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When is flipped classroom more effective and why it flops

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Abstract: A specific form of blended learning model – the flipped classroom approach – is increasingly being adopted by many education institutes around the globe. Yet, many researchers and practitioners remain divided over whether flipped classroom is really an improvement over the traditional classroom. This paper is the first to synthesize all available meta-analytic information on the effectiveness of the flipped classroom approach on student cognitive outcomes, and provide the currently best available evidence on the optimum use of flipped classroom. Cognitive outcomes refer to the domain-specific knowledge (e.g., facts, concepts) of a subject. This paper also summarizes the key reasons why flipped classroom flops. Using a meta-synthesis approach to examine 19 flipped classroom meta-analytic studies on student cognitive outcomes, involving 1,126 empirical studies and more than 85,000 flipped and 90,000 non-flipped participants, this paper found positive significant effects, ranging from small to medium effect size with a median of 0.42, favouring the use of flipped classroom in achieving better student cognitive outcomes. Current evidence suggests flipped classroom is more effective when formative assessment (e.g., quizzes) are used. Flipped classroom appears to be equally effective among learners from different educational levels. However, findings concerning the possible moderating effect of flipped classroom implementation duration and across subject disciplines were inconclusive. This paper also identifies several key student- and instructor-related challenges factors that could lead to flipped classroom failure through a comprehensive meta-synthesis of 16 systematic reviews and meta-analyses. Practical suggestions for alleviating these challenges are discussed. Overall, the findings presented in this paper can provide useful recommendations to help practitioners design more optimal flipped classroom lessons.

Keywords: Flipped classroom, flipped learning, meta-synthesis, effect, learning outcomes

1. Introduction

Educators have long been intrigued with the potential of technology to help enhance student learning. One such technology supported instructional approach that has captured the attention of many K-12 and university educators around the globe is the flipped classroom model. In a flipped classroom model, students learn lecture materials before class usually through some form of technology-supported means such as video recorded lectures, and online exercises. Students then spend the in-class time completing some form of active learning tasks such as group discussions, and independent work to apply what they have learned under the supervisor of the instructor. Advocates of the flipped classroom approach believe that increasing active learning opportunities can help students learn the lecture materials better. Others such as Abeysekera and Dawson (2015) postulate that the self-paced nature of pre-class activities in a flipped classroom can reduce cognitive load which can in turn theoretically enhance learning outcomes.

1.1 Problem statement

Nevertheless, not every educator is sold on the idea of flipped classroom. A survey of 290 European universities revealed that only 15% of institutions found the flipped classroom approach to be "fully useful" (Gaebel & Zhang, 2018). Critics claim that it is difficult to get students on board the flipped classroom model, and that the model only benefits students from families with more resources

(McGuire, 2020). The traditional lecture format still remains the instructor's preferred teaching method (McKie, 2019).

Although extensively studied over the years, there is still debate about the effectiveness of flipped classroom in improving learner outcomes (Strelan, Osborn, & Palmer, 2020; Zainuddin, Haruna, Li, Zhang, Chu, 2019). On one hand, some primary studies show that flipped classroom can induce significantly better student learning performance (e.g., Schultz, Duffield, Rasmussen, & Wageman, 2014; Tsai, Shen, & Lu, 2015). On the other hand, other primary studies found flipped classroom fails to improve student learning performance (e.g., traditional learning is just as effective as flipped learning) (e.g., DeSantis, Van Curen, Putsch, & Metzger, 2015; Yong, Levy, & Lape, 2015). Moreover, a recent randomized controlled trial experiment published in a Massachusetts Institute of Technology discussion paper that involved a total of 1,328 students across 80 economics and mathematics classes found that flipped classroom exerted no long-term effects on student learning, but exacerbated the achievement gaps between white and black or Hispanic students when compared to the traditional lecture group (Setren, Greenberg, Moore, & Yankovich, 2019).

1.2 Prior meta-analyses of flipped classroom

In order to address the problem of conflicting results, researchers in recent years have begun to conduct meta-analyses of flipped classroom primary studies. Meta-analyses can help estimate the size and consistency of effect sizes of flipped classroom implementations across different studies and quantify the variance when effect sizes vary. A meta-analysis can also help identify possible factors that modify that effect (Gurevitch, Koricheva, Nakagawa, & Stewart, 2018).

To the best of our knowledge, the earliest meta-analysis on flipped classroom was published in 2016. Since then the number of flipped classroom meta-analyses have skyrocketed. As many as 19 meta-analyses examining the effects of flipped classroom versus non-flipped classroom on student cognitive outcomes have been conducted so far (see Results). Student cognitive outcomes, usually accessed through tests and exams, refer to the domain-specific knowledge of a subject such as concepts, theories, and facts (Klein, Kuh, Chun, Hamilton, & Shavelson, 2005). Rather than doing yet another meta-analysis of flipped classroom, this study calls for a temporary moratorium on new meta-analyses. Instead, this study aims to synthesize the quantitative results of all currently available meta-analyses in order to provide a general picture of what we currently know about the effects of flipped classroom. Put another way, this study aims to capture the main essence of what the extant body of literature says about the quantitative impact of flipped classroom on student cognitive outcomes and what factors (if any) may render flipped classroom more effective.

