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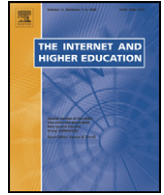
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# The use of flipped classrooms in higher education: A scoping review<sup>☆</sup>

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## ABSTRACT

There is increasing pressure for Higher Education institutions to undergo transformation, with education being seen as needing to adapt in ways that meet the conceptual needs of our time. Reflecting this is the rise of the flipped or inverted classroom. The purpose of this scoping review was to provide a comprehensive overview of relevant research regarding the emergence of the flipped classroom and the links to pedagogy and educational outcomes, identifying any gaps in the literature which could inform future design and evaluation. The scoping review is underpinned by the five-stage framework Arksey and O'Malley. The results indicate that there is much indirect evidence emerging of improved academic performance and student and staff satisfaction with the flipped approach but a paucity of conclusive evidence that it contributes to building lifelong learning and other 21st Century skills in under-graduate education and post-graduate education.

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## 1. Introduction

Institutions of higher education are facing increased scrutiny to improve student learning and demonstrate programme effectiveness. Even though academics have access to numerous online teaching tools we know that teaching and learning is not all about the technology. The literature tells us that one of the primary components of effective teaching is student engagement and that engagement is critical for learning (Barkley, 2010; Coates, 2006). This is also supported by Bryson and Hand (2007) who established that students were more likely to engage if they were supported by educators who established inviting learning environments, demanded high results, and challenged higher order thinking. Hockings, Cooke, Yamashita, McGinty, and Bowl (2008) suggest that students who are most deeply engaged will reflect, question, conjecture, evaluate and make connection between ideas. In contrast students who are disengaged appear to take a surface approach to learning by copying out notes, focusing on fragmented facts and jumping to conclusions.

Current educational approaches within higher education utilise blended learning; where students may for example, receive a combination of traditional face to face (F2F) instruction in class and are also required to complete activities outside of the class, facilitated through a range of technological resources. Blended learning has become increasingly popular in

higher education globally, forming the cornerstone of curriculum design and providing opportunity for learning not previously possible or available to students (Lage, Platt, & Treglia, 2000). Reflecting this is the rise of the flipped classroom or inverted classroom (Lage & Platt, 2000), first popularised in secondary education in the United States (Bergmann & Sams, 2009).

The flipped classroom paradigm has recently emerged from K-12 education (Ash, 2012). Most descriptions of the flipped classroom suggest that multimedia lectures be recorded so students can view them out of class and at their own pace (homework). This asynchronous approach frees up in class time for student centred synchronous learning activities. Advocates in K-12 recommend a range of in-class activities including individual practice (e.g. completing maths problems) so that the teacher can then provide individualised help or large scale in inquiry projects (Prober & Khan, 2013). In higher education courses it has been suggested that class time should focus on knowledge application (Pluta, Richards, & Mutnick, 2013). It may also allow the teacher a better opportunity to detect errors in thinking.

It could be argued that the flipped classroom has been in existence within the broader educational sphere for a number of years, through the requirement of students having to complete preparatory work before attending class to discuss concepts at a deeper level (Strayer, 2012). Flipped classrooms take what was previously class content (teacher led instruction) and replace it with what was previously homework (assigned activities to complete) now taking place within the class (Pierce & Fox, 2012). In addition, the flipped classroom fosters student ownership of learning through the completion of preparatory work and being more interactive during actual class time. Proponents of flipped class suggest that this pedagogical approach is advantageous for a number of reasons; it allows students to learn at their own pace and that

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they may have flexibility of when they engage with electronic resources, it frees up actual class time for robust discussion and associated problem solving activities related to the aforementioned resources, and that these discussions could be initiated by the students, not the staff member. This model then puts more responsibility for learning on the students so students can work towards mastery of the material. The flipped learning approach is significant as it has the potential to fully equip students, and those already in the work force, with skills to address 21st Century health care or other discipline-related problems.

Economic restraints on behalf of universities may also see the flipped approach as a means of delivering cost-effective, student-centred curricula in the face of increasing student numbers and/or decreases in state or national funding or institutional structures that favour faculty research over student learning. Advancing digital technologies within the higher education sector are challenging both the pedagogical stance of traditional didactic teaching seen for decades within universities and equally offering dynamic and innovative opportunities for student learning. Additionally, universities need to be seen at the cutting edge of technological and educational advancement, to maintain student throughput and graduate outcomes.

Research would suggest to best engage students and to promote learning, teaching approaches that go beyond traditional lecture instruction are the most effective (Ferreri & O'Connor, 2013). This is important and indeed necessary for two reasons; one, there are a suite of technologies available to enhance student learning and two, students particularly those of the current millennial generation (born after 1980) expect it. Simply, for this generation they require learning and engagement to be reactionary and immediate. In response to these expectations, universities internationally have recognised over the last ten to twenty years that in order to promote learning, maintain student engagement and to increase student satisfaction, the utilisation of technology with or without traditional pedagogical approaches is considered essential.

Within the literature there is increasing indirect evidence, such as increased student satisfaction and course grades, promoting the flipped learning approach (Mason, Shuman, & Cook, 2013; Wilson, 2014). As the higher education sector is moving more towards online delivery of courses, and with the wider adoption of flipped classroom, the purpose of this scoping review was to provide an indication of the current literature relating to flipped classrooms. In particular, it was designed to establish how key aspects of the flipped class contribute to its effectiveness and to an improved student learning experience. These key aspects include; the design and conceptual framework of the flipped class, as well as the types and utilisation of specific technologies to engage students. In addition, the authors wished to explore whether economic drivers as well as pedagogical acceptance by key stake holders were important factors effecting student flipped learning outcomes.

Despite scoping reviews being a relatively new addition to searching the literature (Davis, Drey, & Gould, 2009), scoping reviews (or scoping studies) are becoming increasingly widespread as a means to summarise literature in a topic area such as allied health, workforce planning and education. Whilst there is no precise definition of what constitutes a scoping review, it usually consists of one or more components, which may include literature mapping, conceptual mapping and policy mapping (Anderson, Allen, Peckham, & Goodwin, 2008). Scoping reviews differ from systematic reviews in that the latter are utilised to answer precise questions, with defined methodologies to assess article quality (O'Brien, Wilkins, Zack, & Solomon, 2010), whilst the former are relevant in fields containing a paucity of rigorous evidence, therefore incorporating literature that encompasses a broad range of study designs (Levac, Colquhoun, & O'Brien, 2010). Mays, Pope, and Popay (2005) suggest that a scoping review is an effective means of highlighting the relevant literature to the researcher, with the aim of rapid mapping of key concepts underpinning a research area. Davis et al. (2009) argue that a scoping review is a robust method of identifying primary and secondary sources of literature with its success based on both

developmental and intellectual approaches. The authors contend that a scoping review affords meaning to the 'what' and the 'why' explanations of inquiry as opposed to the 'who', 'where' and 'how', providing a comprehensive overview of the research under question (2009, p. 1387).

