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Investigating self-regulated learning and academic achievement in an eLearning environment: The case of K-12 flipped classroom

Ahlam Mohammed Al-Abdullatif

Abstract: This study aimed to investigate the impact of a flipped classroom on the self-regulated learning (SRL) and academic achievement of seventh-grade junior high school students. A quantitative approach was used to compare the traditional and flipped classroom approaches. The data were obtained using the Motivated Strategies for Learning Questionnaire (MSLQ) along with students achievement scores. Cognitive learning strategies and metacognitive self-regulation strategies were investigated as indicators of students SRL strategies. The results indicated that 64 seventh-grade participants demonstrated a good-to-high level of practicing SRL within the flipped classroom environment. Moreover, the student participants appeared to self-regulate their metacognitive learning strategies in the flipped classroom environment more than those in the traditional learning environment. In terms of their academic achievement, no statistically significant difference was detected between the traditional and flipped classrooms. Associations between the students SRL and academic achievement were identified, and several implications and recommendations were derived.

ABOUT THE AUTHOR

Ahlam Mohammed Al-Abdullatif is an assistant professor in educational technology, in Curriculum and Instruction Department at King Faisal University in Saudi Arabia. Al-Abdullatif’s research interest is in the area of eLearning particularly on how Information and Communication Technology (ICT) enhances teaching and learning practices. She is an active professor and researcher, who published a number of research articles with well-known publishers. Al-Abdullatif won the Faculty Excellence Award at King Faisal University (2017) and the E-learning Excellence Award from the National Centre of E-learning in Saudi Arabia (2018). Currently, she is engaging in a number of research projects that are investigating the quality of teachers and students knowledge and competences when integrating technologies in classrooms.

PUBLIC INTEREST STATEMENT

This study investigates the relationship among the flipped learning model, self-regulated learning (SRL), and academic achievement in the K–12 context. Therefore, it contributes to the empirical research on K–12 education regarding the flipped classroom model. This study assessed the degree to which students practiced self-regulating strategies for learning, including their use of cognitive learning strategies and metacognitive self-regulation strategies. Results indicated that the majority of student participants possessed the essential qualities to use cognitive and metacognitive self-regulation strategies in flipped learning activities. A number of challenges were reported by a few participants, mostly in terms of their self-regulation in the out-of-class activities. As the findings of this study highlighted the significant relationship between K–12 students SRL and academic achievement, the development and integration of an appropriate SRL model within the flipped learning environment is of considerable relevance in the K–12 context.

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1. Introduction

There is a great deal of focus by the Ministry of Education in creating e-learning environments based on technology integration that enhances and transforms the quality of teaching and learning (Al-Abdullatif & Alsaeed, 2019). Therefore, several pedagogical practices by K–12 teachers, to integrate various technological approaches and tools in teaching and learning, have increased in the last decade. The flipped classroom approach is on top of these pedagogical approaches. The flipped or inverted classroom has gained increasing popularity as a new instructional pedagogy in many educational institutions around the world (Akçayır & Akçayır, 2018; Bin Jwair, 2018; Hao, 2016; Lo & Hew, 2017; Silva et al., 2018; Sletten, 2015). Flipped classrooms have now been implemented in many disciplines in both school and university contexts (Akçayır & Akçayır, 2018). According to Lo and Hew (2017), teachers flip their classroom by delivering course content through online videos and materials for students to study before class so that they can utilize their in-class time for more active learning and higher-order thinking activities. Students in a flipped classroom watch pre-recorded videos covering the main concepts of the content prior to coming to class. Afterward, they engage in further learning activities in class by practicing the knowledge they have learned and collaborating activities, such as discussions, projects, case studies and solving problems (Hamdan et al., 2013; Lai & Hwang, 2016; Sletten, 2015). The flipped learning approach provides students with opportunities to use various learning styles, as they can engage in individual, competitive, or collaborative learning (Bin Jwair, 2018). The potential of this approach in enhancing students achievement and success in learning has been emphasized in the literature (Muir, 2017).

For flipped learning to be more effective, however, students need to take an active role and become responsible for their own learning process (Lai & Hwang, 2016; Sletten, 2015). Self-regulated learning (SRL) involves students use of multiple learning strategies that assist with self, environmental, and cognitive monitoring and adjustment of the learning process (Zimmerman, 2008). SRL is a proactive process whereby students must self-direct their learning (Zimmerman, 2008). Highly self-regulated learners feel empowered because they perceive that success is largely dependent on their ability to effectively use and adjust learning strategies (Cleary & Zimmerman, 2004). The promotion of SRL strategies among students is one of the most important contributors to the development of independent learners, as it ensures their success in the learning process. However, while flipped classrooms are gaining more popularity as a pedagogical approach, there is a lack of empirical research investigating the relationships between flipped instruction and students SRL (Hewitt et al., 2014), particularly in K–12 education (Akçayır & Akçayır, 2018; Gough et al., 2017; Lo & Hew, 2017). Therefore, this study examines the influence of the flipped classroom model on students SRL and academic achievement.

2. Flipped classroom model

In recent years, the educational paradigm has shifted the focus from the teacher-centered approach to student-centered learning (Lai & Hwang, 2016). As such, multiple learning models have been adopted to provide students with various ways of learning (Li et al., 2014), one of which is the flipped learning model, whose development has been influenced by social constructivism (Green, 2015). The flipped learning model is regarded as a learning method that emphasizes the learner as an active agent and creator of understanding, who is involved in a series of hands-on collaborative activities, while the teacher serves as a facilitator, rather than as an instructor, of learning (Green, 2015; Sankey & Hunt, 2014). The flipped learning model is also known as the inverted classroom model (Bergmann & Sams, 2012). While there is no single or agreed-upon
definition of flipped learning in the academic literature (Alamry, 2017), Jensen et al. (2015, p. 1) offered a concise definition: “a learning model in which content attainment is shifted forward to outside of class, and then followed by instructor-facilitated concept application activities in class.” Further, Bishop and Verleger (2013) defined the two types of learning activities in which students engage in the flipped classroom model: “interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom” (p. 5). This means that students learn content prior to class time, after which they deepen their understanding of this content in class (Lai & Hwang, 2016).

