Received September 2021; | Revised November 2021; | Accepted December 2021

DOI: 10.52631/jemds.v2i1.71

REVIEW ARTICLE

A Systematic Review of the Flipped Classroom Research in K-12: Implementation, Challenges and Effectiveness

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Abstract

This study presents a systematic review of flipped classroom literature in K–12 with a focus on investigating flipped classroom implementation strategies, challenges, and effectiveness. Three electronic databases were searched: a) Scopus, b) Web of Science, and c) Education Research Complete. In the end, thirty-four articles were included in the final set of studies reviewed. Findings from the review revealed that flipped classroom literature in K–12 was mostly undertaken in high school contexts. Huge variations on the design of pre-class, in-class, bridging activities and technologies utilized were found in the review where viewing of instructional videos, performance of individual and group activities, and conducting question and answer sessions were found to be the prevalent forms of pre-class, in-class and bridging activities, respectively. Videos were found to be the main technological tool used in all the studies. The challenges found with flipped classroom implementation revolved around the following: a) student's motivation and accountability; b) increased teacher's workload; c) resistance of students due to unfamiliarity to the approach; d) access to technology; and e) delivery. Lastly, although findings on the effectiveness revealed that most of the reviewed studies found flipped classrooms to be effective, there were also studies which reported producing mixed and contradicting results. Future efforts in flipped classroom research in schools must extend the idea found in this review on how to design and implement flipped classrooms to yield better student results.

KEYWORDS:
Flipped classroom, Blended learning, Elementary education, Secondary education, Teaching/learning strategies, Improving classroom teaching

1 | INTRODUCTION

Advances in technologies have allowed changes on how instruction is delivered and are continuing to enable more student-centered pedagogical approaches. The flipped or inverted classroom, for example, is a teaching and learning approach that moves lecture delivery out of the classroom, typically using videos and online content, to allow students' engagement in active learning activities inside the classroom Bergmann and Sams (2012). The flipped classroom highlights the potential of technology-enhanced instruction capable of supporting constructivist pedagogies as educational systems continue to give increasing focus on deeper learning approaches Freeman, Becker, Cummins, Davis, and Giesinger (2017). R. C. Clark and Mayer (2016) argue

that blended learning strategies such as the flipped classroom offers smart solutions to bridging gaps between traditional classroom-based learning and digital learning by providing flexible, active and individualized learning with technologies.

The flipped classroom has its roots in higher education, but the approach is widely adopted in schools Talbert (2017). The inception of flipped classroom in both school and higher education was motivated by pedagogical problems such as insufficient class time and was driven by innovations in technologies Talbert (2017). It is observed that although widely adopted in schools, research on flipped classroom is more prevalent in higher education Talbert (2017). This may be due to the fact that higher education academics are more exposed to research and publication endeavours than their school counterparts. Hence, despite the noted wide adoption in schools, it is often observed that the flipped classroom is less researched in schools compared in higher education.

There are huge variations in flipped classroom models and implementation strategies, possibly equating to the number of teachers utilizing the approach in their instruction Talbert (2017). In a scoping review which examined flipped classroom implementations in higher education, it was revealed that a wide array of technologies, strategies, and activities were employed by academics in implementing flipped classrooms O'Flaherty and Phillips (2015). In school contexts, the watching of instructional videos was found to primarily form part of students' pre-class learning, whereas collaborative tasks and teacher-assisted instruction typically drive in-class learning Abdelrahman, L. A. M., DeWitt, D., Alias, N., & Rahman, M. N. A. (2017). Pioneers of the approach in the K-12 setting, however, maintain that teachers may opt to employ other learning materials to deliver content and may refer to explicit pedagogical models in flipped classroom implementation Bergmann and Sams (2012). Teachers and students normally face challenges with teaching and learning in flipped classrooms Bergmann and Sams (2012). One of the most common challenges found in the literature concerns students and their access to devices and connectivity to view instructional videos at home K. R. Clark (2015). Teachers' lack of time, resources and skills in the preparation of pre-class materials and setting up of infrastructure for pre-class learning was also found to be a significant challenge raised by teachers in several studies (e.g. Aidinopoulou, V., & Sampson, D. G. (2017); Chen (2016)). Other challenges include students' accountability on performing pre-class activities. Since the success of in-class activities depends on students' faithful performance of pre-class activities, students' lack of preparation often poses significant challenge on teachers' end.

Reports on the number of flipped classroom studies undertaken in the recent years show that published studies in the field grow significantly year after year Karabulut-Ilgu, Jaramillo Cherrez, and Jahren (2018); Talbert (2017). Varying and oftentimes contradicting results continue to populate the flipped classroom research as a result of individual teachers' designs of flipped classroom models Karabulut-Ilgu et al. (2018); Lo, Lie, and Hew (2018); Talbert (2017). Despite the seemingly noted wide adoption of the flipped classrooms in schools coupled with the growing interests of teachers in adopting the approach, there appears a need to synthesize the findings from these studies. Hence, this study presents a systematic review of the research literature on flipped classroom implementation strategies (i.e. pre-class activities, in-class activities, bridging pre-class and in-class strategies, and technologies utilized), challenges on implementation, and the reported effectiveness of the approach in K-12 instruction. This study attempts to provide a comprehensive information on the common practices in flipped classroom design and implementation, and areas for further research.

This systematic review aimed to explore the current research on flipped classrooms in K-12 contexts. This review was guided by the following research questions: (RQ1) How is flipped classroom implemented in K-12 contexts? (RQ2) What are the challenges encountered by school teachers with flipped classroom implementation? (RQ3) Based on current research, is flipped classroom effective in school instruction?

2 | METHOD

2.1 | The study selection process

Studies investigating flipped classroom implementation were explored to answer the research questions. This review utilized the following search terms: (flip* OR invert*) combined using a three-word proximity rule with (class* OR instruct* OR learn* OR teach* OR subject), and joined with keywords that denote school contexts: primary OR elementary OR "grade school" OR secondary OR "high school" OR "middle school" OR K12 OR "K-12". Through this search structure, general phrases such as 'flipped classroom', 'flipped learning' and 'inverted instruction' were incorporated, as well as more specific phrases such as 'flipping a mathematics classroom' and 'flipping an elementary science subject'.