Arksey and O'Malley's (2005) work on scoping reviews focuses on four potential reasons why researchers undertake such a review. That is, to examine the extent and nature of research activity; to identify whether a systematic review is necessary; to summarise and disseminate research findings; and to identify potential research gaps within the existing literature (2005, p. 21). The approach to scoping reviews taken in this article considers research findings and draws conclusions from the existing literature regarding the state of research activity. This type of scoping review facilitates the identification of gaps in the evidence base where no research has previously been conducted, with the potential to summarise and convey findings, as well as identifying the relevance of the need of a systematic review or otherwise (Arksey & O'Malley, 2005).

## 2. Methods

The approach for the scoping review is underpinned by Arksey and O'Malley's (2005) five-stage framework, which adopts a rigorous process of transparency, enabling replication of the search strategy and increasing the reliability of the study findings. The five stages of Arksey and O'Malley's framework; (1) identifying the initial research questions, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarising and reporting the results were utilised in this review of the flipped classroom literature.

### 2.1. Identifying the initial research questions

The focus of our review was the exploration of key aspects of the flipped class that influence its effectiveness and contribute to an improved student flipped learning experience. To ensure that a substantial range of literature was captured relating to the topic of interest, we posed the following initial research questions to guide the search:

1. What technologies are being used to engage students in a flipped class?
2. What considerations are there pertaining to the economic and time constraints required to implement a flipped class?
3. What is known about the pedagogical acceptance by both staff and students?
4. What are the educational outcomes arising from a flipped class?
5. What is known about the conceptual framework used to design a flipped class?

### 2.2. Identifying relevant studies

Arksey and O'Malley (2005) suggest that a wide definition of key words for search terms should be adopted to glean a 'broad coverage' of available literature. Key concepts and search terms were developed to capture literature that related to flipped or inverted classroom, flipped or inverted teaching within higher education from Australian and international perspectives. A university librarian was consulted who was a subject specialist in the field of teaching and learning. Their input was useful in the refinement of key search terms and identifying databases most likely to produce the results sought. Techniques for searching included the use of search tools such as educational subject headings and Boolean operators to narrow, widen and combine literature searches. The linked descriptive key search terms that were developed to guide the search are outlined in Table 1.

In being as comprehensive as possible in the identification of primary evidence, and cognisant of the practicalities of time and monetary

constraints (Kenny et al., 2013), inclusion and exclusion criteria were developed. The last fifteen to twenty years has seen the integration of the information age into higher education curriculum, through blended learning techniques and the use of flipped classrooms (Lage et al., 2000; Strayer, 2012). Research prior to this time was unlikely to reflect these specific pedagogical techniques in higher education. Therefore, the time period 1995 to 2014 was considered appropriate. A full list of inclusion and exclusion criteria is outlined in Table 2.

The following EIGHT electronic databases were searched: MEDLINE, CINAHL, Psych INFO, ERIC, EMBASE, SCOPUS, Johanna Briggs Institute, Web of Science and the Cochrane database, to identify peer-reviewed literature. In addition, a hand search of the reference lists of identified articles was undertaken and Google Scholar was utilised to identify any other primary sources within grey literature. The review of literature was completed over four months, ending in October 2014.

### 2.3. Study selection

Using the key search descriptors, 1084 articles were identified. A review of the abstracts revealed large numbers of articles that were irrelevant, particularly those related to primary and secondary education settings utilising flipped class. These articles were primarily associated with teaching techniques, resources utilised in flipped classroom and high school student evaluations and feedback, so were excluded. There were a large number of articles removed from the search as they were duplicated in five of the eight databases. No relevant articles or systematic reviews were identified in the Cochrane or Joanna Briggs databases. A further eighty articles were identified using Google Scholar; however, a significant number of these did not meet inclusion criteria. Guided by the inclusion and exclusion criteria, 28 studies were identified as being relevant to the research topic. Full text versions of the articles were obtained, with each article being reviewed and confirmed as appropriate by the authors. This process provided an opportunity to identify any further additional relevant literature from a review of the reference lists of each article. The process of article selection followed the Preferred Reporting of Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Moher, Liberate, Tetzlaff, Altman, & The PRISMA Group, 2009). Fig. 1 below illustrates the process of article selection.

During the process of study selection, several studies were excluded. Examples include studies that detailed extensive reports on the use of flipped classrooms in primary education and secondary education, where the focus of the scoping review is the higher education sector (Flumerfelt & Green, 2013; Fulton, 2012), conference proceedings and other non-refereed publications (Allen, 2013; Mehta, Hull, Young, & Stoller, 2013; Pluta et al., 2013).

### 2.4. Data charting and collation

The fourth stage of Arksey and O'Malley's (2005) scoping review framework is the charting of selected articles. Summaries were developed of each article related to the author, year, location of study, study design, study methods and sample size and a brief comment on the limitations and recommendations of the individual selected study. Detail of included studies is provided in Table 3.

**Table 1**  
Key search terms.

Search terms
('Undergraduate' OR 'student' OR 'university') AND ('class' OR 'flip' OR 'invert')
('Flipped learning' OR 'education' OR 'instruct' OR 'model' OR 'theor')
('Higher education' OR 'tertiary' OR 'active learning' OR 'blended learning')

**Table 2**  
Inclusion and exclusion criteria.

Criterion	Inclusion	Exclusion
Time period	1994 to 2014	Studies outside these dates
Language	English	Non-English studies
Type of article	Original research, published in a peer review journal	Articles that were not peer reviewed or original research
Ethics clearance	Studies with approved ethics notification	Studies without approved ethics notification
Study focus	Undergraduate students in higher education Participants in employment where flipped classroom is utilised.	All other students and employment settings
Literature focus	Articles where the overwhelming theme relates to flipped classroom activity	Articles that made a passing or token reference to flipped classroom activity. Articles that were editorials or discussion or personal opinion pieces.
Population and sample	Undergraduate students enrolled in a recognised undergraduate programme of study. Employers who utilise flipped classroom in employment settings.	All other students not enrolled in undergraduate study and employment places that do not utilise flipped classroom in their operations.