1.3 Contribution of the present study

In this study, I performed a meta-synthesis of all 19 flipped classroom meta-analyses on student cognitive outcomes. The research approach of meta-synthesis springs from the interpretive paradigm of naturalistic inquiry (Guba, 1978; Noblit & Hare, 1988) and is aimed at "understanding and describing key points and themes contained within a research literature on a given topic" (p. 4). The steps of meta-synthesis typically include the following (Walsh & Downe, 2005): (a) search for articles, (b) make decision on inclusion of articles, (c) appraise studies (judge the quality of the included articles, for example identify the potential confounds), (d) analyze studies (for example determine how studies are similar or different through a compare and contrast exercise), and finally (e) synthesize findings. Meta-synthesis is an interpretive, rather than an aggregating method that aims to integrate the findings from various studies (Walsh & Downe, 2005). Although meta-syntheses are traditionally used to examine qualitative research findings, several researchers (e.g., Strobel & van Barneveld, 2009; Wilder, 2014) have expanded the use of meta-syntheses to synthesize quantitative meta-analytic studies.

This study also summarizes the main student-related challenges that can undermine the use of flipped classroom. Understanding the key student-related challenges can help educators take the necessary steps to address them. A meta-synthesis of 16 systematic reviews and meta-analyses revealed two key student-related reasons why flipped classroom may flop. Please note that some meta-analyses reported student-related challenges. Practical suggestions, gleaned from relevant empirical studies, to mitigate these challenges are discussed. Overall, the findings presented in this

paper can provide useful recommendations to help practitioners design more optimal flipped classroom lessons. The following research questions guided the present study:

Research question 1: What are the general findings of previous meta-analyses concerning the overall effect of flipped classroom on student learning outcomes?
Research question 2: What factors contribute to more effective use of flipped classroom as reported by previous meta-analyses?
Research question 3: What are the key student- and instructor-related challenges that can undermine the use of flipped classroom as reported by previous systematic reviews, as well as meta-analyses?

2. Method

2.1 Search strategy

I searched for as many systematic reviews, as well as meta-analytic articles as possible. To do this, I performed a search of major educational databases such as Academic Search Complete, British Education Index, ERIC, MEDLINE, Teacher Reference Center using the following search terms *("review" OR "synthesis" OR "meta-analysis") AND ("flip*" OR "invert*") AND ("class*" OR "learn*")*. The date of publication remained open for the initial search. Besides the search of academic databases, I also conducted a Web search (e.g., Google Scholar, Google) and screened the reference lists of relevant articles. All articles must be written in English.

2.2 Data extraction

To address RQ1: "What are the general findings of previous flipped classroom meta-analyses concerning the overall effect of flipped classroom versus non-flipped classroom on student learning outcomes", I extracted the following data from each eligible meta-analysis article: (a) the type of subject discipline, (b) participant grade level, (c) the number of primary empirical studies, and (d) effect size data concerning student learning outcomes. Student learning outcomes must be measured by tests or exams. Meta-analysis articles that relied solely on subjective measures such as student *perceived* learning outcomes or *non-cognitive* outcomes (e.g., student perceived satisfaction) were excluded.

To address RQ2: "What factors contribute to more effective use of flipped classroom as reported by previous meta-analyses?", I extracted the moderator analyses results from each eligible meta-analysis article.

To address RQ3: "What are the main student- and instructor-related challenges that can undermine the use of flipped classroom as reported by previous flipped classroom systematic reviews, as well as meta-analyses (if relevant)?", I adopted the grounded approach. The first step was an initial reading of all qualitative data (e.g., student and instructor comments about the challenges of flipped classroom) to obtain an overall idea of the data, and to generate relevant emerging codes. Similar codes were organized into themes. To enhance the consistency of coding, several exemplary quotes that clearly illustrate each constructed theme were identified.

3. Results

3.1 Articles reviewed

Figure 1 shows the PRISMA flowchart that illustrates the entire article screening process. The initial academic databases search resulted in 2,912 records. Eighteen additional records were identified by searching the Web. After removing duplicates, 2,527 remained. The titles and abstracts of the remaining 2,527 records were screened. Many records were excluded because they were irrelevant to the purpose of the present study (e.g., FLIP as a therapeutic target in cancer). Subsequently, 49 full-text records were assessed for eligibility. Of these 49 full-text records, 14 were excluded because they did not focus on student cognitive outcomes, or the specific challenges of flipped classroom

implementation. Ultimately, 35 records consisting of 19 meta-analyses and 16 systematic reviews were included in the present meta-synthesis.