Three electronic databases were searched: a) Scopus, b) Web of Science, and c) Education Research Complete. Scopus and Web of Science were used as both have broad coverage of peer-reviewed literature, including social sciences studies. Education

Research Complete, on the other hand, was added as it is a leading journal in education exclusively indexing published articles in the field. Specific criteria were set in order to obtain insights in order to answer the research questions. For studies to be included in the review, the studies must be empirical, account for flipped classroom implementation in K-12 contexts (i.e., primary school, middle school, junior high school, or senior high school) and report on flipped classroom effectiveness in teaching and learning. Additionally, the studies must include a clear description of the two main aspects of a flipped classroom (i.e. preclass and in-class) and must detail the strategies and technologies utilized in the implementation of the approach. Lastly, the studies must be published in English and are peer-refereed.

2.2 | Search outcomes and analysis

The search terms used in this review yielded a total of 722 journal articles as of August 2018 from the three research databases searched. The article selection process was anchored in the Preferred Reporting of Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement Moher, Liberati, Tetzlaff, Altman, and The PRISMA Group (2009). Figure 1 illustrates the overall article selection process for this review. A total of six hundred thirty-eight articles were initially examined against the inclusion criteria by reading the titles and abstracts. A huge number of articles, totalling to 560, were discarded as they did not satisfy the criteria, most of which are unrelated to flipped classroom research or are flipped classroom studies that are situated in contexts other than K-12. Seventy-eight articles qualified for full-text assessment, of which 44 were removed due to irrelevance or absence of a clear account of flipped classroom implementation. In the end, thirty-four articles were included in the final set of studies reviewed. The main sets of data retrieved from each article include the following: author/s, title, year, location, methodology, focus of the study, participants, duration, flipped classroom implementation strategies (i.e., pre-class, in-class, and bridging strategies), technologies utilized, major findings, and challenges.

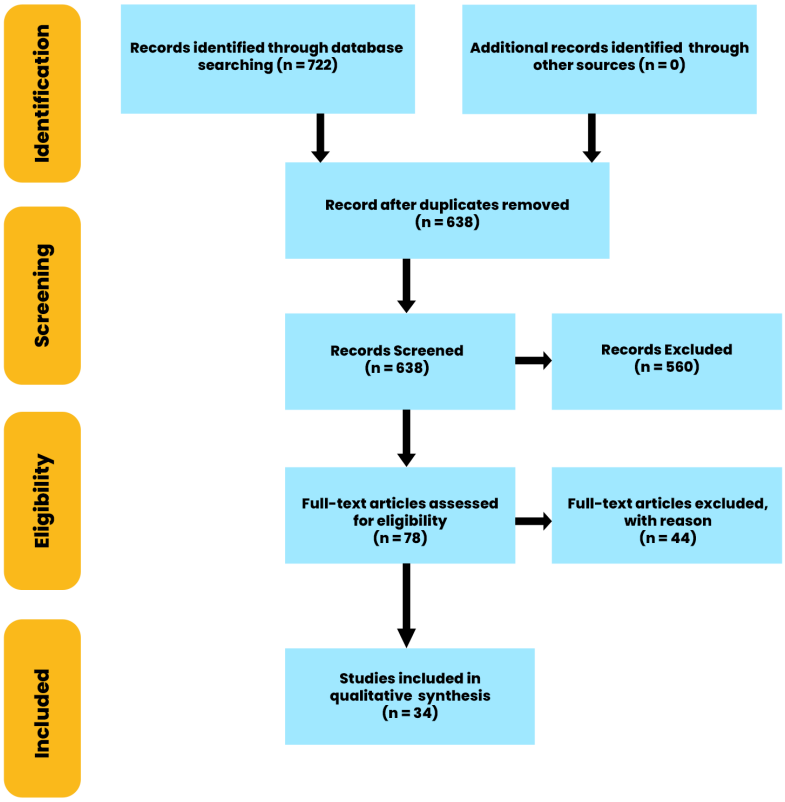

FIGURE 1 Article selection diagram (adopted from Moher et al., 2009)

3 | RESULTS AND DISCUSSION

3.1 | General description of the studies

The thirty-four journal articles included in this review were found to cover a mix of primary school, junior high school, and senior high school. Specifically, eight studies were undertaken in elementary schools and 26 studies involved junior high and senior high schools. Most of the studies were conducted in the United States of America (USA) (n = 9), Taiwan (n = 8), Hong Kong (n = 7), Greece (n = 3) and Turkey (n = 2). The rest of the studies were conducted in Qatar, Canada, Nigeria, Cyprus, and Serbia, with one study from each country. In terms of learning areas, most of the studies were situated in mathematics classes (n = 13), sciences (i.e., biology, physics, and chemistry) (n = 8), and information and communications technology (ICT) (n = 7). The rest involved English (n = 4), Social Studies (n = 2), Liberal Studies and Humanities (n = 3), Engineering (Advanced Placement) (n = 1), and Health (n = 1).

The effectiveness of the flipped classroom approach in school education was the primary focus of the majority of the studies. Specifically, most of the studies (n = 27) involved the examination of the effectiveness of flipped classroom in increasing students' performance and learning outcomes, while the effectiveness in raising students' attitude and satisfaction were involved in the investigation by almost half of the total studies (n = 18). Other aspects investigated in the reviewed studies include students' participation and engagement (n = 8), implementation benefits and challenges (n = 6), and effects on students' self-efficacy (n = 6). A few studies examined how flipped classroom explicitly impacts students of varying achievement and self-efficacy levels (n = 6), students' critical thinking (n = 3), use of classroom time (n = 2), and cognitive load (n = 1). It was also found that two studies implemented flipped classrooms anchored explicitly in a standard instructional design model Lo and Hew (2017b); Lo et al. (2018). A summary of the studies is presented in Appendix (Table A.1).

3.2 | RQ1: How is flipped classroom implemented in K-12 contexts?

3.2.1 | Pre-class activities

Pre-class activities prepare students for successful in-class learning by engaging students to watch instructional videos, study other instructional materials, and participate in other out-of-class activities, online or offline Bergmann and Sams (2012). Hence, the pre-class activities found in this review vary across studies; hence, themes were identified to categorize the pre-class activities. Pre-class activities in the reviewed studies generally include the following: video watching, online tests and exercises, note-taking, handout completion, mind maps, annotations, engagement in other learning materials, reflections, discussion, and goal-setting.