### 2.5. Summarising and reporting findings

The fifth and final stage of Arksey and O'Malley's (2005) scoping review framework summarises and reports findings.

## 3. Findings

This scoping review yielded 28 articles from five countries. Of these; 23 studies were conducted in the United States, two in Australia, one in the United Kingdom, one in Taiwan and one in Malaysia. There was a notable absence of literature from Europe. In this section we present articles which were the focus of our initial research questions. They included articles with discussion on: types of resources utilised in flipped classroom, what takes place during pre-class and F2F class, support to develop resources, pedagogical acceptance of the flipped classroom by academic staff and students, evaluation of outcomes, and design principles.

### 3.1. What technologies are being used to engage students in the flipped class?

#### 3.1.1. Pre-class asynchronous activities

A large number of articles focussed on the types of resources utilised in varying disciplines for pre-class flipped classroom preparation. These resources included; pre-recorded lectures in the form of podcasts/vodcasts, screencasts, annotated notes and captured videos (2, 5, 6, 8, 12–18, 20, 23, 24). Additional resources noted were the use of pre-readings, automated tutoring systems and study guides (3, 4, 21) interactive videos from an online repository e.g. the Khan Academy suite of resources, case-based presentations and simulations (1, 4).

#### 3.1.2. Face to face synchronous activities

Activities utilised within F2F flipped class included; case-based presentations, team-based discussions, panel discussions, expert led discussions, role-plays and student presentations, discussions and debates (3, 5, 12–15). Many of these activities utilised smartphone apps, tablets, think pair-and-share activities and clicker questions to enable real time formative assessments (individual or paired quizzes of student learning), with the objective of providing immediate feedback concerning misconceptions or gaps in students' knowledge empowering

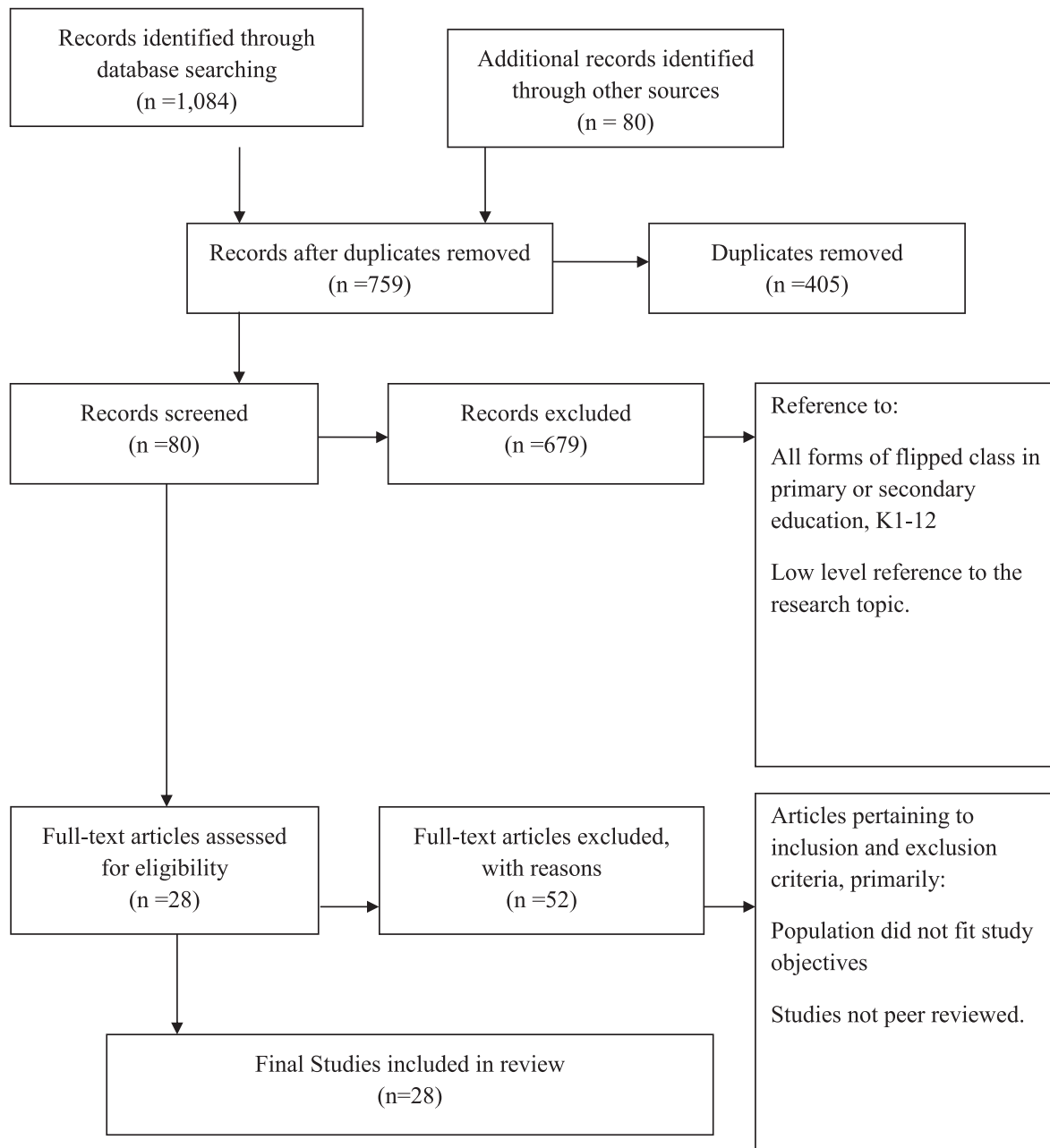


Fig. 1. PRISMA flow diagram for article selection.

students to reach higher levels of Blooms taxonomy (1, 3, 11, 17). This was complimented by micro lectures to support knowledge gaps (6). One study utilised summative assessment as an incentive to encourage students to attend class (11).

### 3.2. What is known about the time, cost, and staffing required flipping a class?

Articles in the scoping review acknowledge that lead in time for faculty was intense (12, 23). Designing and implementing off-loaded content such as development of lectures, readings and quiz test banks (3, 25) requires thoughtful planning and preparatory work. For example there is a need to rework existing resources and/or develop new resources (2) particularly pre-recorded lectures (3). There is a cost and time to develop a library of videos over time until the “best” videos

emerge which would only then minimise time, as then selection of core content would have withstood the test of scientific validation (5). Some institution resources were independently funded (6).

There is an intensity and effort required to develop the interactive materials. Some higher education (HE) institutions are developing support staff (including specialist educational developers), who will go into the classroom and help staff plan sessions and helping them learn how to use different kinds of teaching methods. In addition, some institutions are developing a technological team to assist instructors in the development of their electronic ancillary materials (12, 23, 25, 26).