3.2 RQ1: "What are the general characteristics and findings of previous meta-analyses concerning the overall effect of flipped classroom versus non-flipped classroom on student cognitive outcomes"

The set of 19 included meta-analyses with a list of education context, number of primary studies, number of participants, effect size metric, and overall average effect size is presented in Table 1.

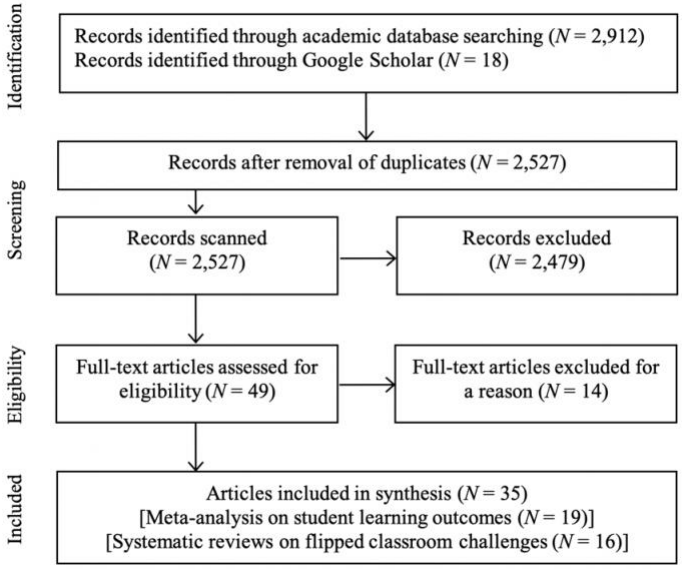

Figure 1. Flowchart of article selection.

Table 1. *Summary of meta-analyses examining student cognitive outcomes (N = 19)*

Meta-analysis	Education context	Primary Studies (*N*)	Participant (*N*)	Effect size metric	Overall mean effect size
Algarni (2018)	All levels	34	All: 8,598 (separate samples not reported)	*SMD*	0.27, $p < .05$
Chen et al. (2018)	Higher education	46	FC: 4,526, NFC: 4,828	*SMD*	0.35, $p < .05$
Cheng et al. (2019)	All levels	55	FC: 3,727, NFC: 4,185	*g*	0.19, $p < .05$
Gillette et al. (2018)	Higher education	5	FC: 685, NFC: 710	*g*	0.37, $p < .05$
Hew & Lo (2018)	Higher education	28	FC: 2,295, NFC: 2,420	*SMD*	0.33, $p < .05$
Hu et al. (2018)	Higher education	11	FC: 742, NFC: 742	*SMD*	1.06, $p < .05$
Kang & Shin (2016)	All levels	36	Not reported	*SMD*	0.53, $p < .05$
Karagöl & Esen (2019)	All levels	55	FC: 2,210, NFC: 2,400	*g*	*0*.57, $p < .05$
Låg & Sæle (2019)	All levels	271	FC: 23,856 NFC: 27,372	*g*	0.35, $p < .05$
Lo & Hew (2019)	All levels	29	FC: 2,590 NFC: 2,739	*g*	0.29, $p < .05$
Lo et al. (2017)	All levels	21	FC: 1,620 NFC: 1,564	*g*	0.30, $p < .05$
Orhan (2019)	Higher education	13	FC; 328 NFC: 323	*g*	0.74, $p < .05$

Shi et al. (2019)	Higher education	33	FC: 3,674 NFC: 3,273	*SMD*	0.53, $p < .05$
Strelan et al. (2020)	All levels	198	FC: 15,641 NFC: 18,037	*g*	0.50, $p < .05$
Tan et al. (2017)	Higher education	29	FC: 1,896 NFC: 1,798	*SMD*	1.13, $p < .05$
van Alten et al. (2019)	All levels	114	FC: 12,017 NFC: 12,661	*g*	0.36, $p < .05$
Zhang (2018)	All levels	28	FC: 7,847 NFC: 5,624	*g*	0.42, $p < .05$
Zheng et al. (2020)	All levels	95	All: 15,386 (separate samples not reported)	*g*	0.66, $p < .05$
Zhu et al. (2019)	K-12	25	FC: 1,739 NFC: 1,579	*SMD*	0.56, $p < .05$

Note: FC refers to flipped classroom; NFC refers to non-flipped classroom; *SMD* refers to standardized mean difference, *g* refers to Hedges' *g*.