According to Bergmann and Sams (2012), the flipped classroom model is centered around learners, not teachers. Before class meetings, teachers are responsible for introducing students to new knowledge through instructional videos, elaborating concepts through explanatory notes and illustrative examples, and with a learning guide (Bergmann & Sams, 2012; Lo & Hew, 2017). At the same time, students are responsible for making appropriate use of videos and other learning material provided to help them construct the required understanding. The role of the teacher, therefore, is to provide guidance and constructive feedback to students (Bergmann & Sams, 2012). In-class time can thus be utilized for conducting collaborative and interactive learning activities, with guidance and support from the teacher and peers (Bergmann & Sams, 2012; Lo & Hew, 2017).

In Akçayır and Akçayır (2018) large-scale systematic review (71 research articles) of the literature on the flipped classroom model, the authors found that improvement in student learning performance was the most frequently reported advantage of the model. One explanation for this might be that flipped classrooms constitute a student-centered approach (Bergmann & Sams, 2012), which embodies a number of learning theories, such as active learning, peer-assisted learning, and collaborative learning, all of which can enhance students learning outcomes in the flipped classroom context (Bethehavas et al., 2016; Bishop & Verleger, 2013; Lai & Hwang, 2016; Leo & Puzio, 2016; Sohrabi & Iraj, 2016). Although many studies have indicated that the flipped classroom model yields positive academic outcomes, others have drawn attention to associated challenges. For example, designing the flipped instruction is time consuming for teachers and difficult to manage (Chen et al., 2015; Schlairet et al., 2014); the lack of self-regulated behaviors by some students (Lai & Hwang, 2016; Sun et al., 2017) to engage in out-of-class learning activities (Lai & Hwang, 2016), thus, students are not adequately prepared for in-class learning activities (Al-Zahrani, 2015); and insufficient guidance and feedback for students while out of class (Chen et al., 2015).

While the effectiveness of the flipped classroom has been substantially investigated in the higher education context (Gough et al., 2017), there is very little research on this model in the K–12 context. A recent systematic review conducted by Akçayır and Akçayır (2018) on the literature on the flipped model in education indicates that “there has been little interest in implementing flipped classroom model in the K–12 setting. Thus, this model’s pedagogical potential has not yet reached far into K–12 schools” (p. 343). Consequently, there have been calls for increased research on the flipped classroom model in K–12 (Akçayır & Akçayır, 2018; Gough et al., 2017; Lo & Hew, 2017).

3. Flipped classroom research in K–12 education

Due to the increasing popularity of flipped classrooms, some K–12 teachers have shifted their pedagogical focus in order to utilize this model in their classrooms to enhance their students learning performance. A systematic review conducted by Lo and Hew (2017) of 15 research articles of flipped classrooms in K–12 suggested that the use of the flipped classroom model in the K–12 setting had positive educational outcomes. They indicated that K–12 students in flipped classrooms improved their communication skills, independent learning, and changed their learning habits. A recent study by Lee (2018) on middle school students found that flipped classroom model promoted students active learning, self-confidence and learning enjoyment. However, the most frequently reported challenges of the flipped classroom model include students being
unfamiliar with the flipped learning approach, pre-class learning activities are time consuming and require significant effort, students disengagement in the out-of-class learning, and insufficient support with out-of-class learning activities (Lo & Hew, 2017; Lo et al., 2017). Further, in a study of a high school computer applications course, Johnson and Renner (2012) found that students in flipped classrooms lacked a sense of responsibility for their learning.

In terms of the influence of the flipped classroom model on students academic achievement, there were variations in the existing K–12-related studies of the flipped model compared to the traditional or non-flipped model. Some studies reported that students achievement in the flipped classroom was significantly better than that of students in the traditional classroom (Chao et al., 2015; Lee, 2018; Tsai et al., 2015; Wei et al., 2020). Other studies, however, reported no significant difference in students achievement between the flipped and traditional classrooms (Chen, 2016; DeSantis et al., 2015; Gundlach et al., 2015; Kennedy et al., 2015).

4. Theoretical framework

4.1. Self-regulated learning theory

The shift from the teacher-centered approach to a more student-centered learning environment requires students to be more responsible and to control their own learning processes. SRL is advocated in the literature as an important competence for students in student-centered learning environments, where students actively engage in constructing and interpreting knowledge (Alsancak Sirakaya & Ozdemir, 2018). Wolters et al. (2005) defined SRL as “an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment” (p. 251). Zimmerman and Schunk (2011, p. 1) further maintained that SRL is “the process whereby learners personally activate and sustain cognitions, affects, and behaviors that are systematically oriented toward the attainment of learning goals.” It concerns “how students become masters of their own learning process” (Zimmerman, 2008, p. 166) and is one of the most important proactive learning processes in helping students acquire and improve their academic skills.