For some studies the lead in time was short commencing at the beginning of the course (11, 23), depending on whether this was an introductory or foundation course with large lecture content (23) to be presented as podcasts. However, the greater majority acknowledged



a long lead in time even up to several years (3) to develop scientifically validated resources and a need for greater upfront financial investment into developing the resources (16).

Staff support was often not acknowledged as an initial limitation to flipped class, as the majority of studies focused on the use and implementation of pre-existing resources such as videos from the Khan Academy or those sourced from various social media outlets. One study highlighted the time consuming process of developing previously used resources such as lectures and converting them into a video clip (2). Two further studies (8, 18) stressed the importance of having necessary infrastructure for reliable delivery of activities in flipped class, such as high speed internet capacity and an information technology (IT) support department to assist with any “trouble-shooting” concerns and technical support to maintain and update material.

### 3.3. Acknowledging pedagogical acceptance by staff and students

The introduction of a flipped classroom approach required clear expectations to be given to students to reduce their frustrations regarding the time taken to do the pre-class activities (2), with some students critical that they had to take responsibility for their own learning outside of F2F contact time (23). However, other studies reflected efficient student adaptation with flipped class (2), suggesting that it be introduced to students early in their studies.

Both students and staff are dependent on the lecture method because it is familiar, comfortable, instructor centred and requires little active student participation, hence the reason some teaching staff are reluctant to abandon the lecture approach (8). A number of studies suggest students adapted to the new flipped approach easily (2, 17, 15). Fewer studies assessed the perceptions of staff in relation to acceptance of flipped class, which on the whole were positive (3, 15). Staff surveys indicated additional time and technological support is required in relation to development of activities and uploading of student grades, as the introduction of flipped class increased the number and frequency of assessments (3).

### 3.4. Evaluating indirect and direct educational outcomes from a flipped classroom

The majority of articles evaluated student outcomes by comparing an existing course taught in a traditional manner with a course embedding a flipped class. A large number of articles, using surveys with Likert scale and free text responses, reported an increased student satisfaction with the flipped approach and the active learning methods used (2, 5, 6, 11, 12, 14–16, 21, 22, 24–26). Similarly the flipped approach showed increased academic performance as measured by improved examination results and/or overall improvement in pre-test to post-test scores, and/or course grades compared with historical controls (2, 3, 6, 8, 14) as well as increased attendance from 30 to 80% when the flipped classroom model was used (5).

Qualitative feedback from student course evaluations suggested improved opportunities for developing communication skills, preferences for working in teams in the flipped model and increased teacher encouragement of active student engagement and learning compared with a traditional class (3, 17, 21). However the same studies, despite an improvement in student grades, found that students were quite negative towards the introduction of flipped class.

Despite acknowledgement of these positive flipped classroom attributes, very few articles used a robust scientific approach to evaluate educational outcomes as it relates to improved student learning particularly of higher order thinking cognitive skills such as improved problem solving, inquiry and critical or creative thinking (3, 9, 28). However, as pointed out in *Gilboy, Heinerichs, and Pazzaglia (in press)*, citing *Goodwin and Miller (2013)* ‘the absence of evidence does not mean there is evidence of absence.’

In addition to HE practices, flipped classrooms have also been utilised in professional settings, e.g. hospitals. For example, the notion of “flipping the wards” was used to better align teaching on the wards and clinical education in academic medical centres under the constraints of residency duty hours during anaesthetic training (1, 15, 18) and with graduate nurses, to provide learning opportunities structured around their shift work (12). However, in regard to the application of flipped class used in these settings, there was little evidence of improved proficiencies in practice (3) or improved patient care outcomes (15).

There were a number of qualitative comments that the flipped model enhanced the learning experience and promoted student empowerment, development and engagement (6, 12, 22); that the flipped model promoted more independent learners, increased group collaboration and greater innovation with learning (14–16, 21) resulting in students who are better communicators and have better interpersonal and problem solving skills as a result of the introduction of flipped class (3).

There was no evidence to show whether the flipped approach is best introduced in introductory/first year (4, 8, 10, 16, 21, 24,) courses vs. second (3, 5, 8, 11, 22), third or fourth (11) year courses. In addition there were no reported differences in the short term outcomes to suggest a smaller cohort of students (<150) (2–7, 9, 12–15, 21, 22, 25–27) performed differently to a larger flipped class (>150 students) (8, 10, 16) nor whether it was more suitable to flip an under-graduate (1–11, 13, 14, 16, 17, 21–24, 26, 27) vs. post-graduate courses (1, 12, 13, 15, 18, 25). Similarity there was no evidence presented to suggest whether flipping the entire course (majority of scoping review articles) is more beneficial than flipping only a few selected class sessions/modules per course (4, 14).

There is little evidence from the reviewed articles that reflects any long term improved educational outcomes of flipped vs. traditional delivery, as the articles only compared traditional classroom instruction with flipped class for single course offerings, not against consecutive offerings of flipped classroom, for example throughout a whole of programme approach.

### 3.5. What is known about the conceptual frameworks used to design a flipped class?

Very few studies reported on the use of their results to develop design principles for small face to face under-graduate flipped courses (10, 13, 18) e.g. one article reported on developing design strategies for before, during and after class activities based on educational objectives using Blooms taxonomy (9).

## 4. Discussion

In this section we summarise and convey each of our findings to provide a panoramic overview of what is currently known about the effectiveness of the flipped classroom approach and draw attention to areas where there are prominent gaps within the literature.