All 19 meta-analyses included two-group comparison design studies such as quasi-experiments, historical control cohort, and experiments. In a quasi-experiment or historical control cohort, the flipped class would typically be treated as the experimental group, while the non-flipped class as the control group. Only two meta-analyses (Hu et al., 2018; Tan et al., 2017) restricted inclusion to *randomized control trials* (RCTs), which is a common recommendation in meta-analysis (Reeves et al., 2008), albeit difficult to operationalize in education due to the paucity of RCT studies. Out of the 18 meta-analyses, 16 employed the random effects model in their computation of the effect sizes since the conditions that could affect learner outcome, including frequency of lessons flipped, student population, and course level, may differ among studies in the analysis (Gurevitch & Hedges, 1999). One meta-analysis (Orhan, 2019) employed the fixed effects model, while another (Algarni, 2018) did not explicitly report which model was used.

All 19 meta-analyses examined the effect sizes of primary studies obtained from peer-reviewed journals. Several meta-analyses included the analysis of *additional* primary studies from *unpublished* sources (e.g., Chen et al., 2018; Cheng et al., 2019; Karagöl & Esen, 2018; Liu et al., 2018; van Alten et al., 2019). Seven of the 19 meta-analyses conducted some form of methodological quality assessment on the primary studies they reviewed (Chen et al., 2017; Gillette et al., 2018; Hew & Lo, 2018; Hu et al., 2018; Liu et al., 2018; Tan et al., 2017; Xu et al., 2019). It is interesting to note that these meta-analyses all focus exclusively on disciplines within *health professions* education (e.g., nursing, medicine, pharmacy). One possible reason for the prevalence of quality checking on health professions education research as compared to other fields is the global movement for quality in medical education. Five meta-analyses employed the Cochrane risk-of-bias-tool to assess each primary study to determine whether the study yielded a low risk of bias (unlikely to seriously alter the results), a high risk of bias (seriously weakens confidence in the results), or an unclear risk of bias (Gillette et al., 2018; Hu et al., 2018; Liu et al., 2018; Tan et al., 2017; Xu et al., 2019). The other two meta-analyses used the Medical Education Research Study Quality Instrument (MERSQI) (Hew & Lo, 2018), and the Effective Public Health Practice Project Quality Assessment (EPHPP) Tool (Chen et al., 2018).

Overall, all 19 meta-analyses concluded that flipped classroom improved learners' cognitive outcomes significantly better than non-flipped classroom. The basic findings of these meta-analyses varied from weak to strong support of flipped learning. The overall average effect sizes for cognitive outcomes ranged from 0.19 to 1.13, with a median of 0.42. The two largest effect sizes (1.06 and 1.13) came from studies conducted exclusively with Chinese nursing students (Hu et al., 2018; Tan et al., 2017) reported in Chinese-medium publications.

3.3 RQ2: "What factors contribute to more effective use of flipped classroom as reported by previous meta-analyses?"

Next, we turn to the question, *when is flipped classroom more effective?* To do this, I examined the moderators analyzed in the previous meta-analyses, and their results (e.g., Q_B data, and *p* values). A

majority of meta-analyses commonly examined the use of quizzes in flipped classroom, the educational level of participants, the subject disciplines, the study duration or implementation duration, and the types of publication. There are, of course, other moderating factors that were analysed but we will focus only on these aforementioned factors due to page constraint of this article.

We observe empirical support showing that flipped learning appears to be *more effective* when quizzes are used before and/or during class time. Evidence for this statement is provided in five meta-analyses (Hew & Lo, 2018; Lag & Saele, 2019; Lo & Hew, 2019; Lo et al., 2017; van Alten et al., 2019). A moderator analysis of health professions education studies indicated that the effect size was significantly higher when quizzes were employed at the *start* of face-to-face class lessons (p = 0.02, Hew & Lo, 2018). A meta-analysis of flipped mathematics education studies also revealed that the effect size was significantly higher when instructors used a structured formative assessment such as a quiz at the start of face-to-face lessons compared to instructors who did not (p = 0.013, Lo et al., 2017). Van Alten et al. (2019) similarly found that the use of quizzes in flipped learning showed a significant difference (p = 0.044) compared to studies where quizzes were not included.

The use of flipped classroom appears to be equally effective among learners from different educational levels. No significant effect size difference among elementary, high school, undergraduate and graduate learners were found (Cheng et al., 2019; Karagöl & Esen, 2019; Lag & Saele, 2019; Lo & Hew, 2019; Orhan, 2019; Tan et al., 2017; van Alten et al., 2019). The effect on cognitive outcomes did not appear to be moderated by different publication types (Cheng et al., 2019; Kang & Shin, 2018; Orhan, 2019; van Alten et al., 2019).