Students exhibit characteristics of SRL through a range of learning strategies to control and monitor their cognition, motivation, and behavior in learning processes (Bin Jwair, 2018; Sletten, 2015). Cognitive regulation consists of both the cognitive and metacognitive learning activities that individuals engage in to change or adapt their cognition (Alamry, 2017). Wolters et al. (2005) identified that cognitive regulation can occur through rehearsal, organizational and elaboration strategies, and the monitoring of metacognition. The regulation of cognition is the actual selection and use of various cognitive learning strategies, which range from simple memory learning strategies (e.g., remembering and understanding) to higher-order thinking strategies (e.g., problem-solving and reasoning) (Alamry, 2017). The selection of these learning strategies is considered an aspect of cognitive control and regulation; however, the decision to use them, to stop using them, or to switch from one strategy to another is considered an aspect of metacognitive control and regulation (Wolters et al., 2005). Previous studies have illustrated that flipped learning activities can help improve students metacognitive skills (Bin Jwair, 2018; Hewitt et al., 2014).

4.2. Self-regulated learning and the flipped classroom model

SRL requires students to take an active role in their own learning by monitoring and regulating aspects of their cognition, behavior, and study environment (Wolters et al., 2005). Therefore, it aligns with the flipped classroom model (Sletten, 2015), where students are required to motivate themselves to be actively engaged in their own learning. For example, Lai and Hwang (2016) noted that self-regulated students can efficiently schedule students out-of-class time to browse and understand instructional materials (e.g., videos and content notes) prior to class. This can prepare them to engage and collaborate with their teacher and peers during their in-class time for in-depth learning, in turn enhancing their learning performance. This suggests that students failure to
manage their learning in out-of-class time is associated with a lack of self-regulated competence (Lai & Hwang, 2016). Akçayır and Akçayır (2018) revealed that most challenges in the flipped classroom model are related to out-of-class activities, such as inadequate student preparation prior to class. Therefore, what learning strategies students select and how they utilize them in learning are both vital (Rahimi et al., 2015). Consequently, how students perform their self-regulation is a critical factor in attaining successful learning outcomes in the flipped classroom environment (McLaughlin et al., 2013). In a discussion of several SRL characteristics of the flipped classroom environment, Talbert (2017, p. 1) stated that students “exert control over their learning, selecting appropriate strategies and tasks without the need for a teacher to tell them what to do, and they make changes when it becomes apparent that what they are doing isn’t working as well as it could”.

The student is an active learner and is responsible for his or her own learning process—a process intersected between SRL and learning through the flipped classroom model. Moreover, SRL is considered a prerequisite for ensuring the success of learning through the flipped learning model. Therefore, students need to possess SRL skills in order to attain successful learning outcomes in flipped classrooms. Studies have pointed to the importance of SRL competence in increasing students performance in distance learning activities and the flipped learning environment (Hewitt et al., 2014; Montgomery et al., 2019; Rodrigues & Zealand, 2016; Sun et al., 2017). Despite the potential of SRL in flipped learning, there is a lack of research on the correlation between them (Lai & Hwang, 2016; Moos & Bonde, 2016; Sletten, 2015). Alamry (2017) argued that more attention should be given to investigating flipped learning and SRL in K–12 education because of the scarcity of research in this area. To date, only one research article (Lai & Hwang, 2016) was found to investigate the SRL of fourth graders in a flipped classroom. The result of this study revealed that high self-regulated students achieved significantly different learning outcomes compared to low self-regulated students. Due to the lack of research on SRL within flipped learning in the K–12 context, it may be difficult to determine the effectiveness of this instructional model in K–12 classrooms (Gough et al., 2017). This study contributes to the knowledge base of K–12 education regarding the investigation of SRL within flipped classrooms and the effectiveness of this model on students academic achievement.

5. Research questions and hypotheses
This study aimed to explore the relationship between the flipped classroom model with SRL and academic achievement in the K–12 setting by addressing three research questions: (RQ1) how does the flipped classroom model influence students SRL strategies compared to the traditional classroom approach? (RQ2) Are there any differences between students cognitive learning strategies and metacognitive self-regulation strategies in the flipped and traditional classrooms? (RQ3) How does the flipped classroom model influence students academic achievement compared to the traditional classroom approach? (RQ4) Is there a relationship between students SRL and academic achievement? Accordingly, five alternative hypotheses (H0) were proposed to answer these three questions:

H01: statistically, significant differences exist at the 0.05 level of the means of students SRL between the traditional and flipped classroom groups.

H02: statistically, significant differences exist at the 0.05 level of the means of students cognitive learning strategies between the traditional and flipped classroom groups.

H03: statistically, significant differences exist at the 0.05 level of the means of students metacognitive self-regulation strategies between the traditional and flipped classroom groups.

H04: statistically, significant differences exist at the 0.05 level of the means of students academic achievement scores between the traditional and flipped classroom groups.
H05: statistically, significant differences exist at the 0.05 level of the means of students SRL and academic achievement scores in the flipped classroom group.

6. Method

6.1. Participants and context

The participants comprised two classes of female seventh graders in a junior high school. The two classes included 32 students each, with 64 participating students in total. One class was selected to be the experimental group, which was taught with the flipped classroom model, while the other class was assigned the status of control group, which was taught using the traditional classroom (face-to-face) approach. Both groups of students were assigned similar learning activities in a mathematics course. Four of the mathematics units consisted of 16 lessons to be taught in both classes over a two-month period.

6.2. Instruments

This study investigates SRL and students academic achievement in a flipped classroom learning environment. Two measuring tools were used to achieve the study purpose. An achievement exam was used to measure the participants academic achievement. The Motivated Strategies for Learning Questionnaire (MSLQ), adopted from Wolters et al. (2005), was used to examine SRL. The achievement exam aimed to measure the students level of understanding in four mathematics units. This exam was a standardized test developed by the teacher and was a mandatory assessment tool for all seventh-grade mathematics teachers to implement after teaching the four units. The achievement exam consisted of 20 questions, which varied between multiple-choice and problem-solving questions, with a total score of 10, weighted as 10% of the total assessment score.