### 4.1. What technologies are being used to engage students in the flipped class?

The articles in this scoping review, which encompassed a wide range of disciplines both undergraduate, post-graduate and work force; including STEM disciplines (i.e. science, technology, engineering, and mathematics) humanities, law and economics and in the hospital setting, suggest the actual notion of offloading content and engaging students in the F2F class activities is more important than the specific resources used for flipping. For example, the scoping review outlines that a wide array of methods can be used for pre-class preparation, which students can undertake their learning in a reflective and self-paced manner. These have been shown to improve learning specifically;

**Table 3**  
Included studies.

(Study number) Author details	Year	Location	Intervention/resource/pre-class/face-to-face (F2F) in-class	Study design/participants sample	Outcomes
(1) Martin, Farnan and Arora	2013	USA	<p>"Flipping the wards" to better align teaching on the wards under the constraints of medical residency duty hours</p> <p>U/G and P/G clinical education in academic medical centres and on ward setting</p> <p>1. Pre-class: interactive case based presentations, simulations rather than lectures, scenarios, readings, interactive Khan academy resources/modules.</p> <p>2. In-class: examples of suggested interactive discussions, teaching resident to outsource clinical questions the team may have during rounds and to report back, using apps on smartphones/tablets to highlight teaching points.</p>	<p>Descriptive paper outlining the new strategies only. No qualitative or quantitative data given.</p>	<p>No evidence given to support this approach more effective than conventional teaching methods e.g. traditional lecture.</p> <p>No measureable educational outcomes such as increased exam performance or improved patient care demonstrated.</p>
(2) Mason, Schuman and Cook	2013	USA	<p>To produce graduates who have good problem solving skills so FC frees up time for learner centred activities and encourage student to become independent learners.</p> <p>Senior level in U/G mechanical engineering course.</p> <p>1. Pre-class: video lectures.</p> <p>2. In-class: solve problems in groups or individually; students' present results to class. Instructor clarifies concepts.</p>	<p>N = 20</p> <p>Qualitative, anonymous responses of student perception of teaching.</p> <p>Quantitative, comparison of grades on two assessment pieces comparison made to previous year before introduction and after (different years and different cohort of students) and also different content coverage.</p>	<p>CEI-equal or greater satisfaction</p> <p>Quantitative-showed equal or better exam scores on design problems.</p> <p>Increased coverage of content with FC.</p> <p>Initial student expectations were unclear, highlighting their frustrations, but adapted easily to new delivery format.</p> <p>Lectures of 50 min considered too time consuming, with redevelopment of existing resources required.</p> <p>No follow up in terms of original reason for intervention, not clear if students were effective independent learners or acquired good problem solving skills as a result of the intervention?</p>
(3) Ferreri and O'Connor	2013	USA	<p>Redesign of a large second year U/G pharmacy course previously delivered in a traditional lecture format to a small group case based course to acquire proficiencies in communication, problem solving and interpersonal skills.</p> <p>1. Pre-class: pre-readings and study guides.</p> <p>2. In-class: case based activities in groups; assessment of learning in class with clicker questions followed by discussion. No follow up in community pharmacy or proficiency in practice.</p>	<p>N = 150</p> <p>Redesign over two years.</p> <p>25 lectures pre-recorded.</p> <p>Mid-term and final exams. Ongoing projects across the teaching period were tied to FC activities.</p> <p>Qualitative and quantitative measures utilised.</p> <p>Faculty member's perspectives also assessed via self-evaluations.</p>	<p>CEI improved satisfaction re opportunities for developing communication skills, participation in group work. However significantly more negative comments, despite increased grade scores</p> <p>Quantitative findings, improved course grades.</p> <p>Faculty and learners reported rewarding active learning. Acknowledgement of large support team to assist with implementation.</p> <p>No follow up with competencies re change in practice and/or increased confidence post-graduation.</p>
(4) Wilson	2014	USA	<p>Lecture/homework flipped to increase student engagement with learning.</p> <p>U/G statistics course in a social science degree:</p> <p>1. Pre-class: readings from specific texts, Khan academy videos of statistics lectures.</p> <p>2. In-class: FC done weekly, greater time for activities related to stats, weekly quizzes to gauge level of learning and engagement of FC activities.</p> <p>Following F2F time, homework problems to solve for future group work to bring back which is graded.</p>	<p>N = 20–25</p> <p>Qualitative and quantitative measures.</p> <p>Introductory level-students have little/no experience with stats.</p> <p>View ranged from being useful to a complete waste of time. Some resistance from students so lecturer gone from 0.5 flipped to 3/4 flipped.</p>	<p>CEI improvement re course and instructor but still lot of negative comments concerning no lecture. Students don't like increased personal expectation for own learning, considered as unfair! Students bored/disengaged.</p> <p>Study considered whether a particular student demographic may work better with the introduction of FC, e.g. proactive learners.</p> <p>Course grades up by 10%.</p>
(5) Prober and Khan	2013	USA	<p>Proposal of a model for medical education based on "flipped classroom" approach.</p> <p>1. Pre-class: access a brief 10 min video to learn new concepts in own time.</p> <p>2. In-class: expert to lead interactive session-problem and team based exercises, simulations, role-plays, and debates.</p>	<p>115/141 (82%) responded, first and second year medical students in a number of courses.</p>	<p>Students favoured the FC model compared with a primary lecture format.</p> <p>Recommend process be time neutral, acknowledgement of pre-class time.</p> <p>Considerations re cost and time to develop a library of videos over time, updates until "best" videos emerge which then would minimise time as selection of core content would have withstood the test of scientific validation.</p>
(6) McLaughlin, LaToya, Esserman, Davidson, Glatt, Roth, Gharckholona-rehe and Mumper	2013	USA	<p>Study linked to Ferreri and O'Connor (2013). Study extended to include same course but to be delivered across two satellite campuses.</p> <p>1. Pre-class: recorded lectures</p> <p>2. In-class: active learning exercises include: clicker questions, think-pair-shares, student</p>	<p>N = 22</p> <p>Satellite students on 2 campuses.</p> <p>Delivered synchronously via video conference to the satellite classrooms</p> <p>n = 22 from internal of 153 in 2011 and 162 students in 2012</p> <p>Qualitative data: responses from</p>	<p>Belief that learning is a shared responsibility between tutor and student and FC supports this.</p> <p>Qualitative results: suggest FC promoted student empowerment, development, and engagement. Students reported learning pre- and F2F more engaging, enhanced</p>

Table 3 (continued)