Results concerning the possible moderating effect of flipped classroom implementation duration were mixed. For example, on one hand, van Alten et al. (2019) found no significant effect size difference among different durations (e.g., 1-10 weeks, > 10 weeks). Cheng et al. (2019) similarly found no significant effect size among durations of one semester, and one semester or more. On the other hand, Zheng et al. (2020) found that the effect of flipped learning in social sciences was significantly higher than in implementation duration of 5-8 weeks as compared to 2-4 weeks, 9-24 weeks, and more than 24 weeks. One possible reason for this is that different meta-analyses used different categories to classify the implementation duration – hence making it difficult to make useful comparisons. Results concerning the impact of flipped learning on different subject disciplines were also mixed (e.g., Cheng et al., 2019; Shi et al., 2019; van Alten et al., 2019). One possible reason for this is that different meta-analyses used different categories to classify the subject disciplines – hence making it difficult to make meaningful comparisons across different meta-analyses.

3.4 RQ3: "What are the key student- and instructor-related challenges that can undermine the use of flipped classroom as reported by previous flipped classroom systematic reviews, as well as meta-analyses?"

A meta-synthesis of 16 systematic reviews and meta-analyses found several key student-related and one key instructor-related challenges that could lead to flipped classroom failure.

Student-related key challenge 1: Unwilling to prepare for class. Not all students are willing to complete the pre-class work due to two key reasons or factors. First, students are unhappy with the perceived extra workload in terms of time and effort imposed by the pre-class activities (Akçayır & Akçayır, 2018; Al-Samarraie et al., 2019; Betihavas et al., 2016; Bond, 2020; Brewer & Movahedazarhouligh, 2018; Kraut et al., 2019; Lo & Hew, 2017; Lo et al., 2017; Njie-Carr et al., 2017; O'Flaherty et al., 2015; Ramnanan & Pound, 2017; Turan & Akdag-Cimen, 2019; Ward et al., 2018; Zainuddin & Halili, 2016; Zhang, 2018). Second, may students still prefer the traditional classroom format because they do not like or perceive the value of active learning inherent in flipped classroom (Akçayır & Akçayır, 2018; Betihavas et al., 2016; Bond, 2020; Brewer & Movahedazarhouligh, 2018; Karabulut-Ilgu et al., 2018; Lo & Hew, 2017; Lo et al., 2017; Vanka et al., 2020; Ward et al., 2018; Zainuddin et al., 2019; Zhang, 2018).

Student-related key challenge 2: Not engaged with pre-class work. First, students are not able to get immediate help or feedback while they study at home (Al-Samarraie et al., 2019; Bond, 2020; Akçayır & Akçayır, 2018; Lo & Hew, 2017; Lo et al., 2017; Ramnanan & Pound, 2017; Zainuddin et al., 2019). Second, the video lectures are not interesting to watch (Akçayır & Akçayır, 2018; Al-Samarraie et al., 2019; Bond, 2020; Karabulut-Ilgu et al., 2018; Lo & Hew, 2017; Lo et al., 2017; Njie-Carr et al., 2017; Zainuddin & Halili, 2016). Students are unmotivated to watch the videos due to

three main reasons: the videos are too long, the audio quality is poor, and the perception that videos are not as important as worksheets.

Instructor-related key challenge: Unwilling to try out flipped classroom. Instructors' reluctance of implementing flipped classroom appear to stem from three main factors: unfamiliarity with the technological tools (e.g., video recording technology), unhappiness with the perceived extra workload before and during class, and familiarity with the traditional lecture format (Al-Samarraie et al., 2019; Akçayır & Akçayır, 2018; Betihavas et al., 2016; Karabulut-Ilgu et al., 2018; Kraut et al., 2019; Lo & Hew, 2017; Lo et al., 2017; Njie-Carr et al., 2017; O'Flaherty et al., 2015; Ward et al., 2018; Zainuddin & Halili, 2016). By far, the most commonly reported factor was instructor unhappiness with the perceived extra workload. The actual time needed for an instructor to prepare flipped course materials can be nearly six times more than traditional course preparation (Wanner & Palmer, 2015). In addition, during in-class sessions, an instructor may need to serve many students requesting assistance at the same time (Karabulut-Ilgu et al., 2018).

4. Discussion

Probably the main practical implication we can draw here is that flipped classroom is worth implementing. Overall, meta-analytic evidence suggests that flipped classroom is more effective than traditional classroom in improving learner cognitive outcomes. All meta-analyses reported positive significant effects, ranging from small to medium effect size with a median of 0.42, favouring the use of flipped classroom. Compared to non-flipped classroom, flipped classroom provides students with more than one exposure to the course materials. Students are first exposed to the course materials during the pre-class activity. Students engaged with the course materials again later during the in-class session. Multiple exposure to course materials can help improve student understanding of the lesson.