Video watching was implemented in all the studies included in this review. This was primarily done to deliver content prior to in-class learning and to demonstrate procedural information necessary for the succeeding laboratory or hands-on activities (e.g.Chang and Hwang (2018); Chao, Chen, and Chuang (2015); Cukurbasi and Kiyici (2018); Kostaris, Sergis, Sampson, Giannakos, and Pelliccione (2017); Lo and Hew (2017b); Lo et al. (2018); Tsai, Shen, and Lu (2015)). Pre-class online tests and exercises were employed in approximately half of the studies to facilitate students' self-assessment (DeSantis, Curen, Putsch, and Metzger (2015); Leo and Puzio (2016); Lo (2017); Lee and Lai (2017); Sergis, Sampson, and Pelliccione (2018)), while activities such as notetaking, completion of handouts and worksheets, and mind map creation activities were implemented in some studies to foster accountability and motivation in pre-class learning (Kirvan, Rakes, and Zamora (2015); Kong (2015); Winter (2018)). It was found that only a few studies have embedded discussion or chat support and activities to help students interact with their classmates or contact their teacher in case difficulties arise while engaging in out-of class learning (Jong (2017); Aidinopoulou, V., & Sampson, D. G. (2017); Tsai et al. (2015)). One study explicitly included goal-setting activity, which required students to set their achievement expectations and their target learning time for studying the content (Lai and Hwang (2016)). This was part of the overall design of the flipped classroom model in the study that aims to foster self-regulation among learners.

3.2.2 | In-class activities

In-class learning is the regular classroom meeting following pre-class learning which is typically allocated for student-centered activities Bergmann and Sams (2012). In the reviewed studies, themes were identified to capture the in-class activities implemented by teachers, which generally include the following: group activities, individual activities, question and answer or a

review of pre-class video watching, teacher-assisted instruction and feedback provision, quizzes, direct instruction/reteaching or reinforcement, laboratory tasks, student presentations and next-day preparation.

Implementation of group activities was the main strategy found in most of the studies. Irrespective of learning areas, these activities were generally centred on providing opportunities for students to collectively discuss concepts, work on tasks, and present their outputs (Abdelrahman, L. A. M., DeWitt, D., Alias, N., & Rahman, M. N. A. (2017); Bhagat, Chang, and Chang (2016); Kostaris et al. (2017); Olakanmi (2017); Sezer (2017)). In relation to specific learning areas, studies on flipped science and mathematics subjects reported employing problem-solving activities, inquiry- and problem-based learning, laboratory tasks performance, and worksheets completion (Hwang and Lai (2017); Olakanmi (2017); Sezer (2017); Zupanec et al., 2018) ; flipped computer classes, on the other hand, centred their inclass activities on computer-based task performance and collaborative problem solving (Cukurbasi and Kiyici (2018); Sergis et al. (2018); Tugun, V., Uzunboylu, H., & Ozdamli, F. (2017)) , whereas flipped languages and social science classes observed strategies such as social inquiry learning, concept map making, reading activities, gallery walks, recording and presentation of outputs (Huang and Hong (2016); Jong (2017); Kong (2015)).

Individual activities were also implemented in in-class learning in almost half of the studies. These were basically geared towards deepening every student's understanding of concepts being taught. Specific individual activities include practice exercises, information searching, individual exploration of instructional materials, journal writing and reflection activities. Some studies which reported these activities also explicitly described coupling them with feedback provision (Jong (2017); Kostaris et al. (2017); Sergis et al. (2018)).

There were instances, nevertheless, when students came to class unprepared. Thus, several studies employed in-class accountability quizzes and evaluations of students' levels of preparedness to engage in activities (Abdelrahman, L. A. M., DeWitt, D., Alias, N., & Rahman, M. N. A. (2017); D'addato and Miller (2016); Zupanec et al., 2018). Prepared students typically engaged directly in the planned active learning activities for the day. However, in instances when students were evaluated as not yet ready for in-class active learning activities, teachers reteach the pre-class materials or reinforce concepts using other instructional materials (K. R. Clark (2015)).

3.2.3 | Bridging pre-class and in-class strategies

A few studies have explicitly outlined the strategies to connect the pre-class and in-class aspects of flipped classrooms in their implementation. These strategies are essential to provide a smooth transition from pre-class engagement to the performance of activities inside the classroom (Hwang and Lai (2017)).

Based on the data gathered, question and answer discussions centered on clarifying misconceptions were the common approach to transitioning students' pre-class learning to in-class engagement (Aidinopoulou, V., & Sampson, D. G. (2017); Gariou-Papalexiou, Papadakis, Manousou, and Georgiadu (2017); Hwang and Lai (2017): Zupanec et al., 2018). This strategy centered on reinforcing concepts to students and the correction of any misconceptions so that proper application of concepts will be observed in the performance of tasks inside the classroom. The second most common way to bridge students' pre-class learning to in-class learning is through the conduct of a brief review of video lectures, normally occupying the first 5-15 minutes of the class time (Lo et al. (2018); Lo and Hew (2017a); Schultz, Duffield, Rasmussen, and Wageman (2014); D'addatp Miller, 2016). This strategy mainly aimed at activating prior learning of students from the pre-class learning. Other connecting strategies involved presentations or checking of pre-class output or activity (e.g. Kong, 2015; Lo, 2017), administering accountability quizzes and exercises (D'addato & Miller, 2016; Kirvan et al. (2015)), and the delivery of mini-lectures (Lo et al. (2018)).

3.2.4 | Technologies utilized

The reviewed studies reported utilising various technologies in flipped classroom implementation. Generally, all the reviewed studies utilized instructional videos as the primary material for the delivery of content outside the classroom. A number of studies also used learning management systems, such as Moodle and Edmodo, to manage the delivery of instructional videos and the facilitation of pre-class activities (Abdelrahman, L. A. M., DeWitt, D., Alias, N., & Rahman, M. N. A. (2017); Kirvan et al. (2015); Kostaris et al. (2017); Sergis et al. (2018)). Other researchers, however, chose to use websites, web pages or curation sites as learning platforms in lieu of learning management systems (Graziano and Hall (2017); Huang and Hong (2016); Tugun, V., Uzunboylu, H., & Ozdamli, F. (2017); Cheung Ruby Yang (2017)). One study, interestingly, has simply used a cloud service (i.e. Dropbox) to distribute the instructional videos to students (Bhagat et al. (2016)). A few studies, nevertheless, allowed students to copy video files through flash drives and compact disks due to access and connectivity issues (R. C. Clark and Mayer (2016); Sezer (2017)).