The MSLQ has been empirically validated and is commonly used in SRL investigations (Wolters & Pintrich, 1998). It is a self-report instrument that seeks students perceptions of their cognitive and metacognitive learning strategies (Wolters et al., 2005). Cognitive strategies consist of three scales: rehearsal, elaboration, and organization. Wolters and Pintrich (1998) indicated that when the validity of the MSLQ was measured through factor analyses, the results for younger students (the K–12 context) supported the creation of two scales: a general cognitive strategy scale and a metacognitive strategy scale. Both scales provide reliable and valid indicators of students academic SRL (Wolters et al., 2005). The metacognitive self-regulatory activities include “various planning, mentoring and regulation strategies for learning, such as setting goals for reading, mentoring comprehension as one reads, and making changes or adjustments in learning as one progresses through a task” (p. 252). According to Wolters et al. (2005), Cronbachs alphas of .83 to .88 for the general cognitive strategy scale and .63 to .74 for the metacognitive self-regulation scale are acceptable. The following Table 1 lists the reliability test of the two scales (factors) along

| Table 1. Reliability Test of MSLQ Scale (N = 64) | Current study | Original MSLQ |
|-----------------------------------------------|---------------|---------------|
| **MSLQ Scales**                               | **Items No.** | **M** | **Cronbachs Alpha** | **Cronbachs Alpha** |
| Factor 1: Cognitive learning strategies       | 14 items      | 5.2  | .88             | .69             |
| Factor 2: Metacognitive self-regulation       | 12 items      | 4.6  | .72             | .79             |
| Total MSLQ                                    | 26 items      | 4.9  | .89             | .74             |
with the overall original MLSQ survey instrument. Table 1 shows that Cronbach's alpha for factor 1 was .88 and for factor 2 was .72, which represented a good-to-high level of reliability for the two MLSQ scales in current study.

In sum, the MLSQ survey instrument used in this study consisted of two valid and reliable factors: a general cognitive learning strategies factor (consisting of 14 items) and a metacognitive self-regulation factor (consisted of 12 items). All the learning strategies presented in the 26 items provide a valid and reliable way of measuring various regulatory activities that contribute to students SRL in K–12 contexts (Wolters et al., 2005). The participants using the MLSQ were asked to rate their responses using a 7-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me).

For the purpose of this study, the instrument was translated into Arabic. The validity of the translated version was attained by seeking the opinion of experts specialised in instructional technology and educational psychology who were sufficiently proficient in English language. They were consulted about the accuracy of the 26 translated items and how well they reflected the intended meaning of the original MLSQ statements. Overall, the experts agreed on most of the items and suggested some items to be rephrased for greater simplicity and clarity. Moreover, to increase validity, a group of five students from the seventh grade were asked to voluntarily answer the questionnaire to ensure their understanding of all 26 items and to adjust accordingly. After the author followed the suggestions, the instrument was finalized and ready to be applied.

### 6.3. Experimental procedure

This study utilized the flipped classroom model with seventh-grade students in mathematics classrooms. The teacher assigned two of her mathematics classes for the purpose of this study. Each class consisted of 32 students. One class was selected for flipped classroom teaching, while the other class was selected for traditional (face-to-face) classroom teaching. At the beginning of the semester, the teacher introduced the syllabus and learning outcomes to both classes. The students in the flipped classroom underwent orientation for the new mode of instruction, with an emphasis on their active role in viewing and understanding the instructional content materials prior to class time. All the digital materials, including the instructional videos, content notes, and online quizzes, were prepared and uploaded to the “Easyclass” platform—a learning management system utilized by the teacher with her classes. The instructional videos for all the lessons were provided from relevant educational channels on YouTube and iEN, the National Education Portal for digital curricula in Saudi Arabia.

The learning procedure for the flipped classroom model followed the “K–12 flipped classroom model” adopted from Lo and Hew (2017), shown in Figure 1. This model consisted of two central teaching strategies: out-of-class learning activities and in-class learning activities. In the out-of-class learning phase, the students were required to view the instructional videos, complete content notes, and practice their understanding by taking simple online quizzes. This phase focused on providing the students with direct instruction on the knowledge level of remembering and understanding (Lai & Hwang, 2016). It was supported by the teacher through online discussion using a telegram channel, which was initiated by the teacher for this purpose. The telegram channel was the communication platform used for student support and guidance. The teacher was required to
Figure 1. K–12 Flipped classroom model (adopted from Lo & Hew, 2017, p. 22).

| Out-of-class learning | In-class learning |
|-----------------------|------------------|
| Direct instruction focusing on remembering and understanding levels | Group learning activities focusing on application of knowledge and solving advanced problems |
| Watching instructional videos | Short lectures (if necessary) |
| Completing content notes | Brief review and Q & A |
| Taking online quizzes | Individual practices |
| | Conclusion and preview |
| | Small-group activities |

Supported by online discussion | Supported by teachers and peers

ensure that the students were adequately prepared for the next phase—the in-class learning activities. At the beginning of the class period, the teacher provided a brief review of the main content ideas or conducted a short quiz to ensure the students understanding and to clarify misunderstanding where necessary.

The teacher would occasionally start the in-class time by illustrating the complex concepts that could not be introduced to the students via the instructional videos. To extend the students knowledge, the teacher would then spend most of the in-class time practicing the knowledge gained with the students and solving higher-order thinking problems. The students engaged in in-class learning activities, both independently and collaboratively, through group learning activities. Finally, the teacher concluded the lesson by reviewing with the students what they learned and gave a brief review on the out-of-class learning activities for the next lesson as a way of motivating their interest (Lo & Hew, 2017).