Future implementations of flipped classroom should incorporate formative assessment such as short reviews or quizzes since the use of reviews tends to significantly increase the effect size of student cognitive outcomes. These reviews may consist of specific instructor's generated questions to assess student learning based on the pre-class materials. The use of a review enables an instructor to determine students' possible factual or conceptual misunderstandings about the content materials. If students' misunderstandings are identified, the instructor can provide the necessary remedial action such as reviewing the pre-class materials or changing the in-class teaching plans to specifically correct the misconceptions.

Despite the overall advantage of flipped classroom over the traditional approach, it is important to note that not all flipped classroom implementations are smooth. This paper identifies several student- and instructor-related challenges that could diminish the benefits of flipped classroom. I shall discuss some practical recommendations gleaned from relevant empirical studies to alleviate these challenges in the following sections.

How can practitioners mitigate student unwillingness to complete the pre-class work? To recall, students are unwilling to do the flip pre-class work because they perceive the pre-class work as extra workload, and that they prefer the passivity of traditional teacher-lecture format. In order to deal with the former, it is important for the flipped classroom instructor to retain the overall workload hours as in its traditional format. Lo and Hew (2017) suggest that instructors first estimate the total time typically required for the students to complete the homework that is traditionally done outside the classroom. Instructors can then use this time estimation as a reference when designing their out-of-class learning activities of flipped classrooms.

A more difficult challenge is to address the students' preference for the relatively passive learning of a traditional classroom. Flipped classrooms require the students to spend their in-class lessons on active learning activities (e.g., group discussion) instead of merely listening to a teacher's lectures. Students tend to view active learning activities negatively because they dislike spending the required additional cognitive effort to complete the activities (Deslauriers, McCarthy, Miller, Callaghan, & Kestin, 2019). Students also perceive they learn *less* than in passive classes (Deslauriers et al., 2019). However, students' perceptions were faulty because students in active learning classrooms in reality learned more (Deslauriers et al., 2019). Since the success of flipped classroom hinges on student 'buy-in' of active learning, it is important that efforts be made to explain to students the advantages of active learning in the classroom. Early intervention by the instructors such as explaining clearly the value of increased cognitive effort and convince students that they can benefit

from active learning (Deslauriers et al., 2019) to be helpful in fostering positive student attitude toward active learning.

How can practitioners address the problem of student disengagement with the pre-class work? Unlike a traditional classroom, students in a flipped classroom environment cannot ask their teacher while watching the instructional videos. Previously some studies (e.g., Bhagat et al., 2016) suggest the use of online discussion forum for students to post their questions and discuss with other people. However, the asynchronicity of a forum or email introduces a time lag between postings and replies. This time lag could discourage students from posting their comments (Hew, Tang, Lo, Zhu, 2018). To overcome this problem, teachers can use a mobile instant messaging app such as WhatsApp or WeChat for students to seek help. MIM apps such as WhatsApp and WeChat allow users to engage in quasi synchronous communications on their mobile phones. In times of urgent communication needs, many students may only have their phones available. When a MIM message arrives, a notification will automatically show up on the user's phone screen, which encourages timely response (Hew et al., 2018). Findings from a study (Hew et al., 2018) suggest that MIM app can be viable platform to encourage students to communicate with other people when they need to seek help or feedback from other people.

Students can also be disengaged when they watch video lectures particularly when the videos are too long. To deal with the problem of long videos, instructor should consider segmenting it into shorter clips of about 6 min long (Guo et al., 2014). Besides the issue of video length, practitioners should also be concerned about the quality of the audio in the video, as well as how the instructor presents the course materials on videos. Some students perceive that videos are not as important as worksheets. For example, a few students complained about watching videos in Snyder et al. (2014) that "I feel like I'm just reading and listening to facts". It is hard for students to retain any information that they learn from a video simply by watching it once, especially when the video contains new information (Lam, Hew, Jia, 2020). Having a worksheet to fill in can help focus learner attention to the video's details, and possibly watching it multiple times (Lam et al., 2020).

How can practitioners mitigate instructors' unwillingness to try out flipped classroom? The support from IT staff is essential in helping instructors to implement flipped classroom (Critz & Knight, 2013). Not every instructor is an experienced user of flipped classroom. They may thus be inexperienced in handling the technical problems of video production. Gaughan (2014) recalled the experience of creating his first instructional video. He stated that it was a painless experience with the assistance of IT staff. In fact, "With low-cost computer-based video capture capabilities becoming more readily available, capturing, editing and posting digital video recordings is a realistic option for anyone" (Albert & Beatty, 2014, p. 419). For example, applications such as "Microsoft Office Mix" for Windows users and "Explain Everything" for iOS users are some user-friendly tools of producing instructional videos. However, it would be better if universities can provide training of using these new technologies.