Apart from learning platforms, several technologies were also utilized to facilitate the execution of preclass learning for students. Among these were Google Forms for reflection and self-check exercises and online quizzes to check students' understanding of the concepts presented in the videos (Hwang and Lai (2017); Kong (2015); Leo and Puzio (2016); Winter (2018)). Facilitation of communication with students and teachers was also found in very few studies which employed Facebook groups, chat support, and discussion platforms to make it possible to ask questions and clarify misunderstandings with peers or teachers (e.g., Technologies used inside the classroom, in addition to computers, laptops, or mobile devices, include ebooks Lai and Hwang (2016) and discipline-specific software such as LEGO and Scratch for computer subjects which include coding and programming activities (Cukurbasi and Kiyici (2018); Tugun, V., Uzunboylu, H., & Ozdamli, F. (2017)) West Point Bridge Designer for engineering design activities (Chao et al. (2015)); and ZMaker, Photocap and SketchUp (Lee and Lai (2017); Tsai et al. (2015)) for computer subjects which involved the production of e-books. Graphing calculators were also used in studies situated in Mathematics classes (Graziano and Hall (2017); Kirvan et al. (2015)).

3.2.5 | Discussion on Flipped Classroom Implementation

The high diversity in implementation strategies employed by school teachers in flipped classroom implementations may be a direct influence of the seemingly too simplistic conceptualisation of flipped learning, that is, an approach which involves content delivery prior to class and classroom time being spent for active learning. In designing the in-class aspect of flipped classrooms alone, Karabulut-Ilgu et al. (2018), for example, argue that a wide-ranging type of activities seem to fall under the term active learning because it is a broad terminology which is interpreted and utilised differently by researchers. The high variation in implementation strategies may also be related to the observation frequently raised in existing flipped classroom literature highlighting the lack of solid conceptual frameworks to guide the design of flipped classrooms Lo et al. (2018); Song, Jong, Chang, and Chen (2017)). This lack of guiding frameworks was evident on the shortage of explicit strategies to effectively transition students from pre-class to in-class learning in the body of reviewed studies. Seamless flipped learning or the smooth transition from pre-class to in-class learning is argued to serve as an efficient scaffold for students towards improving their learning performance (Huang and Hong (2016)). The First Principles of Instruction (Merrill (2002)) as utilised in a couple of studies was interpreted as facilitative of designing structured flipped classrooms (Lo (2017); Lo et al. (2018)). There is potential on embedding this instructional design model in flipped classrooms and may serve as a reference to explore other similar frameworks or principles as bases for flipped classroom designs.

The technologies utilised in the reviewed studies were generally facilitative of the flipped classroom implementation. Instructional videos and learning platforms were found to be the primary tools in delivering flipped classroom in the reviewed studies. Although video watching may be the norm in pre-class flipped learning, other strategies and technological tools for delivering content may be further explored and utilised. It was observed that only a handful of studies complemented pre-class instructional videos with other learning materials such as readings, e-books and podcasts.

New technologies may be explored, and familiar tools may be reconsidered on how they will fit in facilitating the implementation of flipped classrooms. McLaughlin, White, Khanova, and Yuriev (2016) suggested that greater variation in technological tools may be instrumental to further continue the evolution of the flipped classroom as a pedagogical approach. Specifically, for pre-class learning, technological tools other than videos, which may include interactive online materials such as e-books, as implemented in a couple of studies, may be further explored to deliver content outside the classroom. In addition, the rise of adaptive technologies which presents huge possibilities on personalising instruction may also be further tapped to provide personalised content and activities at both the outside and inside of the classroom, efficiently scaffolding students as they proceed from pre-class to in-class dimensions of flipped learning. In the existing body of studies, only two studies (Hwang and Lai (2017); Lai and Hwang (2016)) was found to have so far tapped and explored adaptive technologies being embedded in flipped classrooms.

3.3 | RQ2: What are the challenges encountered by school teachers with flipped classroom implementation?

Studies which included an investigation of the students' and/or teachers' perceptions of flipped classrooms were the main sources of data for the challenges encountered on flipped classroom implementations. Based on the analysis of retrieved data, five themes emerged as challenges on flipped classroom implementation: a) students' motivation and accountability; b) increased teacher workload; c) resistance of students due to unfamiliarity with the approach; d) access to technology; and e) delivery. Students' motivation and accountability were the common challenges found in the studies reviewed (Abdelrahman, L. A. M., DeWitt,

D., Alias, N., & Rahman, M. N. A. (2017); Cukurbasi and Kiyici (2018); Gariou-Papalexiou et al. (2017); Lo et al. (2018); Olakanmi (2017); Cheung Ruby Yang (2017)). This challenge pertains to students not being motivated to engage in pre-class learning activities and the lack of general preparation for in-class engagement. Accountability issues pose a challenge to teachers as students' interactions in pre-class cannot be monitored and verified. For example,Lo and Hew (2017a) noted that it was hard to determine if students really engaged in pre-class activities or not, or if the outputs students submitted for the subsequent in-class learning were authentic products of individual students themselves.

