult to identify when, under what circumstances and in what ways the flipped classroom approach might be relevant as a pedagogical choice. For future research, more systematic, both cumulative and empirically grounded knowledge is needed to build a stronger evidence base. Furthermore, a better anchoring in, for example, learning theory or instructional design or in established research methodologies from educational technology research traditions could improve the quality and usefulness of the flipped classroom approach. Our results and recommendations therefore support the conclusions of the earlier review by O'Flaherty et al. (2015) but also foreground the relative impact of the higher education sector, provide more systematic knowledge and offer a problematising stance on the siloed character of the research and its knowledge base. The problem of siloed research and an absence of a shared knowledge base and 'contribution awareness' beyond the clusters of educational technology and the STEM areas, for example, are well known within higher education research (Tight, 2014). In the case of higher education, siloed research is characterised by local cases within departments, subject areas, courses, etc. (Tight, 2012). Our results show that the research on flipped classrooms is similarly siloed, suggesting that achieving the goal of improving practice will be difficult if future research does not make explicit connections to earlier studies and results within the overall field of interest.

Appendix 1**Table 4** Records screened by a two-step revised protocol. (*n* = 31)

(Study number) Author details	Cited by Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
(1) Strayer	142	USA 2012 Mathematics Statistics Education HE	How the learning environment of an inverted introductory statistics classroom compares to the learning environment of a more traditional lecture-homework introduction to statistics classroom Inform teaching practice and suggest implications for structuring productive classroom learning communities.	Knowledge space theory A learning environment framework	Mixed-methods: qualitative and quantitative Experimental study: CUCEI instrument 28 and 27 students, one semester Study of researcher's own teaching practice	Concludes that students with the flipped classroom model are less satisfied with how classroom structure orients them to the learning tasks in the course, but are more open to cooperative learning and innovative teaching methods.
(2) Tucker	121	USA 2012 General	Historical description of development of flipped classroom approach	None	N/A	Reflects on who will control the tools and how their potential can be developed.
(3) McLaughlin, Roth, Giatt, Gharholonarehe, Davidson, Griffin, Esserman & Mumper	84	USA 2014 Pharmaceutical Education HE	Describe the philosophy and methodology used to redesign a basic pharmaceuticals course and outline the research conducted to investigate the outcomes the project Provide a guideline for instructors and educational programs seeking to develop, implement, and evaluate innovative and practical strategies to transform students' learning experience	Student-centred learning Problem-based learning Inquiry-oriented strategies Active learning pedagogy	162 students/2nd year/1 course/13 weeks/multiple campuses Experimental study: Pre-and post course surveys	Claims that class attendance, student learning and the perceived value of this model all increased after participation in the flipped classroom approach. Concludes that the approach for enhancing learning and foster students for coming health care needs warrants careful consideration for educators.
(4) Mason, Shuman & Cook	81	USA 2013 Engineering Education HE	Compare the effectiveness of an inverted classroom (IC) to a traditional classroom with regard to: Content coverage, student performance on traditional quizzes, exam problems, student	Active, cooperative and problem-based learning Learning styles and preferences	Two year-study: Traditional classroom (TC) used 1st year, IC 2nd year, 20 students each year, 10 week courses Control-treatment experiment comparing an IC to a TC	Argues that the IC approach compared to a traditional approach allowed the instructor to cover more material and that students in IC performed as well or better

Table 4 Records screened by a two-step revised protocol ($n = 31$) (Continued)