Many instructors also lamented that it was time consuming to prepare flipped classroom materials especially the instructional videos. However, it is not necessary to flip the entire course at one go (Naccarato & Karakok, 2015). In fact, instructors can "start, and proceed, at a reasonable pace" (Snyder, Paska, & Besozzi, 2014, p. 314) by working on two to three topics every year (Lo & Hew, 2017). Starting small with these topics can also enable teachers to gain experiences of implementing flipped classroom. Instructors can also utilize existing video clips from YouTube and Khan Academy. Nevertheless, it is important to note that although instructors may shorten the video preparation time by editing existing video resources, many of these existing videos do not offer personalization or specificity unlike custom video made by the instructor (Alpert, 2016). Instructor self-created videos are found to be more appealing than videos that do not feature the instructor (Bond, 2020). Therefore, it would still be better for the instructors to develop their own videos in the long run. Even though a significant amount of start-up effort is required to create flipped classroom resources, these resources can be reused in subsequent semesters, which makes the preparation of a flipped course cost-effective in the long run.

5. Conclusion

This study is the first to synthesize the available meta-analytic information on the effectiveness of the flipped classroom approach on student cognitive outcomes. It also summarizes the key reasons why

flipped classroom flops. Here I conclude by presenting several implications for practice and future research. From a practical perspective, this paper identifies a useful set of meta-analyses for educators, policy-makers and researchers to draw upon when thinking about the flipped classroom approach. This paper also provides useful recommendations to alleviate the key challenges in order to help educators design more optimal use of flipped classroom. In future work, it would be interesting to examine and compare some of the design strategies for the in-class activities implemented in the flipped classroom studies with largest effect sizes versus lowest effect sizes. Future research should also investigate how the conventional flipped classroom approach can be transformed into fully online flipped classroom to support student learning during emergency school closure periods. Presently, a majority of the primary studies examined were only one semester long in duration. Short-term studies carry the risk of the novelty effect. Learners may become bored with the same flipped classroom approach over time which might diminish their desire to use it. Longitudinal studies are sorely needed to examine whether and how learners' engagement with flipped classroom changes over time.

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References

Due to page constraints, references for the meta-synthesis articles in Table 1 are not listed here. Please request them from the author.

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research. Higher Education Research and Development, 34(1), 1–14.

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. *Computers & Education*, 126, 334-345.

Albert, M., & Beatty, B. J. (2014). Flipping the classroom applications to curriculum redesign for an introduction to management course: Impact on grades. *Journal of Education for Business*, 89(8), 419-424.

Alpert, F. (2016). Revitalizing the live lecture class with instructor-created videos. *Sage Open*. https://doi.org/10.1177/2158244016680686

Al-Samarraie, H., Shamsuddin, A. & Alzahrani, A.I. A flipped classroom model in higher education: a review of the evidence across disciplines. *Education Tech Research Dev* (2019). https://doi.org/10.1007/s11423-019-09718-8

Betihavas. V., Bridgman, H., Kornhaber, R., & Cross, M. (2016). The evidence for 'flipping out': A systematic review of the flipped classroom in nursing education. *Nurse education today*, 38,15-21

Bhagat, K. K., Chang, C. N., & Chang, C. Y. (2016). The impact of the flipped classroom on mathematics concept learning in high school. Educational Technology & Society, 19(3), 134–142.

Bond, M. (2020). Facilitating student engagement through the flipped learning approach in K-12: A systematic review. *Computers & Education*, 151.

Brewer, R., & Movahedazarhouligh, S. (2018). Successful stories and conflicts: A literature review on the effectiveness of flipped learning in higher education. *Journal of Computer Assisted Learning*, 34(4), 409-416.

Critz, C. M., & Knight, D. (2013). Using the flipped classroom in graduate nursing education. *Nurse Educator*, 38(5), 210-213.

DeSantis, J., Van Curen, R., Putsch, J., & Metzger, J. (2015). Do students learn more from a flip? An exploration of the efficacy of flipped and traditional lessons. *Journal of Interactive Learning Research, 26*(1), 39–63.

Deslauriers, L., McCarthy, L. S., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(39), 19251–19257.

Gaebel, M., & Zhang, T. (2018). Trends 2018. Learning and teaching in the European Higher Education Area. European University Association 2018. Retrieved from https://eua.eu/downloads/publications/trends-2018-learning-and-teaching-in-the-european-higher-education-area.pdf

Gaughan, J. E. (2014). The flipped classroom in world history. *History Teacher, 47*(2), 221-244

Guba, E. G. (1978). *Toward a methodology of naturalistic inquiry in educational evaluation* (CSE Monograph 8). Los Angeles: University of California, Los Angeles, Center for the Study of Evaluation. Retrieved from http://cresst.org/wp-content/uploads/cse_monograph08.pdf

Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement: an empirical study of MOOC videos. In Proceedings of the first ACM Conference on Learning@ Scale Conference (pp. 41–50). New York, NY: ACM.