The second most common challenge concerns teachers on having an increased number of tasks added to their workload. It was raised by teachers in several studies that the preparation of videos posed significant challenge to them as it demands significant amounts of time and that some teachers need to first learn technical skills in video production (Aidinopoulou, V., & Sampson, D. G. (2017); Chen (2016); Gariou-Papalexiou et al. (2017); Leo and Puzio (2016)). Moreover, some teachers mentioned that thinking of strategies that will suit their students' individual needs was also an additional task for them, whereas some raised the challenge of finding videos that suit the learning goals and students' preferences (Abdelrahman, L. A. M., DeWitt, D., Alias, N., & Rahman, M. N. A. (2017); Chen (2016)). The resistance of students to adapt to the new approach was also observed in a number of studies. This was mainly due to the ingrained culture of traditional lecture-based classrooms widely experienced by students and has been observed as a routine in their schools (Abdelrahman, L. A. M., DeWitt, D., Alias, N., & Rahman, M. N. A. (2017); Cukurbasi and Kiyici (2018); Olakanmi (2017)). Access to technology was also an issue in a number of studies because not every student involved in the flipped classroom implementation have the needed devices and connectivity at home that will enable them to participate in pre-class activities (Abdelrahman, L. A. M., DeWitt, D., Alias, N., & Rahman, M. N. A. (2017); D'addato and Miller (2016); Gariou-Papalexiou et al. (2017)). Nevertheless, several teachers addressed this issue by giving students copies of video files through flash drives and compact disks, permitting students to use the school's computer laboratory during free time, or by lending students with laptops and mobile connectivity that they can use at home in the entire duration of flipped classroom implementation (R. C. Clark and Mayer (2016); D'addato and Miller (2016)). Lastly, delivery of pre-class activities relates to the challenge of effectively facilitating pre-class learning primarily due to the lack of technological support for monitoring and assisting struggling students while they engage in pre-class activities. For example, Lo and Hew (2017a) mentioned that students would have wanted to have instant feedback in online exercises, however, the learning design and the technology utilised did not support such.

Considerable challenges with flipped classroom implementation appear to have inhibited the effective delivery of the approach as revealed in the reviewed studies. Specifically, the identified five major challenges underscore the idea that flipped classroom challenges in schools are mainly related to students, teachers, and to the actual execution of the approach. This was found to parallel the findings in a similar study which categorised challenges to the flipped classroom as student-related, faculty-related, and operation-related (Lo and Hew (2017a)).

In this review, challenges concerning students are found to be the most substantial which involved students' motivation, accountability and resistance. The issues on lack of students' motivation and accountability may have resulted from the lack of facilitating strategies particularly in pre-class learning where students are on their own in performing the assigned tasks. Carbaugh and Doubet (2016) suggest that in order to foster motivation in flipped learning, teachers may advocate for providing choices and connection to students. Providing choices and connection may practically be achieved by embedding differentiated approach to instruction in both pre-class and in-class learning aspects of flipped classrooms.

In pre-class learning, differentiation in terms of aligning content to the interests of students may be effective in fostering intrinsic motivation among students (Carbaugh and Doubet (2016)). In mathematics, for example, this may involve grouping students based on their interests, where mathematical problems may be contextualised and may be the starting point for pre-class discussion activities (Carbaugh and Doubet (2016)). Alternatively, Lo et al. (2018) suggested adding gamification concepts to pre-class learning through the awarding of points or badges to students in the learning management system. It is argued that embedding game elements in learning has beneficial effects on students' motivation (Hew, Huang, Chu, and Chiu (2016)). On the other hand, providing multiple activities in in-class learning may be explored to foster differentiation. In K. R. Clark (2015) implementation, in-class learning was implemented by assigning three stations where students could freely choose what set of activities to sequentially engage in: a) re-watch and discuss the pre-class instructional video with peers; b) perform practice exercises assigned for the day; or c) clarify misconceptions with the teacher. This strategy was found to provide personalised instruction to students, which apparently contributed to the overall positive attitude of students in flipped learning.

The resistance of the students to the new approach as raised in several studies may have stemmed from the lack of preparation for students before flipping the instruction. White et al. (2016) argue that as much as teachers need continuous technical and administrative support in addition to the need for resources, students may also necessitate support to familiarise themselves with

learner-centred environments such as flipped classrooms. As revealed in some studies, the resistance of the students against flipping of instruction was mainly caused by their constant exposure to the traditional didactic instruction and the lack of study skills essential for their engagement in pre-class learning (Cukurbasi and Kiyici (2018); Olakanmi (2017); Tugun, V., Uzunboylu, H., & Ozdamli, F. (2017)). As flipped classroom entails a shift in learning mindset, students and parents may, therefore, benefit from orientation sessions on the new approach. In the orientation, teachers may familiarise students on the nature of flipped learning by articulating how the flipped instructional process works, what is the role of the teacher, and what are the expectations for students. In addition, teachers may demonstrate and conduct hands-on activities to train students on how to effectively engage in pre-class activities which may include effective video watching techniques, notetaking strategies, participation in discussion, and how to seek support in case of difficulties. The involvement of parents in the orientation is geared toward encouraging support for monitoring students' engagement and learning at home.

Challenges for teachers were found to centre on the increased workload and the substantial demand for preparation and monitoring. Teachers either lack the luxury of time or the necessary technical competencies to produce instructional videos. Thus, school teachers may resort to the successive production of instructional videos year after year or the collaborative production of videos by teaching teams (Gariou-Papalexiou et al. (2017); Lo et al. (2018); Cheung Ruby Yang (2017)). In video production, nevertheless, it must be taken into consideration the insight drawn from the review that some students were not comfortable with the idea of watching instructional videos not specifically made by their subject teacher. To further capacitate teachers on the effective implementation of flipped classrooms, a broader school-wide support might be needed to effectively deliver flipped learning for students. Support from the administration might address common challenges such as the shortage of equipment and the need for professional development of teachers (Bergmann and Sams (2012)). Most of the reviewed studies were products of individual teachers' initiatives, which might imply that school-supported flipped learning initiatives may be more facilitative for teachers and may yield more favourable outcomes for both teachers and students.

Challenges related to the execution of the flipped classroom primarily relate to technological aspects of access to devices and connectivity. As some of the researchers in the reviewed studies have implemented, this can be addressed by providing copies of instructional videos on flash drives and compact disks. Other researchers have also noted the use of computer laboratories in schools as spaces where pre-class learning may be undertaken by students. Although this strategy contradicts one of the major benefits of flipped learning—fostering anytime-and-anywhere learning—for contexts that lack the resources to effectively implement flipped classrooms, this might be the most effective means to facilitate pre-class learning.