(Study number) Author details	Cited by	Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
(5) Gannod, Burge & Helmick	72	2008	USA Software Engineering Education Higher Education (HE)	observations and perception of the IC format	Cooperative, collaborative, active learning Learning theory essentials: the ideal learning situation is customized, provides immediate feedback, is constructive, motivates students to persist, and builds enduring conceptual structures	Mixed-methods Pilot study/24 students/Computing course Comparisons between traditional and inverted classroom models	on comparable quizzes, exam questions and on open-ended design problems. While students initially struggled with the new approach, they adapted quickly and found the IC format to be satisfactory and effective. Their experiences suggest how different courses from the Software Engineering 2004 Model Curriculum Volume can incorporate the flipped classroom approach.
(6) Prober & Khan	50	2013	USA Medical Education HE	Propose a new model for medical education based on the "flipped classroom" design to meet the digitally empowered learner, an expansion of biomedical knowledge and increased specialisation within the practice	Building a framework of core knowledge Embedding knowledge through interactive formats. Encouraging in-depth pursuit of specific knowledge failure of skin-deep learning (Alberts, Science)	141 respondents, 1st and 2nd year students	Identifies a need to define a core curriculum that can meet digitally competent learners. Suggests interactive exercises for enhancing the relevance and retention of students' knowledge and facilitation of in-depth learning fuelled by indi- vidual students' aptitude and passion.
(7) Davies, Dean & Ball	45	2013	USA Information Systems College	Flipping the classroom and instructional technology integration in a college-level information systems spreadsheet course	Make reference to approaches of computer- aided differentiated instruction, flipped and blended learning models,	Pre- -post test quasi-experimental method on student achievement within one course	A technology-enhanced flipped classroom was suggested to both be effective and scalable, and better facilitate learning than the simulation based

Table 4 Records screened by a two-step revised protocol ($n = 31$) (Continued)

(Study number) Author details	Cited by	Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
(8) Missildine, Fountain, & Summers, & Gosselin	43	2013	USA Adult health nursing courses HE	The purpose of the study was to determine the effects of FC approach on nursing students compared with a control group.	for improving student learning No, theoretical underpinning. A hybrid approach by implementing technologies measured by examination average and students' satisfaction is mentioned.	Quasi experimental design: comparing 3 approaches to learning 1. Traditional lectures 2. Lectures and lectures capture back-up 3. FC approach Two adult health nursing courses	training. Students also found this approach to be more motivating since it allowed for greater differentiation of instruction. Concludes that students were less satisfied with the flipped classroom method than with either of the other methods. Suggests that blending new teaching technologies with interactive classroom activities can result in improved learning but not necessarily improved student satisfaction.
(9) Pierce & Fox	43	2012	USA Pharmaceutical Education HE	To implement a "flipped classroom" model for a renal pharmacotherapy topic module and assess the impact on students' performance and attitudes	Transition of students from passive receptacles of information into active learners Learner-centeredness A process-oriented guided inquiry learning (POGIL) activity was used, based on a constructivist theory of learning	Design experiment, 8 week course, 71 students Experimental study: pre and post tests/group comparisons	Claims improved student performance and favourable student perceptions with the instructional approach, which includes student-mediated contact with the course material prior to classes, benchmarking and formative assessments administered during the module, and the interactive class activities.
(10) Tune, Sturek & Basil	42	2013	USA Cardiovascular, respiratory, and renal physiology course HE	Assess the effectiveness of a FC approach compared to a control group	None	Measuring test scores on exams Opinion surveys 27 students	Concludes that within a comparable group of graduate students, participants in the flipped course scored significantly higher. Exam averages for students in

Table 4 Records screened by a two-step revised protocol (n = 31) (Continued)