6.4. Data collection and analysis
The ethical approval was obtained from the Research Ethical Committee (REC) of the university where the author work, and the data were collected during the first semester of the 2020 academic year. The measuring tools of this study included the pre-test and post-test of the MLSQ survey questionnaire on SRL and the post-test of the achievement exam. In the first week, the students from both groups (n = 64) completed the pre-test of the MLSQ survey questionnaire in order to examine the homogeneity between the two sample groups. The MLSQ survey questionnaire on SRL consisted of items related to SRL strategies and measured cognitive learning strategies and metacognitive self-regulation strategies. Once the teaching had ended in the four mathematics units, the students from the flipped classroom were asked to complete the post-test of the MLSQ survey questionnaire. The students from both groups then took the post-test of the achievement exam in order to measure their academic achievement level.

IBM SPSS v.25 was employed to conduct the statistical analysis. Descriptive statistical analyses of the percentages, means, standard deviations, and standard errors of the participants responses to the MLSQ survey questionnaire were performed. The descriptive analysis aimed to report student participants perceptions regarding their SRL (cognitive learning strategies and metacognitive self-regulation). An independent samples t-test was performed to measure the statistical differences between the flipped and traditional classroom groups in terms of their SRL (cognitive learning strategies and metacognitive self-regulation) and academic achievement. Paired sample t-tests were performed to measure the statistical differences between the two SRL factors—
cognitive learning strategies and metacognitive self-regulation—within the two groups. A Pearson correlation test was performed to examine the association between the students’ SRL and academic achievement.

7. Findings and discussion

In order to calculate the homogeneity between the two groups (traditional and flipped classrooms), the MSLQ scale was distributed to both groups prior to the application of the experiment (pre-test). An independent samples t-test was carried out on the pre-test responses of both groups. Table 2 presents the means and standard deviations for the traditional (m = 4.7, SD = 1.01) and flipped classroom (m = 5.1, SD = 0.930) groups. Homogeneity was found between the traditional and flipped classroom groups, as there was no statistically significant difference (t = 1.345, p > 0.05) between the two groups prior to the application of the experiment.

In the following section, findings are discussed in terms of the three research questions of this study.

RQ1: How does the flipped classroom model influence students’ SRL strategies compared to the traditional classroom approach?

To measure the SRL strategies, the participants were asked to respond to 26 items, and their responses were rated on a 7-point Likert scale. This helped identify how the students felt about being self-regulated learners. Table 3 lists the means (with standard deviations) for each of these 26 MSLQ statements, the degree (in percentages) to which they perceived themselves as practicing a good-to-high level of SRL strategies, and the degree (in percentages) to which they perceived themselves as practicing a “low” to “not at all” level of SRL strategies. The majority of the participants indicated a good-to-high level of practicing cognitive learning strategies and metacognitive self-regulation strategies (4 < mean > 6). This means that the flipped classroom model positively influenced the participants’ SRL strategies. One explanation might be that the flipped learning model is student-centered (Bergmann & Sams, 2012); it emphasizes the learner as an active agent and creator of understanding (Green, 2015; Sankey & Hunt, 2014). Students in flipped learning environments have control over their learning, as they select appropriate strategies and tasks independent of the teachers’ instruction, and they decide on changes and adjustments in their learning strategies as their learning progresses (Talbert, 2017).

Despite the above-reported positive impact of the flipped classroom model on the students’ SRL strategies, few participants reported having no or a low level of practicing cognitive learning strategies. For example, for item 2 and item 3, 18.8% and 12.5% of the participants, respectively, reported that rehearsing content material was challenging for them when studying the out-of-class learning activities. Rehearsing as a cognitive learning strategy was reported by Pintrich et al. (1993) as a basic strategy in influencing the attention and encoding process of learning. These students seemed to lack the skills to practice this basic cognitive strategy, particularly when the mode of learning was shifted to the student-centered flipped classroom model rather than the teacher-centered approach, which is more likely to instruct students on what and how to learn (Green, 2015; Sankey & Hunt, 2014).

Conversely, few students expressed that they were practicing a number of the metacognitive self-regulation strategies at a low level. For example, in item 15, 28% of the students indicated the challenge of maintaining their focus and not being distracted when learning in the out-of-class materials. While in item 21, 12.5% of the students indicated the difficulties faced in making adjusting their cognitive learning strategies, to course requirements and teaching style. Likewise, in item 17, 12.5% of the students reported another difficulty regarding monitoring their understanding of
Table 3. Students perception of their self-regulated learning strategies in the flipped classroom (N = 64)