It was also found that extending support to students, particularly in pre-class learning, was not met in some studies due to restrictions on technologies utilised Schultz et al. (2014); Cheung Ruby Yang (2017)). It was found that not all studies have embedded accountability mechanisms and discussion or chat support to assist students in preclass learning. Relating to the concept of social constructivism and the role of a more knowledgeable peer, discussion activities are arguably integral in technology-enhanced instruction (Jensen, Kummer, and Godoy (2015); Vygotsky and Cole (1978)). Jensen et al. (2015) posit that constructivist perspectives support the notion that the presence of a more knowledgeable person in both phases of the flipped classroom is integral to the effective learning of the students. Therefore, to enhance flipped classroom delivery, embedding discussion support for students through chat and discussion platforms may be targeted and implemented. Otherwise, mechanisms such as short messaging services (SMS) may be explored to provide students the opportunity to seek support and talk with peers if, for example, difficulties are encountered while engaging in pre-class learning.

3.4 | RQ3: Based on current research, is flipped classroom effective in school instruction?

It was found that the effectiveness of the flipped classroom in the reviewed studies was examined using different research designs. Most of the studies employed quasi-experiments comparing flipped classrooms with traditional lecture-based classrooms. However, some studies employed pre-experiments (D'addato and Miller (2016); Kong (2015);Winter (2018)) and a few studies involved experimental designs comparing conventional constructivist approaches and flipped classroom-enhanced constructivist approaches (Jong (2017)). Lastly, a few studies introduced a new approach to closely examining the effectiveness of flipped classrooms by employing three-group experiments that investigated the effectiveness of specific flipped classroom models against the conventional video-based flipped classroom and the traditional lecture-based classroom Chang and Hwang (2018); Hwang and Lai (2017)). Table 1 outlines the summary of the effectiveness of the flipped classroom as reported in the reviewed studies.

The reviewed studies yielded different results on the effectiveness of the flipped classroom in school instruction. Most of the studies that employed a pre-experimental design found that the flipped classroom is an effective approach in increasing students'

TABLE 1 Summary of Findings on Effectiveness of Flipped Classroom

Research Design	Findings	Studies
Pre-Experimental	Pre-Experimental FC was effective.	D'addato and Miller (2016); Gariou-Papalexiou et al. (2017); Kong (2015); Lee and Lai (2017); Lo (2017); Lo and Hew (2017b)*; Winter (2018)
	FC produced mixed results	Clark (2015); Grypp and Luebeck (2015); Yang (2017)
Quasi-Experimental [Flipped classroom (FC) vs. Traditional classroom (TC)]	FC was more effective than TC.	Abdelrahman et al. (2017); Bhagat et al. (2016)*; Chao et al. (2015); Cukurbasi and Kiyici (2018); Huang and Hong (2016); Kostaris et al. (2017)*; Lo et al. (2018); Olakanmi (2017); Schultz et al. (2014); Sergis et al. (2018)*; Sezer (2017); Tugun et al. (2017); Zupanec et al. (2018)
	FC had no difference from TC.	Chen (2016); DeSantis et al. (2015); Graziano and Hall (2017); Kirvan et al. (2015)
	FC produced mixed results.	Aidinopoulou and Sampson (2017); Leo and Puzio (2016)
Quasi-Experimental (Flipped Constructivist Approach vs Conventional Constructivist Approach	Constructivist Approach with Flip is more effective than Conventional Constructivist Approach	Jong (2017)*; Tsai et al. (2015)
Quasi-Experimental [Specific Flipped classroom model (FCM) vs. Conventional Video-Based Flipped classroom (VBFC)]	Specific FCM is more effective than Conventional VBFC	Chang and Hwang (2018); Hwang and Lai (2017)*; Lai and Hwang (2016)

**involved inter-cluster analysis of performance (i.e. low, average, high achiever/efficient)*

learning achievement, participation, higher-order thinking, and learning attitudes. However, a couple of studies yielded mixed results, in which it was revealed that although students' outcomes benefited in the flipped classroom, students' preferences and attitude toward the approach remained inferior to the traditional classroom (Grypp and Luebeck (2015); Cheung Ruby Yang (2017)). Grypp and Luebeck (2015) noted that while most of the students said that they would suggest flipped classrooms in other mathematics classes, the data showed that there was no overpowering consensus on students' preference between flipped and traditional classrooms. On the other hand, Yang (2017) found that only one of the two pre-experimental groups gained statistically significant improvement in subject knowledge. However, she noted that students were, in general, positive about the flipped classroom approach.

Studies that employ quasi-experimental research designs dominate the reviewed articles. The studies (n = 19) examined the effectiveness of flipped classroom intervention versus the control group of the traditional lecture-based classroom. The majority of these studies reported that the flipped classroom was more effective than the traditional classroom. However, there are studies which found no difference between flipped and traditional classrooms (e.g. Chen, 2016; Clark, 2015), while others reported mixed results where the effectiveness of flipped classrooms was found in one aspect being investigated (e.g. learning outcomes), but different in another aspect (e.g. learning attitude or satisfaction) (Aidinopoulou, V., & Sampson, D. G. (2017)). Studies which reported the effectiveness of the flipped classroom over the traditional classroom generally noted superior learning performance and motivation of students exposed to the intervention than the control group (Abdelrahman, L. A. M., DeWitt, D., Alias, N., & Rahman, M. N. A. (2017), Bhagat et al. (2016), Schultz et al. (2014)). Nevertheless, different results were also found, such as in Aidinopoulou, V., & Sampson, D. G. (2017), where significant learning outcomes were gained in historical thinking skills,

but not in historical concept memorisation, and in Leo and Puzio (2016), where the improvement was found to lack statistical significance.

Two studies employed a quasi-experimental design distinct from the majority of the studies. These studies investigated the effectiveness of incorporating a flipped classroom into constructivist approaches (i.e., social inquiry and problem-based learning). In these studies, it was found that the conventional constructivist approaches enhanced with the flipped classroom were superior to the conventional constructivist classroom without the flip. Lastly, three studies employed specific flipped classroom models and investigated their effectiveness against video-based flipped classrooms and traditional lecture-based instruction. Specifically, Chang and Hwang (2018) employed an augmented reality-based flipped classroom where elementary students utilised augmented reality in the performance of their science laboratory tasks inside the classroom. It was found that the specific flipped classroom model was superior to the video-based flipped classroom. Hwang and Lai (2017) employed an interactive e-book-based flipped classroom and compared its effectiveness to the conventional video-based flipped classroom. It was found that the model employed by the researchers was more effective due to the facilitative nature of the technology that provides learners with smooth transitions from pre-class to in-class learning (Hwang and Lai (2017)). Finally, Lai and Hwang (2016) deliberately embedded self-regulation mechanisms in the design of their flipped classroom model. Compared to the conventional video-based flip without self-regulation, the model was found to be more effective in increasing students' learning achievements, self-efficacy, and self-regulation.