(Study number) Author details	Cited by	Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
(11) Mehta, Hull, Young & Stoller	42	2013	USA, Canada Medicine HE	Reviews innovations in learning (exemplified by a massive open online course (MOOC), Flipped classrooms, digital badges, challenging higher education and describe a new vision and model for medical education	Make reference to studies describing problems within medical education and that students lack feedback on clinical training	N/A	specific flipped course modules also tended to be higher. Student surveys implied that the use of homework and in-class quizzes were critical for motivation and likely contributed to the increase in student exam performance. Presents a vision for competency-based learner-centered medical education that can better meet the needs of the health care system.
(12) Enfield	36	2013	USA Undergraduate Multimedia course HE	Investigate the effectiveness of a FC –approach	None	Survey data of 50 students opinions on the effectiveness of a FC approach	Based on student reports the study suggest that the FC approach provided an engaging learning experience that was effective in helping students to learn the content and increased their self-efficacy in their ability to learn independently. N/A
(13) Goodwin	36	2013	USA General K-12 School	Reflection paper on how flipped classroom model might improve student-teacher interaction, feedback, homework, engagement and self-paced learning	Refer to the lack of research and some preliminary non scientific data (from for example the Flipped learning network)	N/A	N/A
(14) Ferreri & O'Connor	35	2013	USA Pharmaceutics course	Describe the redesign of a large lecture-based course into a small-group case-based course	Make references to studies oriented towards student-centered and active learning,	Assessment based on a two-year period, comparisons of students'	Concludes that compared to student experiences in a previous large lecture-based

Table 4 Records screened by a two-step revised protocol ($n = 31$) (Continued)

(Study number) Author details	Cited by	Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
(15) Pierce & Fox	33	2012	USA Pharmacotherapy HE	Report from a flipped classroom experiment using video lecture podcasts and in-class patient case discussion as exercises within a renal pharmacotherapy module	small-group and team-based learning	Design experiment, pre- and post-tests of student outcomes and motivations and comparisons between student groups.	class, students in the smaller-class format reported a preference for working in teams. Students also achieved significantly better academic grades with the new course format.
(17) Lage, Platt & Treglia	33	2000	USA Economics Education HE	Reflections on developing a inverted classroom	Process-oriented guided inquiry learning and students' active learning make instruction more efficient and improve student learning	Design experiment, pre- and post-tests of student outcomes and motivations and comparisons between student groups.	Claims that the flipped classroom model resulted in improved student performance and positive student attitudes towards the experience.
(18) Kim, Kim, Khera & Getman	31	2014	USA Engineering, sociology, humanities HE	Building on the RCOI framework, this study aimed to investigate participants' perceived values of the flipped classrooms with respect to the RCOI components and to elaborate a design framework from which design principles for the flipped classrooms could be specified.	Philosophical foundation: Internet provides students with an excellent complement, not substitute, not heir in-class efforts	Sharing experiences of working with a website with four distinct components and their affordances	Suggests that Internet-based studies provide students with an excellent complement not substitute to their in-class efforts, and can reach a more diverse student population.
(19) Critz & Knight	29	2013	USA Medicine HE	Evaluation of how good FC -approach is on students motivation	Revised Community of Inquiry (RCOI): cognitive, social, teaching and learner presence.	Mixed research methods: student survey, student interview, instructor reflection (115 students)	Proposes nine design principles for the FC classroom on the basis of the design framework that emerged from the data.

Reports positive outcomes of the flipped classroom model, which included online quizzes and intensive in class-learning

Table 4 Records screened by a two-step revised protocol (*n* = 31) (Continued)

(Study number) Author details	Cited by	Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
(20) Flumerfelt & Green	29	2013	USA General K-12	To provide a broad overview of the need for schools to reform	School reform theories by using car industry reforming models (Lean)	None. Provide reflections on the implications of using Lean as a model for school development	activities such as case studies, role-playing and group problem-solving exercises. Reflects on an example of a school projects which showed how continuous improvement changed the traditional use of time on task for instruction and created new opportunities for focusing on the process of learning and summative assessment work, operationalized through the use of screencast technology as instructional technology improvement.
(22) Fulton	28	2012	USA General K-2 school	Report on a school initiative on flipping the classroom with improved results in algebra. Presents 10 reasons for adopting the model.	None	Test scores are referred to.	N/A
(23) Wilson	27	2013	USA Undergraduate statistics course HE	Evaluation of how the FC approach affects student motivation	Fink's (2003) taxonomy of foundational knowledge Concepts used: application, integration, human dimension, caring and learning how to learn	Open-ended questions, course grade measurement 20–25 students over 4 semesters.	Results show that performance, as measured by final grades and performance on exams, was significantly higher in the flipped course. Although many of the new education strategies were successful, some students perceived their increased personal responsibility negatively.
(24) McLaughlin, Griffin, Esserman, Davidson, Giatt,	27	2013	USA Pharmacy education	To determine if flipping a traditional basic pharmaceuticals course would improve student	Transactional distance theory "which defines transactional distance as a	22 satellite students on 2 different campuses.	Suggests that thoughtful course design, enriched dialogue, and promotion of learner autonomy can