| Items                                                                 | M (SD)     | Very less/Not at all true of me % | True/Very true of me % |
|-----------------------------------------------------------------------|------------|----------------------------------|------------------------|
| Cognitive learning strategies                                         |            |                                  |                        |
| (1) Practice material orally.                                          | 5.7 (1.78) | 9.4                              | 71.9                   |
| (2) Practice reading.                                                  | 4.4 (2.07) | 18.8                             | 37.5                   |
| (3) Memorize key words.                                                | 5.0 (2.10) | 12.5                             | 50.1                   |
| (4) List important terms.                                             | 5.7 (1.46) | 0.0                              | 56.3                   |
| (5) Extract important information.                                     | 5.1 (1.72) | 9.4                              | 46.9                   |
| (6) Relate ideas to previous knowledge.                                | 5.4 (1.62) | 6.3                              | 50.0                   |
| (7) Relate ideas to other subjects.                                    | 5.4 (1.47) | 0.0                              | 50.0                   |
| (8) Summarize main ideas.                                              | 5.6 (1.31) | 0.0                              | 50.0                   |
| (9) Connect meanings.                                                 | 5.5 (1.52) | 3.1                              | 46.9                   |
| (10) Apply concepts.                                                  | 5.3 (1.53) | 3.1                              | 43.8                   |
| (11) Organize thoughts.                                                | 5.5 (1.66) | 3.1                              | 56.3                   |
| (12) Skim material for important concepts.                             | 5.8 (1.60) | 6.3                              | 62.5                   |
| (13) Organize ideas via simple graphs.                                 | 5.4 (1.47) | 3.1                              | 56.3                   |
| (14) Outline important concepts.                                       | 6.0 (1.31) | 3.1                              | 71.9                   |
| Metacognitive self-regulation strategies                               |            |                                  |                        |
| (15) Track attention.                                                 | 3.6 (2.18) | 28.2                             | 40.6                   |
| (16) Monitor concentration.                                            | 5.4 (1.62) | 6.2                              | 46.9                   |
| (17) Ensure understanding.                                            | 5.4 (1.91) | 12.5                             | 56.3                   |
| (18) Switch from one strategy to another.                              | 5.3 (1.64) | 9.4                              | 50.1                   |
| (19) Plan reading/browsing material.                                   | 4.8 (1.70) | 15.6                             | 37.6                   |
| (20) Self-testing to ensure comprehension.                             | 5.6 (1.21) | 3.1                              | 46.9                   |
| (21) Make adjustment to course requirements.                           | 5.0 (1.76) | 12.5                             | 43.7                   |
| (22) Check understanding.                                             | 2.7 (1.34) | 6.3                              | 40.7                   |

(Continued)
content materials. For item 19, 15.6% of the participants revealed the challenges involved in planning and setting goals for learning (reading/browsing content material) before class time.

All the reported challenges might have been due to the students lack of experience with this new model of teaching and learning, as the students were used to being taught through the traditional approach, where the teacher plays an active role in planning, organizing, and introducing and illustrating the content materials to students. This first experience of the flipped classroom model required adequate training to ensure that all the students possessed the necessary SRL strategies, both cognitively and metacognitively, to perform successfully in this learning environment. These findings align with those of a number of studies in the literature (Chen et al., 2015; Schlairet et al., 2014) on low self-regulated behaviors among some students (Al-Zaaharni, 2015; Chen et al., 2015; Lai & Hwang, 2016, 2016; Sun et al., 2017), limited student preparation before class (Al-Zaaharni, 2015), and insufficient guidance and feedback for students during out-of-class time (Chen et al., 2015).

**RQ2:** Are there any differences between students SRL (cognitive learning strategies and students metacognitive self-regulation strategies) in the flipped learning classroom compared to the traditional classroom?

In order to answer this research question, three alternative hypotheses were proposed: $H_{a1}$: statistically, significant differences exist at the 0.05 level of the means of students SRL between the traditional and flipped classroom groups; $H_{a2}$: statistically, significant differences at the 0.05 level of the means of students cognitive learning strategies between the traditional and flipped classroom groups; and $H_{a3}$: statistically, significant differences at the 0.05 level of the means of students metacognitive self-regulation strategies between the traditional and flipped classroom groups. To test the validity of these hypotheses, an independent samples t-test was performed.

| Items | M (SD) | Very less/Not at all true of me % | True/Very true of me % |
|-------|--------|----------------------------------|------------------------|
| (23) Analyze tasks and requirements. | 5.4 (1.43) | 6.2 | 47.6 |
| (24) Determine misunderstanding. | 5.5 (1.19) | 0.0 | 50.0 |
| (25) Set goals for learning. | 4.9 (1.50) | 3.1 | 37.5 |
| (26) Correct material organization. | 5.6 (1.47) | 3.1 | 56.7 |

**Table 4. Independent samples t-test of the two groups (N=64)**

| Group | M | SD | SE | t | df | Sig |
|-------|---|----|----|---|----|-----|
| Post-test Traditional classroom | 4.7 | 1.32 | .233 | 1.669 | 62 | .100 |
| Post-test Flipped classroom | 5.2 | .793 | .140 |

* P < 0.05
between the post-tests of the MSLQ survey questionnaire for both the traditional and flipped classroom groups. The results, shown in Table 4, indicate that there were no statistically significant differences in the students responses regarding their SRL between the traditional and flipped classroom groups: t (62) = 1.669, p > 0.05. Thus, the alternative hypothesis, Hα2, was rejected, indicating that both groups of students possessed the essential qualities of being active and responsible for their learning.

To test the validity of Hα2 and Hα3 and examine the differences between the means of the students responses to the two MSLQ factors, the cognitive learning strategies and metacognitive self-regulation strategies were compared between the flipped and traditional classrooms. Table 5 lists a comparison of the means (standard deviations) of the student participants responses in both the traditional and flipped groups according to the two MSLQ factors: the cognitive leaning strategies and the metacognitive-self regulation strategies. As shown in Table 5, the mean response of the students from the flipped classroom (5.4) was slightly higher than that of the students from the traditional classroom (4.9) in terms of factor 1—cognitive learning strategies—with a 0.5 difference. Likewise, the mean response of the students from the flipped classroom (4.9) was slightly higher than that of the students from the traditional classroom (4.2) in terms of factor 2—metacognitive self-regulation strategies—with a 0.7 difference. In general, the student participants in both groups demonstrated a good-to-high level of practicing both the cognitive learning strategies and the metacognitive self-regulation strategies (4 < m > 5.5).