Findings on the effectiveness of the flipped classroom in schools are found to be inconsistent. This means that while most of the reviewed studies reported that flipped classrooms in schools are effective, there are studies that either reported similar findings in both flipped and traditional classrooms or reported producing mixed and contradictory results. Due to the great diversity in terms of strategies and technologies embedded in flipped classroom implementations in schools, it is difficult to pinpoint what could have contributed to the effectiveness or non-effectiveness of the flipped classroom in the reviewed studies (Jensen et al. (2015)). Nevertheless, general insights on the effectiveness of flipped classrooms in schools were drawn from analyzing the research designs employed by the researchers and looking at the inter-cluster analysis of students' performance. The two key insights on flipped classroom effectiveness drawn from the analysis are: a) flipped classroom models anchored in specific pedagogical models may be superior to conventional video-based flipped classrooms; and b) flipped classrooms appear to mostly benefit low achieving and low self-regulating students than students with high achievement and high self-regulation.

Insights from this review suggest that flipped classroom models anchored in specific pedagogical models and having embedded explicit technologies and self-regulation strategies are more effective than conventional video-based flipped classrooms. This means that by grounding flipped classrooms on standard constructivist approaches such as problem-based learning and inquiry learning, flipped classrooms may yield better outcomes for students. It can be noted that the studies which employed such strategies in intervention groups (Chang and Hwang (2018); Hwang and Lai (2017); Jong (2017); Lai and Hwang (2016); Tsai et al. (2015)). all reported more effectiveness of such models than conventional video-based flipped classrooms or conventional classroom-based constructivist learning. This suggests that although most of the studies, particularly the quasi-experimental studies which compared flipped and traditional classrooms, reported that flipped classrooms in schools are more effective than traditional classroom-based instruction, there appears to be a possibility of accentuating this effectiveness by grounding flipped classroom models on specific pedagogical strategies, technologies, and strategies.

Flipped classrooms grounded in constructivist approaches, as revealed in this review, may be better than conventional video-based flipped classrooms. This may be due to the apparent alignment between the technological affordances of flipped classrooms and the nature of constructivist approaches. In Tsai et al. (2015), for example, elementary students engaged in a problem-based learning (PBL) unit of e-book production were found to have performed better than their counterparts exposed to conventional problem-based learning. The authors claimed that the flipped classroom has allowed students to continue engaging in problem-solving activities even beyond classroom time, highlighting the idea that technological affordances of learning platforms and discussion support have complemented the nature and demands of problem-based learning on continuous collaboration to find solutions to the problem at hand.

Interestingly, embedding specific technology and self-regulation strategies were also found to be superior to the conventional flipping of instruction. In Chang and Hwang (2018), for example, the use of augmented reality in problem-based learning was found to provide personalised assistance to students encountering different issues while performing laboratory tasks. Such an approach, when compared to the traditional video-based flipped classroom, was found to be superior in terms of raising students' performance as the technology employed in the implementation was designed to provide personalised feedback to students, thus making it more effective in guiding students in performing laboratory tasks as compared to teacher-facilitated in-class task performance. On the other hand, explicit self-regulation techniques in the delivery of flipped classrooms, on the other hand,

were seen to contribute to the promotion of metacognition, self-efficacy, and efficient use of time (Lai and Hwang (2016)). In Lai and Hwang (2016), a flipped classroom system was utilised to diagnose and give programmed feedback on students' performance. The system has allowed students to set goals for learning before engaging in pre-class activities and self-evaluate their performance after engaging in activities inside the classroom. The system then provides feedback based on the diagnosis, instructing learners on what to do next. This approach was found to be more effective in raising students' performance than the conventional video-based flipped classroom. This finding correlates with what is found in the literature stating that self-regulation mechanisms are integral to the construction of knowledge and effective learning, leading to the improvement of performance and outcomes (McNamara (2011); Zimmerman, Bonner, and Kovach (1996)). Overall, by deliberately comparing these specific flipped classroom models to conventional video-based flipped learning, these studies highlight that flipped classrooms may be more effective if there are solid pedagogical approaches serving as the basis for flipped classroom design and if there are explicit self-regulation strategies embedded in its implementation.

Finally, studies that involved an inter-cluster analysis of students' performance revealed that students with low achievement and self-regulation levels were found to benefit most from flipped classrooms in schools (Hwang and Lai (2017); Jong (2017); Kostaris et al. (2017); Lo and Hew (2017a); Sergis et al. (2018)). Evidence from the review suggests that this might be the case across different learning areas, as studies which reported this consistent pattern were situated in various subjects. This means that the flipped classroom may have the potential to improve the outcomes of struggling students regardless of their learning area and may, therefore, facilitate teachers and schools in advancing learning equity. Arguably, this may be brought on by the increased time teachers spend helping struggling students with the performance of activities inside the classroom. Kostaris et al. (2017) associated this pattern with the scaffolding achieved in face-to-face sessions where feedback is given to students both by their classmates and their teachers. On the other hand, Nouri (2016) correlates this insight to the utilisation of instructional videos, which is seemingly more beneficial to low-achieving students than high-achieving students due to the fact that in flipped learning, instructional videos may be accessed at a time convenient to learners and may be paused and replayed, thereby providing learners control over their own learning.

3.5 | Conclusion and Recommendations

This review aimed at providing recent understandings on the current body of flipped classroom research in schools. As flipped classrooms continue to gain traction in schools as policies direct institutions to focus on deeper learning approaches, studies on the approach's effectiveness must continue to be undertaken. Based on the reviewed studies, three key insights were drawn in relation to the research questions posed: a) there is a high diversity in implementation strategies employed by school teachers in using flipped classrooms, encompassing different pre-class activities, in-class strategies, connecting strategies, and technologies; b) there are considerable challenges on flipped classroom implementation in schools which appear to hinder teachers and students in reaping the most from flipped classrooms; solutions to which are feasible which may enhance future flipped classroom implementations; and c) findings on the effectiveness of the flipped classroom in schools are equivocal, that is, although most studies reported that flipped classrooms are effective, there are also studies which either found no difference between flipped and traditional classrooms or have produced mixed and contradicting results. Nevertheless, there appears to be a pattern regarding the effectiveness of grounding flipped classroom models on standard instructional designs or constructivist approaches and through the embedding of explicit self-regulation strategies.