Table 4 Records screened by a two-step revised protocol ($n = 31$) (Continued)

(Study number) Author details	Cited by	Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
Roth, Gharikholonarehe & Mumper			HE	academic performance, engagement, and perception.	psychological and communication gap between the instructor and learner formed by psychological distance" Implicit psychological theories, which may support ideas of students "engagement", "motivation", and "critical thinking".	A survey was administered at the beginning and at the end of the flipped course. Both qualitative and quantitative analysis	enhance the quality of satellite students' experiences in a flipped basic pharmaceuticals course.
(25) Love, Hodge, Grandgenett, & Swift	26	2014	USA Mathematics, computer science, engineering HE	Compare the effectiveness of two specific instructional models – traditional lecture and a flipped model	None	Survey Student exams (55 students)	Students in the flipped classroom had a more significant increase between the sequential exams compared to the students in the traditional lecture section, while performing similarly in the final exam. The survey indicated that the flipped classroom students were very positive about their experience in the course, and particularly appreciated the student collaboration and instructional video components.
(26) Porter, Bailey-Lee & Simon	24	2013	USA Computer Science HE	Evaluating 10 years of instruction of 4 different courses spanning 16 Peer Instruction (PI) course instances.	Peer instruction and student feedback as student-centred teaching methods improve learning	Conducts a post-hoc, in-situ study of PI adoption in four different courses based on student success and fail rates over 10 years	Claims that the adoption of the PI methodology in the classroom reduces fail rates. For the same instructor teaching the same course, PI was found decreasing the fail rate.
(28) Bergmann & Sams	20	2012	USA General		Student centered approach	Argumentative reflections	Argues that flipped learning has great potential to positively

Table 4 Records screened by a two-step revised protocol ($n = 31$) (Continued)

(Study number) Author details	Cited by	Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
(29) Abeysekera, & Dawson	19	2015	USA General HE	Reflecting on FC –approach by focusing the f-to-f time in classroom	Theoretical model development	Self-determination theory: intrinsic and extrinsic motivation A cognitive load perspective	affect student learning. Suggest that it is more than just a trend in education and is gaining momentum, already making a difference for students. Construct a theoretical argument that flipped approaches might improve student motivation and help manage cognitive load.
(30) Baeppler, Walker, & Driessen	19	2014	USA Chemistry HE	Examines the effect of reducing seat time of a large lecture chemistry class by two-thirds and conducting it in an active learning classroom rather than a traditional amphitheater.	Active and blended learning	Experimental design, control group Post-test Standardized multiple-choice exam Survey	Demonstrated that in an active learning classroom, student faculty contact could be reduced by two-thirds and students achieved learning outcomes that were at least as good, and in one comparison significantly better than, those in a traditional classroom. Student perceptions of the learning environment were improved. This suggests that active learning classrooms are a more efficient use of physical space.
(31) Lockwood & Esselstein	19	2013	USA HE	Reports on an inverted classroom pilot in linear algebra and introductory programming classes.	Make reference to inverted and inquiry-based models, inspired by intelligent tutoring systems and assessment techniques	Informal data (online surveys, course evaluations and student demonstrations) from one course of 231 students in introductory programming during the 2011–2012 academic year was collected.	Preliminary results show students' appreciation of the inverted classroom model. In the course experiment an e-workbook was produced which is freely available.