Moreover, the result from the independent sample t-test, shown in Table 5, indicates that there were no statistically significant differences between the two groups in terms of the students responses regarding practicing cognitive learning strategies: t (62) = 1.702, p > 0.05. Thus, the second alternative hypothesis, Hα2, was rejected. This means that the students in both groups practiced similar cognitive learning strategies, although the mean response of the students in the flipped classroom group was slightly higher. This reveals that even with the flipped model of instruction, where the in-class learning activities shifted to out-of-class learning activates and vice versa, the students were able to practice cognitive learning strategies as they did in the traditional classroom approach. Thus, inverting the classroom instruction did not affect the students skills and attitude to self-regulate their cognition. They were able to use various learning strategies, such as note-taking, outlining, summarizing, selecting main ideas, comparing, and constructing. They were also able to meaningfully engage in in-class learning activities with their teacher and peers, which resulted in them being cognitively involved in the learning process (Pintrich et al., 1993).

| Table 5. Independent-samples t-test of the two factors of MSLQ (N = 64) |
|---------------------------------------------------------------|
| **Table 5. Independent-samples t-test of the two factors of MSLQ (N = 64)** |
| MSLQ | Traditional | Flipped | T-test |
|------|-------------|---------|--------|
|      | M   | SD  | SE | M   | SD  | SE | t   | df | Sig   |
| Factor 1: Cognitive learning strategies | 4.9  | 1.44 | .255 | 5.4  | 1.03 | .183 | 1.702 | 62 | .094 |
| Factor 2: Metacognitive Self-Regulation | 4.3  | 1.06 | .188 | 5.0  | .703 | .124 | 3.046 | 62 | .003* |

* P < 0.05
In terms of the metacognitive self-regulation strategies, Table 5 reports statistically significant differences between the two classroom groups in terms of the students’ responses, which favored the flipped classroom model: t (62) = 3.046, p < 0.05. Thus, the third hypothesis, H₃, was accepted. This result indicates that the flipped classroom model positively influenced the student participants in practicing metacognitive SRL strategies. It confirms previous research findings that flipped learning activities can help improve students metacognitive skills (Bin Jwair, 2018; Hewitt et al., 2014), as self-regulated learners take an active role in their own learning by monitoring and regulating aspects of their cognition and behavior (Walters et al., 2005). The result indicated that the seventh-grade participants in the flipped classroom possessed the skills and attitudes to plan, monitor, and regulate their cognition more so than those in the traditional classroom. This might be due to the characteristics of the flipped model in empowering students to take an active role in deciding on using cognitive strategies and to stop using or switching from one strategy to another. Self-regulated learners feel empowered, as they believe that success largely depends on their ability to effectively use and adjust learning strategies (Bin Jwair, 2018). This means that when the students were required to view and understand the learning materials during out-of-class time, they were able to set goals for viewing the instructional videos and content notes, tracking their comprehension as they viewed and read, engaged in self-testing, questioning, and making changes or adjustments as they progressed in their learning (Pintrich et al., 1991). This is explained by the fact that SRL controls performance by helping students set their goals and apply more self-regulatory processes (Lai & Hwang, 2016; Moos & Bonde, 2016).

Furthermore, a paired samples t-test was performed to detect differences between the two MSLQ factors—the cognitive and metacognitive self-regulation learning strategies—within both classroom groups. Table 6 reports that for the traditional classroom group, there were statistically significant differences between the cognitive learning strategies and the metacognitive self-regulation strategies in terms of the students’ responses: t (31) = 5.552, p < 0.05.

Table 6 also indicates that for the flipped classroom, there were statistically significant differences between the cognitive learning strategies and the metacognitive self-regulation strategies in the students’ responses: t (31) = 3.451, p < 0.05. By comparing the means, the results indicate that the student participants from both groups showed a higher level of practicing cognitive learning strategies than of practicing metacognitive self-regulation strategies. For the flipped classroom model, the explanation for this result might be in the models implementation and not the lack of sufficient experience or lack of necessary skills for the students to plan, monitor, and regulate their learning strategies.

**RQ3:** How does the flipped classroom model influence students’ academic achievement compared to the traditional classroom approach? In order to answer this question, an alternative hypothesis was proposed, H₄: statistically, significant differences at the 0.05 level of the means of students’ academic achievement scores between the traditional and flipped classroom groups. To test the validity of these hypotheses, an independent samples t-test was performed.

| Flipped classroom | Factor 1: Cognitive learning strategies | Factor 2: Metacognitive Self-Regulation | t-test |
|-------------------|----------------------------------------|----------------------------------------|--------|
|                   | M          | SD | SE  | M          | SD | SE  | t   | df | Sig      |
|                   | 5.4        | 1.03 | .183 | 4.9        | .659 | .116 | 3.451 | 31  | .002*    |

*P < 0.05
Table 7. Independent-samples t-test of students achievement scores (N = 64)

| Group            | M    | SD   | SE  | t     | df  | Sig  |
|------------------|------|------|-----|-------|-----|------|
| Traditional      | 6.6  | 1.97 | .348| .235  | 62  | .815 |
| classroom        |      |      |     |       |     |      |
| Flipped classroom| 6.5  | 1.99 | .348|       |     |      |

The data in Table 7 reveal no statistically significant differences between the flipped and traditional classroom groups regarding the students academic achievement scores: t (62) = .235, p > 0.05. Thus, the second alternative hypothesis, Hα2, was rejected, although the most frequently reported advantage in recent literature on flipped classrooms is the improvement of students academic achievement and overall learning performance (Akçayır & Akçayır, 2018; Lee, 2018; Wei et al., 2020). This study result supports the claim that the flipped classroom model has a similar impact on students academic achievement compared to the traditional classroom approach (Chen, 2016; DeSantis et al., 2015; Kennedy et al., 2015).