Future endeavours in flipped classroom research in schools must extend the idea found in this review on the potential of the approach to yield better outcomes by grounding flipped classroom design on specific pedagogical models. Moreover, experimentation on integrating new technologies may be further explored and familiar tools may be re-evaluated on how they may potentially support the delivery of pre-class and in-class learning. Lastly, as the effectiveness of the flipped classroom in schools was found to be inconsistent, further work must continue to provide more foundational evidence on the potential of the flipped classroom to transform educational practice, including the continued investigation into the apparent benefits of the flipped classroom to low-achieving and low-self-regulating students.

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How to cite this article: J. R. Satparam, T. Apps, (2022), A Systematic Review of the Flipped Classroom Research in K-12: Implementation, Challenges and Effectiveness, *Journal of Education, Management and Development Studies*, *Vol. 2 No. 1*

APPENDIX

A. SUMMARY OF STUDIES INCLUDED IN THE REVIEW

TABLE A.1 Summary of studies included in the review

Study	Context	Country	Subject	Level	Focus of the Study	Methodology
Abdelrahman et al. (2017)	HS	Qatar	English	7	writing proficiency, satisfaction	Mixed**
Aidinopoulou and Sampson (2017)	E	Greece	Social Studies	5	use of classroom time, learning outcomes	Quantitative**
Bhagat et al. (2016)	HS	Taiwan	Math	8	learning achievement, motivation, different achievement levels	Quantitative**
Chang and Hwang (2018)	E	Taiwan	Science	5	learning achievement, motivation, critical thinking, group self-efficacy, cognitive load	Quantitative**
Chao et al. (2015)	HS	Taiwan	Engineering	11	learning attitude, experience, achievement	Mixed**
Chen (2016)	HS	USA	Health	9	performance, issues on implementation	Mixed**
Clark (2015)	HS	USA	Math	9	students' perceptions and attitudes; learning outcomes	Mixed**
Cukurbasi and Kiyici (2018)	HS	Turkey	ICT	10	students' perceptions	Mixed**
D'addato and Miller (2016)	E	Canada	Math	4	impact in a socioeconomically disadvantaged setting; students' participation, attitudes and perceptions; challenges and benefits	Qualitative*
DeSantis et al. (2015)	HS	USA	Math	9, 10, 11	learning outcomes students'perceptions	Quantitative**

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TABLE A.1 Summary of studies included in the review

Study	Context	Country	Subject	Level	Focus of the Study	Methodology
GariouPapalexiou et al. (2017)	HS	Greece	Biology	7	investigate application of flipped classroom	Qualitative*
Graziano and Hall (2017)	HS	USA	Math	7	learning performance; students' perceptions	Quantitative**
Grypp and Luebeck (2015)	HS	USA	Math	not mentioned	learning outcomes; students' perceptions	Mixed*
Huang and Hong (2016)	HS	Taiwan	English	10	effects on ICT and English comprehension	Mixed**
Hwang and Lai (2017)	E	Taiwan	Math	4	learning achievement; self-efficacy and its difference between lower and higher self-efficient students	Quantitative**
Jong (2017)	HS	Hong Kong	Liberal Studies	11	knowledge acquisition and selfefficacy	Quantitative**
Kirvan et al. (2015)	HS	USA	Math	7, 8	conceptual understanding and student learning	Quantitative**
Kong (2015)	HS	Hong Kong	Integrated Humanities	7, 8, 9	effect on critical thinking	Mixed*
Kostaris et al. (2017)	HS	Greece	ICT	8	cognitive learning outcomes; learning activity distribution; students' motivation and engagement	Quantitative**
Lai and Hwang (2016)	E	Taiwan	Math	4	learning achievement; self-efficacy; self-regulation; relationship between goal setting and self-evaluation and performance	Quantitative**
Lee and Lai (2017)	HS	Hong Kong	ICT	8	students' perceptions; promotion of higher order thinking skills	Mixed*
Leo and Puzio (2016)	HS	USA	Biology	9	learning achievement and perceptions	Mixed**
Lo (2017)	HS	Hong Kong	Math	8	students' attitudes and engagement; improvement of FC design	Mixed*
Lo and Hew (2017b)	HS	Hong Kong	Math	12	impact on underperforming and high ability students; teachers' and students'	Mixed*
Lo et al. (2018)	HS	Hong Kong	Math, Physics, Chinese, ICT	8, 9, 10, 12	learning design, achievement, teachers' perceptions	Mixed**
Olakanmi (2017)	HS	Nigeria	Chemistry	7	effects on performance and attitude; benefits and challenges	Mixed**

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TABLE A.1 Summary of studies included in the review

Study	Context	Country	Subject	Level	Focus of the Study	Methodology
Schultz et al. (2014)	HS	USA	Chemistry	10, 11, 12	students' perceptions; academic performance	Mixed**
Sergis et al. (2018)	HS	not mentioned	ICT, Math, Humanities	8, 10	learning outcomes, satisfaction, self-determination	Quantitative**
Sezer (2017)	E	Turkey	Science	6	effect on learning and motivation, students' perceptions	Mixed**
Tsai et al. (2015)	E	Taiwan	ICT	6	learning performance	Mixed**
Tugun et al. (2017)	HS	Cyprus	ICT	9	students' performance and perceptions	Mixed**
Winter (2018)	E	USA	Social Studies	6	relationship between motivation and performance	Quantitative*
Yang (2017)	HS	Hong Kong	English	8	students' and teachers' perceptions; effect on knowledge; how students and teachers can transfer experiences on FC to other subjects	Mixed*
Zupanec et al. (2018)	HS	Serbia	Biology	7	efficiency, students' involvement	Quantitative**

**Pre-experiment **Quasi-Experiment E – Elementary HS – High School*