Table 4 Records screened by a two-step revised protocol ($n = 31$) (Continued)

(Study number) Author details	Cited by	Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
(32) Smith	19	2013	USA Chemistry HE	The FC approach was implemented in two courses. Report the results of surveys of students' attitudes towards various aspects of the FC approach.	None, or implicit	Anonymous student survey at the end of the course. Students were asked to agree/disagree with statements regarding their attitude towards various aspects of the FC approach. Likert-type scale (1 to 5)	Based on survey results, the study indicates that students perceived the FC approach advantageous in multiple ways, even though it was perceived to be a time burden.
(33) Gilboy, Heinerichs, & Pazzaglia	16	2015	USA Health education/ nutrition course HE	to illustrate how to implement the flipped classroom and to describe students' perceptions of this approach within 2 undergraduate nutrition courses.	"sage on the stage" to "guide on the side" (King, 2013) – constructivist theory of learning. Bloom's taxonomy	Intervention and redesign of traditionally delivered course to blended course using flipped classroom as instructional approach. Development of a template that enabled faculty to design, before, during, and after class activities and assessments based on objectives using all levels of Bloom's taxonomy. Used on 148 students Student surveys	The majority of the 142 students completing the evaluation preferred the flipped method compared with traditional pedagogical strategies. The process described in the report was successful for both faculty and students.
(35) Chen, Wang, Kinshuk, & Chen	15	2014	"Holistic flipped classroom" environment HE	Develop a model that can provide a foundation for further research and practice for flipped learning in HE.	Learning by doing (Dewey) Learning by networking	Implementation of FLIPPED model Student surveys Interviews Computer system log analysis	Findings demonstrated that the proposed model was effective; students reported that they were satisfied with the course, their attendance improved, and their study efforts increased. Results also suggested that the transactional distance changed during the learning process: highly motivated students performed much better than less motivated students. Reflections have culminated in various examples, guidelines,

Table 4 Records screened by a two-step revised protocol ($n = 31$) (Continued)

Author details	Cited by	Year	Setting Country Subject area, Education level	Focus	Theoretical underpinnings	Methods	Outcomes
							and suggestions for practitioners as they consider their own design, implementation, and adoption.

Appendix 2

Table 5 Records excluded after manual screening in step 2 of the review ($n = 6$)

(Study number) Author details	Cited by	Year	Author keywords	Title	Journal
(16) Berridge et al.	33	2012	ADHD; Prefrontal Cortex; Cognition; Methylphenidate; Norepinephrine; Dopamine	Differential Sensitivity to Psychostimulants Across Prefrontal Cognitive Tasks: Differential Involvement of Noradrenergic α_1 - and α_2 -Receptors	Biological Psychiatry
(21) Rampton	29	2002	Applied linguistics; Code-switching; Foreign languages; Interaction; Language teaching; Ritual	Ritual and foreign language practices at school	Language in Society
(27) O'Flaherty et al	22	2015	Higher education; Flipped classroom; Scoping review; Educational outcomes; Face to face teaching; Engagement	The use of flipped classrooms in higher education: A scoping review	Internet and Higher Education
(34) Valiente, Swanson & Lemery-Chalfant	16	2012	Temperament, engagement; student-teacher relationship	Kindergartners' Temperament, Classroom Engagement, and Student-teacher Relationship: Moderation by Effortful Control	Social Development
(36) Malmberg, Hagger, Burn, Mutton & Colls	15	2010	Classroom quality, teacher-student interaction, teacher development, multilevel model	Observed Classroom Quality During Teacher Education and Two Years of Professional Practice	Journal of Educational Psychology
(37) Gelman & Nolan	15	2002	Classroom activity; Experimental design; Fair coin.	You Can Load a Die, But You Can't Bias a Coin	American Statistician

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Availability of data and materials

The dataset supporting the conclusions of this article comprise peer-reviewed scientific publications and these publications are included as references in the reference list.

Authors' contributions

All authors reviewed the research literature. The first author organized the review work and was main responsible for the development of the manuscript. All authors contributed to the analysis of the review. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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