RQ4: Is there a relationship between students SRL and academic achievement? To answer this question, an alternative hypothesis was proposed, Hα3: statistically, significant correlation at the 0.05 level of the means of students SRL and academic achievement scores in the flipped classroom group. To test the validity of these hypotheses, a Pearson correlation test was performed.

Table 8 presents a statistically positive correlation between students SRL and academic achievement scores in the flipped classroom learning environment, p < 0.05, leading to the acceptance of the fifth alternative hypothesis, Hα5. Thus, students with an adequate level of self-regulation were more likely to enhance their academic performance in the flipped learning environment. This finding emphasizes that, in the flipped classroom learning environment, SRL is a key influencer in students learning performance, thus substantiating the findings of Lai and Hwang (2016). This result corroborates existing findings on the importance of SRL competence in increasing students performance in the flipped learning environment (Hewitt et al., 2014; Montgomery et al., 2019; Rodrigues & Zealand, 2016; Sun et al., 2017).

Interestingly, it appears from the results in Table 8 that the positive relationship between students SRL and their achievement is resulted from the significant correlation between students cognitive self-regulation strategies and their achievement scores (p < 0.01). As no significant

Table 8. The relationship between students SRL and academic achievement scores in the flipped classroom (N = 32)

| Correlations                  | Achievements scores |
|-------------------------------|---------------------|
| SRL                           | Pearson correlation | .446*               |
|                               | Sig.                | .010                |
| Cognitive learning strategies | Pearson correlation | .510**              |
|                               | Sig.                | .003                |
| Metacognitive self-regulation strategies | Pearson correlation | .296               |
|                               | Sig.                | .100                |

*correlation is significant at the p < 0.05 level (2-tailed). **correlation is significant at the p < 0.01 level (2-tailed).
correlation was detected between the metacognitive self-regulation strategies and achievement scores (p > 0.05). This implies that, in the flipped classroom learning environment, the level of students self-regulation to select and use various cognitive learning strategies significantly contributes to their learning performance. A potential explanation to this result is that the characteristics of flipped classroom entail students to be self-regulated to select and use basic cognitive learning strategies in both out-of-class and in-class learning activities, where they apply the knowledge and engage in higher-order thinking individually and collaboratively. This type of repeated practice of self-regulation leads the student to master the cognitive content and thus improve the learning performance.

8. Conclusion and recommendations
The present study examined the intersection of the flipped learning model and students SRL and academic achievement of seventh-grade junior high school students. The majority of published studies in the K–12 classroom context investigated the impact of the flipped instructional model on students learning performance and reported on the challenges encountered by both teachers and students (Akçayır & Akçayır, 2018; Lo & Hew, 2017; Silva et al., 2018). However, very few studies (e.g., Lai & Hwang, 2016) have explored the relationship among the flipped learning model, SRL, and academic achievement in the K–12 context. Therefore, this study contributes to the empirical research on K–12 education regarding the flipped classroom model. This study assessed the degree to which students practiced self-regulating strategies for learning, including their use of cognitive learning strategies and metacognitive self-regulation strategies.

The findings of this study revealed that, in the flipped classroom environment, the seventh-grade participants possessed a good-to-high level of SRL skills. However, their SRL skills did not differ from those of the participants in the traditional classroom environment. The results revealed that the majority of the participants possessed the essential qualities to use cognitive and metacognitive self-regulation strategies in flipped learning activities. Due to the student-centered nature of the flipped classroom model, the results also showed that the students practiced metacognitive self-regulation strategies significantly more than the cognitive learning strategies practiced in the traditional classroom environment. This result implies that the active role played by the students in the out-of-class learning activities motivated them to self-regulate their cognition and behavior toward successful learning. The students in the flipped classroom were able to plan, monitor, and regulate their learning as well as decide what learning strategies worked better for them.

Despite these positive results, a number of challenges were reported by a few participants, mostly in terms of their self-regulation in the out-of-class activities, such as setting goals for learning, rehearsing and understanding the content materials, and making changes and adjustments in cognitive learning strategies. Therefore, this study recommends that in order to use the flipped classroom model, teachers must provide students with adequate training to ensure that all students possess the necessary SRL strategies, both cognitively and metacognitively, to perform successfully in this learning environment.

In terms of students academic achievement, the results indicated no significant differences between the flipped and traditional classrooms. However, the result reported a relationship between students SRL and academic achievement. These findings provide guidance for teachers on the implementation of the flipped classroom model in K–12 classrooms, especially given that, in the flipped classroom environment, promoting students SRL competence is a determining factor in the enhancement of learning performance. As the findings of this study highlighted the significant relationship between K–12 students SRL and academic achievement, the development and integration of an appropriate SRL model within the flipped learning environment is of considerable relevance in the K–12 context. Future research may also consider investigating critical factors regarding flipped learning in contributing to the enhancement of students achievement in the K–12 context.
Several limitations were acknowledged in this study. The study’s inclusion of a relatively small sample of seventh graders limits the potential generalizability of the results. Also, the study context comprised a group of female students learning in mathematics classrooms. Therefore, a similar study on different disciplines and considering gender differences may produce different results. Consequently, in future studies on the influence of the flipped classroom model on students SRL and learning performance, researchers should utilize a large sample size and a variance in terms of both disciplinary context and demographic characteristics. In addition, as the current study utilized the quantitative approach, similar investigations may utilize a mixed-methods approach to gain a more in-depth understanding of how students self-regulate out-of- class learning activities in flipped learning compared to traditional learning.

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Author details
Ahlam Mohammed Al-Abdullatif
E-mail: aalabdullateef@kfup.edu.sa
Department of Curriculum and Instruction, College of Education, King Faisal University, 400, Al-Hasa 31982, Saudi Arabia.

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