(Study number) Author details	Year	Location	Intervention/resource/pre-class/face-to-face (F2F) in-class	Study design/participants sample	Outcomes
			presentations, and a quiz. All are formative real time assessments. Prompts to micro lectures to address gaps in knowledge.	anonymous questionnaire at commencement and completion of course. CEI responses. The academic experience was enhanced. Quantitative data: results of final examination.	their learning experience. Quantitative results: examination performance remains unchanged in relation to traditional course offering.
(7) Schlairet, Green and Benton	2014	USA	Fundamental concepts of clinical nursing U/G programme: 1. Pre-class: textbook readings and voiceover power point slides and notes page. 2. In-class: case studies group work, class discussions and presentations. Use of clickers and patient simulators.	15 week course. 40 students in class. No evidence of any robust evaluations of student grades or perceptions.	Redesign of the course as a flipped class very time-intensive up front. Need for administrative support and academic freedom to implement. Also need for in house dedicated IT specialist for pre-class PowerPoints. Future iterations require less time as current resources only require small modifications.
(8) Missildine, Fountain, Summers and Gosselin	2013	USA	Research hypothesis that FC would improve exam grades and student satisfaction vs. traditional lecture only or lecture capture with/without the FC intervention. U/G nursing students in first and second year in consecutive courses. 1. Pre-class: pre-recorded lectures and clips 2. In-class: activity not stated.	N = 589 Quantitative data taken from examination scores between the three groups (traditional lecture/lecture capture +/- FC).	Improved learning outcomes noted, 47 more students passed course than previous. However less student satisfaction, particularly with loss of social interaction through traditional class. Limitations relating to validity of survey instrument, poor internet connection for rural students.
(9) Gilboy, Heinerichs and Pazzaglia	2014	USA	Two undergraduate nutrition classes. Template designed for pre-, in and post-class activities: 1. Pre-class: videos ( <i>Khan Academy</i> ) online modules. 2. In-class: group activity and formative assessment. 3. Post-class: summative assessment.	142/196 students completed a survey, qualitative and quantitative responses.	62% students preferred flipped. Successful for staff and students. Used results to develop design strategies for before, during and after class activities based on objective's using Blooms taxonomy. Limitation of students having less access to teaching staff.
(10) Albert and Beatty	2014	USA	FC approach to an Introduction to management course. 1. Pre-class: videos and assigned readings. 2. In class: activities involved application questions, video cases, movie clips.	Large class size: 650 in the lecture and 325 in flipped class.	Grades on all three exams higher. Used the results of the study to develop a set of design principles for a generic flipped classroom model. Limitations are: only U/G and only face to face
(11) Yeung and O'Malley	2014	UK	Introduction of FC approach to Chemistry degree. 2nd and 4th year students. 10 week course, one F2F class each week: 1. Pre-class: Tablet with writable function plus screencasts used by lecturer to deliver content, use of clickers and online discussion forums. Feedback facilitated through Blackboard. Screen casts for 20–40 min. 2. In-class: F2F interactive workshop activities in chemistry. Short summative test at the end of each workshop	N = 52 Qualitative survey with opened-ended questions relating to student satisfaction	Student feedback was mixed: concerns around increased responsibility for learning, requiring more after-hours work. Lead in time for FC was short, commenced at beginning of year, some resistance with FC actually working, based on increased workload for students. Criticism of FC vs. F2F. F2F better because it is more interactive; can ask a question straight away. However students though FC was better than traditional lecture format, offered flexibility. Limitations related to student understanding of learning framework, thought by many that FC was optional. In response, FC included a summative component as an incentive for attendance.
(12) Critz and Wright	2013	USA	Introduction of FC approach for Nurse Practitioners (in family health). At programme commencement: 1. Pre-class: runs parallel with clinical component-recorded power points and videos (11 out of 15 weeks), 10 h across 15 weeks. 2. In-class: F2F simulated role play of case studies, unfolding case studies; summative quiz comprised 60% of grade.	N = 20 Qualitative survey of student satisfaction. No quantitative measures, reporting of grades only.	Important paper as authors state it is first paper to use FC in graduate nurse education. High satisfaction response from students and faculty, students demonstrated increased autonomy with learning. Greater understanding of students' errors in critical thinking from lecturer's perspective. Limitations: Lead in time for resource development and application was very short. IT support was provided to staff and students.
(13) Kim, Khera and Getman	2014	USA	Three instances of FC being introduced: Engineering, Humanities and Sociology class. 1. Pre-class: resources included video lectures outside of class. 2. In-class: setting problems related to the videos, group presentations, role plays.	115 students enrolled in the three flipped classrooms ranging from first year to third year or more.	Student survey, interviews, instructor reflections. Used the results of the study to develop a set of 9 design principles for a generic under-graduate face to face flipped course. Limitations are: small class sizes less than 50 students, only U/G and only F2F students.
(14) Pierce and Fox	2012	USA	Redesign of Pharmacy course with FC. Pharmacology students specifically related	N = 71 Bench mark and formative assessments	80% of students were satisfied with the use of FC to assist in their learning. They

(continued on next page)



Table 3 (continued)