Gurevitch, J., Koricheva, J., Nakagawa, S., & Stewart, G. (2018). Meta-analysis and the science of research synthesis. *Nature, 555*, 175–182.
Hew, K. F., Tang, Y., Lo, C. K., & Zhu, Y. (2018). Examining a WeChat-supported 5E-flipped classroom pedagogical approach. International Journal of Services and Standards, 12(3-4), 224-242.
Karabulut-Ilgu, A., Jaramillo Cherrez, N., & Jahren, C. T. (2018). A systematic review of research on the flipped learning method in engineering education. *British Journal of Educational Technology*, 49(3), 398-411.
Klein, S. P., Kuh, G., Chun, M., Hamilton, L., & Shavelson, R. (2005). An approach to measuring cognitive outcomes across higher education institutes. *Research in Higher Education, 46*(3), 251–276.
Kraut, A. S., Omron, R., Caretta-Weyer, H., Jordan, J., Manthey, D., Wolf, S. J., et al. (2019). The flipped classroom: A critical appraisal. *Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health*, 20(3), 527-536.
Lam, Y. W., Hew, K. F., & Jia, C. (2020). Toward a flipped 5E model for teaching problem-solution writing: A 2-year longitudinal study. *Language Learning & Technology*.
McGuire, P. (2020). What the flip? The case for and against flipped classrooms. *The Irish Times*. Retrieved from https://www.irishtimes.com/news/education/what-the-flip-the-case-for-and-against-flipped-classrooms-1.4168601
McKie, A. (2019). Flipping great? The case for and against flipping the classroom. *Times Higher Education.* Retrieved from https://www.timeshighereducation.com/news/flipping-great-case-and-against-flipping-classroom
Naccarato, E., & Karakok, G. (2015). Expectations and implementations of the flipped classroom model in undergraduate mathematics courses. *International Journal of Mathematical Education in Science and Technology, 46*(7), 968-978.
Noblit G. W., & Hare R. D. (1988) Meta-ethnography: Synthesizing qualitative studies. Newbury Park, CA: Sage.
O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *Internet & Higher Education.* 25, 85-95.
Ramnanan, C. J, & Pound, L. D. (2017). Advances in medical education and practice: student perceptions of the flipped classroom. *Advances in medical education and practice*, 8, 63-73
Schultz, D., Duffield, S., Rasmussen, S. C., & Wageman, J. (2014). Effects of the flipped classroom model on student performance for advanced placement high school chemistry students. Journal of Chemical Education, 91(9), 1334–1339.
Setren, E., Greenberg, K., Moore, O., & Yankovich, M. (2019). Effects of the flipped classroom: Evidence from a randomized trial. SEII Discussion Paper #2019.07. Retrieved from http://seii.mit.edu/wp-content/uploads/2019/08/SEII-Discussion-Paper-2019.07-Setren.pdf
Snyder, C., Paska, L. M., & Besozzi, D. (2014). Cast from the past: using screencasting in the social studies classroom. The Social Studies, 105(6), 310–314.
Strobel, J., & van Barneveld, A. (2009). When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *Interdisciplinary Journal of Problem-Based Learning, 3*(1), 44–58.
Tsai, C. W., Shen, P. D., & Lu, Y. J. (2015). The effects of problem-based learning with flipped classroom on elementary students' computing skills: A case study of the production of ebooks. *International Journal of Information and Communication Technology Education, 11*(2), 32-40.
Turan, Z., & Akdag-Cimen, B. (2019). Flipped classroom in English language teaching: a systematic review. *Computer Assisted Language Learning*. DOI: 10.1080/09588221.2019.1584117
Vanka, A., Vanka, S., & Wali, O. (2020). Flipped classroom in dental education: A scoping review. *European Journal of Dental Education*, 24(2), 213-226
Walsh, D., & Downe, S. (2005). Meta-synthesis method for qualitative research: a literature review. Journal of Advanced Nursing,50(2), 204–21.
Ward M; Knowlton MC; Laney CW. (2018). The flip side of traditional nursing education: A literature review. *Nurse education in practice*, 29, 163-171
Wilder, S. (2014). Effects of parental involvement on academic achievement: a meta-synthesis. *Educational Review*, 66(3), 377-397.
Yong, D., Levy, R., & Lape, N. (2015). Why no difference? A controlled flipped classroom study for an introductory differential equations course. *PRIMUS, 25*(9–10), 907–921.
Zainuddin, Z., & Halili, S.H. (2016). Flipped classroom research and trends from different fields of study. International Review of Research in Open and Distributed Learning, 17(3), 313–340.
Zainuddin, Z., Haruna, H., Li, X., Zhang, Y., & Chu, S. K. W. (2019). A systematic review of flipped classroom empirical evidence from different fields: what are the gaps and future trends? *On the Horizon, 27*(2), 72-86.