(Study number) Author details	Year	Location	Intervention/resource/pre-class/face-to-face (F2F) in-class	Study design/participants sample	Outcomes
			to a renal module conducted over 8 weeks (23 h teaching time): 1. Pre-class: vodcasts, 4 h out of 23 h of total lecture time, 4 vodcasts in total. 2. In-class: discussed interactive cases of patients. Pre-test/post-test design, class activity (day one) followed by post-test and final exam. Additional resources to support two sessions in emergency medicine for residents: 1. Pre-class: video lectures. 2. In-class: access to medical experts.	administered during module.	found the method of learning convenient, final exam scores increased over traditional instructional methods. Greater opportunity for application of knowledge with case scenarios, more F2F time being able to work on cases in class.
(15) Young, Bailey, Guptil, Thorp and Thomas	2014	USA		Survey size small at 35–38 residents. Series of open ended questions and a Likert evaluative survey.	Qualitative study residents and staff positively received. Residents cited interactivity of sessions and access to experts as advantages of flipped. No measures of improved performance indicators nor patient care outcomes.
(16) Davies, Dean and Ball	2013	USA	Hypothesis to determine what benefit flipping the class would have on student achievement and satisfaction. Introductory information systems course. Two classes (traditional and FC offerings run concurrently): 1. Pre-class: video based lectures. Once a week for 5 weeks. 2. In-class: follow up class attendance for FC group (optional attendance).	N = 301 Pre-test/post-test design. Traditional instruction, with additional resources (simulation), or with FC. Quantitative and qualitative measures.	Compared to traditional class, class with excel spreadsheet and flipped class, FC students spent more time on their homework, were more satisfied with the course and would recommend the course more highly to others that those students using the other two approaches to learning. Student's attendance in the FC group for follow up F2F classes was optional. FC facilitated improved learning and more motivating than simulation based. Suggestion for all students to have Excel spreadsheets on individual PCs is costly. Need for greater upfront investment e.g. development of video resources must take place.
(17) McLaughlin, Roth, Glatt, Gharkholonarehe, Davidson, LaToya, Esserman and Mumper	2014	USA	Philosophy and methodology described to redesign of a pharmacy course (outlined in paper 6). 1. Pre-class: 25 lectures were pre-recorded, combined with interactive learning accelerator module (ILAM). 2. In-class: twice weekly FC for 75 min over 13 weeks. Pair and share activities, formative quizzes through use of clickers and a follow-up written activity to be presented in the next class.	153 students in 2011 and 162 students in 2012. Quantitative data, from pre- and post-course surveys, open-ended questions.	Author's state: Increased class attendance, students learning and perceived value of FC increased following participation, with 91% students access of ILAMs, 98% of 2012 cohort preferred FC compared to traditional course offering from 2011.
(18) Kurup and Hersey	2013	USA	Resources to support anaesthetic registrars: 1. Pre-class: 21 paediatric topics, including on line modules and videos. 2. In-class: discussion time with expert physicians.	Numbers of residents not stated. 60% of residents accessed interactive modules.	5% improvement between pre- and post-test scores for those who were involved in the intraoperative discussion (number of participants not known). Discussed common challenges to flipping and perceived advantages and recommendations for a generic flipped class.
(19) McDonald and Smith (part one).	2013	USA	Strategy for FC for nurses to have greater opportunity to engage in clinical settings: 1. Pre-class: videos and on line lectures. 2. In-class: discussions and interactive activities based on pre-class resources.	Numbers of participants not stated.	Some consideration of the value of using FC in the workplace, or those who are working to improve flexibility of learning (nurses).
(20) Smith and McDonald (part two).	2013	USA	Use of FC and associate resources of videos and pod casts for nurses in the workplace.	Numbers of participants not stated.	Extension of previous article, opportunity and advantage of flexible delivery and uptake in own time for shift workers.
(21) Strayer	2012	USA	Comparison of FC vs. non FC. Introductory statistics course: 1. Pre-class: Automated tutoring system for out of class instruction vs. usual F2F instruction maths students. 2. In-class: activities related to the automated tutoring system for FC students. F2F students went through lectures and course readings in real time	Mixed methods 27 in traditional lecture and 23 in FC (RR > 90%), survey instrument was a course evaluation experience questionnaire. Qualitative data was elicited through student responses being recorded as the class actually took place.	Traditional class never strayed away from a set plan, and less willing to engage in class activities compared with those in the FC. Some issues however in FC with real identification and subsequent grasping of the concepts. Number of advantages highlighted, group collaboration, greater innovation with learning. FC not the best option for an introductory course. Consideration of blend of 30 minute didactic with a 30 minute online homework activity
(22) Forsey, Low and Glance	2013	AUST	Redesign of undergraduate sociology course utilising FC. Massive open online courses (MOOCs), frame work for 2nd year students: 1. Pre-class: online resources, videos,	Mixed methods study 74 participants surveys and focus group interviews (93% RR).	Positive response re flexibility richness of learning and increased productivity (checklists to tick off activities). Increased student and staff satisfaction. Increase in class quiz scores. Students gained more

Table 3 (continued)

(Study number) Author details	Year	Location	Intervention/resource/pre-class/face-to-face (F2F) in-class	Study design/participants sample	Outcomes
			interviews and lectures. 2. In-class: through use of a checklist, students unpacked preparatory pre-class resources and expanded these into group activities.		out of F2F hours. Negatives; lack of interaction, loss of university campus life and culture. Potential to overcome this fragmentation from the larger student body by occasionally having a keystone F2F lecture incorporated into the hybrid classes.
(23) Gannod, Burge and Helmick	2007	USA	Software engineering package (65 separate videos and podcasts) designed for use in curriculum for these students introduced in 1 course to 40 students (technical report): 1. Pre-class: videos and lectures (3–6 h per week). 2. In-class: laboratory experiments and associated activities	None stated and no data.	Interesting article acknowledging learning styles, students who are best suited and lead in time/supports for lecturers with development of resources.
(24) Lage, Platt and Tregila	2000	USA	Introductory economics course, 2, 75 minute sessions per week for either FC or F2F class: 1. Pre-class Video and PowerPoints. 2 In-class: activities and worksheets aligned with pre-class resources.	End of semester survey (Likert scales and open-ended questions), sample size not stated.	Examination of learning styles (traditional vs. FC). Overall preference for the introduction of FC.
(25) Hoffmann	2014	USA	Qualitative research method class (post-graduate education students): 1. Pre-class: online readings, preparatory activities for coding/evaluation of data sets 2 In class: discussion and analysis of data sets, final weeks of course involved analysis of own data sets.	Student evaluations, 17/19 (RR > 90%)	Overall positive student response to the use of FC. Lead in time for lecturers to prepare course materials was acknowledged.
(26) Butts	2014	AUST	Actuary students in a final year programme: 1. Pre-class: online lectures with supportive notes. 2. In-class: activities designed to get students to challenge each other, re activities in Excel.	Two-part survey: Students asked the value of traditional lecture compared with online activities (n = 62). Students then asked about nature of activities and perception of class time (n = 50, from original 62 above).	Student satisfaction at 50%, but increased over time. 25% students did not see any improvement in their learning with FC. Acknowledgement of time needed for academics to adequately prepare resources.
(27) Hung	2014	Taiwan	Flipped format used a WebQuest active learning strategy to organise learning materials. Language education course. 1 Pre-class: class: watch movie trailers and questionnaire. 2. In-class: tutorials and students working in pairs towards follow up presentations.	Comparison between 3 different formats for flipped (n = 25), semi flipped (n = 25) and control group (n = 25). Computer-assisted language programme.	Increased perceived learning engagement, increase in overall learning satisfaction (via robust statistical analysis) increased mean scores on lesson assessments in flipped over two other formats.
(28) Jamaludin and Osman	2014	Malaysia	Use of FC based on Reeves (2013) four-aspect conceptualisation of student engagement to promote active learning relating to behavioural, emotional, cognitive and agentic engagement. Instructional design course, u/grad Teachers of English to Speakers of Other Languages (TESOL).Pre- and in-class resources and activities not stated.	Quantitative data with Likert scale questions (n = 24).	FC demonstrated the 4 aspects of Reeve's engagement model were enhanced, with emotional engagement being the best predictor of interest with learning.

enhanced class preparation, increased classroom interactivity and improved academic performance. However, our review of the current literature has shown that there is little empirical validation across all these contexts. One study suggested that the format and structure of learning materials in the flipped classroom contributed significantly to the student's satisfaction with their flipped learning experiences (27). The flip teaching also offers more flexible learning opportunities for preview and review which could appeal to a range of learner styles for diversity and those with accessibility concerns. There is future potential to explore individual differences in response to different types of course structures i.e., is there a particular demographic or personality that may predict reactions to a flipped class. Placing materials online is a good format to teach lower order cognitive skills but not higher order (Prunuske, Batzli, Howell, & Miller, 2012).

#### 4.2. What occurs in real time during the flipped class?

During class time academics function more as a learning coach than as a teacher, using F2F class time for both individual inquiry

and collaborative activities that clarify concepts and contextualise knowledge through application, analyse, planning and producing solutions (Anderson, Krathwohl, & Airasian, 2001). The results of the scoping review suggest instructors need to redesign their curriculum so that the pre-class activities are integrated better into their F2F classes with active learning pedagogies so students understand the model and are motivated to prepare for class; *how* these resources are integrated into the overall approach is what matters (Tucker, 2012).

#### 4.3. What is known about the time, cost, and staffing required in flipping a class?

The intensity and effort required to develop interactive materials which was acknowledged in only a small number of articles, could pose serious obstacles for some higher education institutions in terms of resource allocation and lack of IT support (9). Some institutions acknowledge more supervision may be required in the F2F real time classes (25). The flipped model requires funding to cover the cost of pre-class resources and ongoing IT support (18).

#### 4.4. Evaluating short-term and long term student outcomes from a flipped classroom

Our review indicates a number of positive student learning outcomes from this pedagogical approach. From our scoping review, we have found that other than in the popular press, there is limited published evidence on student learning outcomes, particularly long term, from flipped learning approaches, particularly in HE (Hamdan, McKnight, McKnight, & Artfstrom, 2013). It is evident though from our review that there is a strong willingness for academics to engage in the redesign of their students' learning experiences using the flipped classroom. This is particularly so for large first year foundational STEM courses.

Studies focussing on student perceptions of the flipped class were generally positive with a significant minority having some negative views. This suggests that the flipped classroom may not be applicable to all subjects. For instance, Strayer (2012) performed a comparative study between a flipped classroom and the traditional classroom for an introductory statistics course. The findings of this study demonstrated that students participating in the flipped classroom were less satisfied with the teaching format than students in the traditional classroom were. Also it is important as Forsey, Low, and Glance (2013) pointed out to guard against the "Hawthorne effects" where any change in operating procedures can produce increases in worker productivity and/or satisfaction.

This review found very few studies that actually demonstrated robust evidence to support that the flipped learning approach is more effective than conventional teaching methods. Only one study used empirical validation to show that a structured flipped classroom in comparison to the traditional one could effectively engage students in deep learning (27). Whilst some studies referred to a modest improvement of academic performance, through outcomes of increased examination scores or improved student satisfaction, further research is required in this area, with longitudinal cohorts evaluating the learning outcomes of utilising flipped approaches compared with traditional teaching methods.

#### 4.5. Acknowledging pedagogical acceptance by staff and students, and what is known about the conceptual frameworks used to design a flipped class?

From the scoping review a key theme emerging was one of the greatest obstacles was related to staff capacity to design, implement and evaluate the effectiveness of their flipped classrooms. It is evident that teachers do recognise the value of using sound pedagogical approaches to enhance the student experiences through curriculum renewal, but need support to develop skills needed to effectively guide the systematic use of technologies and translate conceptual thinking into planned learning sequences. Essential to the effective implementation of flipped learning are 'professional educators' who are reflective and actively engage in scholarly networks (Hamdan et al., 2013, p. 6).

However, an emerging barrier for staff to do this meaningfully seems to be a lack of pedagogical understanding of how to effectively translate the flipped classroom concept into practice, with the aim of engaging first year students. This lack of awareness is trivialising flipped approaches and reducing the potential of this major curriculum renewal opportunity. Although universities, both in Australia and internationally perceive efficiencies in the flipped classroom at a time of cost reductions, the flipped classroom is seen as a strategy that can genuinely improve the student learning experience through increased interactivity. This then becomes an added pressure for many educators to renew their curriculum with an approach that they may not fully understand.

### 5. Implications for research and practice

In this section we explore unresolved issues associated with the current literature of the flipped classroom approach and the student

learning experience, providing clear proposals for further educational research development.

It is evident from the current review that there is a risk that flipped classroom curriculum approaches may 'wither on the vine' through a lack of pedagogical integrity. For example, students are less likely to engage in pre-class activities that lack interactivity, fail to provide formative feedback mechanisms and are/or not coherently linked to the F2F class. Equally, there needs to be a balance between pre-class preparatory activities and time spent with actual F2F work (5). A lack of engagement with the pre-class activities results in variability of student preparedness, adding another level to the learning challenges of already diverse first year student cohorts, particularly in large foundation courses. Both students and staff need to be fully engaged throughout the learning process.

Future research should consider the relationship of other indicators of student engagement in the flipped class (not just examination scores). Constructs such as engagement are not always easily reduced to measurable items on survey instruments or a reflection of examination performance and so warrant further investigation. For example, utilising online activity as a measure to quantitate student engagement, though important, is only one variable known to impact on student development.

The scoping review has identified a number of gaps in the literature that need to be addressed for effective implementation of flipped classrooms for curriculum transformation by educators. These include the under-utilisation of conceptual frameworks that enable a united approach to pre-, F2F and post-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.

There is also a need for stronger evidence in evaluating student learning outcomes that particularly improved student learning and development, as critical thinkers, problem solvers and team players; a need to stimulate higher order thinking through the use of creative technologies and applied learning; and a need for guidelines about current approaches to assessment (Haladyna, Downing, & Rodriguez, 2002) and feedback (Merry, Price, Carless, & Taras, 2013), e.g. writing quality learning checkpoints (in pre- and/or F2F sessions).

Australia, like a number of other countries has distance education students who study remotely, off-campus. In 2010 just under one million (81%) higher education students in Australia were studying internally (on-campus), 12% were external (off-campus) and the remaining 7% were multi-modal (distance or online delivery) (Australian Bureau of Statistics, 2010). Only one study addressed the needs of the off campus student (6), which utilised synchronously delivery via video to a satellite classroom, as all the others involved on campus students.

It is possible to deliver the F2F internal class synchronously to the external class via videoconference but the majority of off campus students enrol in this mode due to its flexible delivery and to avoid being locked into fixed class time. This becomes a potential limitation of the flipped model if the underlying premise is that students engage in real time collaboration with fellow students.

### 6. Conclusion

It is becoming evident that even though universities and work places perceive efficiencies in the flipped classroom at a time of increasing cost-cutting measures, academics also see this as an opportunity for curriculum renewal and developing a more student-centred approach. The flipped model has the potential to enable teachers to cultivate critical and independent thought in their students, building the capacity for lifelong learning and thus preparing future graduates for their workplace contexts. However, there is a danger that educators renewing their curriculum may not fully understand the pedagogy of how to effectively translate the flipped class into practice. Based on this scoping



