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ORIGINAL ARTICLE

Designing a technology-enhanced flipped learning system to facilitate students' self-regulation and performance

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Abstract

In recent years, the flipped classroom has become prevalent in many educational settings. Flipped classroom adopts a pedagogical model in which short video lectures are viewed by students at home before class so that the teacher can lead students to participate in activities, problem-solving, and discussions. Yet the design or use of technology that employs planned instructional strategies with sustainable support of self-regulation is scant. We propose a technology-enhanced flipped language learning system (Flip2Learn) that provides facilitation and guidance for learning performance and self-regulation. A quasi-experimental study was carried out to examine whether Flip2Learn could enhance college students' self-regulatory skills and later contribute to the learning performance in the flipped classrooms. The results showed that Flip2Learn not only better prepared students for flipped classrooms but also better promoted learning performance compared to the conventional flipped classrooms. The results of this research advanced our understanding of the dynamics of flipped classrooms and represented a revolutionary new approach to the technology-enhanced learning for flipped classrooms.

KEYWORDS

flipped classroom, language learning, self-regulated learning, technology-enhanced learning system

1 | INTRODUCTION

Student-centered learning environments have been valued in higher education in recent years (Hannafin & Land, 1997). Although the creation of such learning environments remains a challenge, many educators advocate the model of a flipped classroom, in which educators allocate class time for active learning approaches and leverage advanced technologies for external classroom events, where students can access online video lectures prior to the class (Bergmann & Sams, 2012). Presumably, the use of advanced technologies in this manner gives students more opportunity to engage in active learning during the class because they have prepared and are ready to participate in more interactive, higher-order thinking activities. In turn, students' performance can be monitored continually by the teachers, and students can receive more personalized feedback from them (Fulton, 2012). To fully participate in class activities, students must watch or listen to online materials prepared by the teachers. However, research has shown that not all students benefit equally from learning by video lecture or other multimedia formats (Filiz & Kurt, 2015). As a result, we cannot merely ask our students to watch online materials alone without any support prior to participation in a flipped classroom (Horn, 2013). In this study, therefore, we sought to use technology in combination with planned instructional strategies to better equip students prior to class participation, which in turn, increases their readiness and helps to maximize the benefits of the flipped classroom.

Below, we succinctly introduce and synthesize the literature on flipped classrooms and language learning and describe the self-regulation skills that are required for language acquisition. We then describe the design of a technology-enhanced self-regulated learning (SRL) model and associated research questions, followed by the methodology to evaluate the effectiveness of the learning system to facilitate the flipped learning experience. The paper concludes with a discussion of the results and their theoretical and practical implications.

2 | REVIEW OF RELEVANT LITERATURES

2.1 | Flipped classroom and language learning

The flipped classroom model has attracted strong advocates among educators looking for alternatives to traditional teaching methods.

Broadly, flipped classroom can be defined as a pedagogical approach that requires students to self-study or preview learning materials out of class in order to acquire new knowledge and to participate in a variety of in-class activities in order to put the newly learned knowledge into practice (Bergmann & Sams, 2012). The core elements of the flipped classroom are student self-regulation and engagement in the learning process. It emphasizes a student-centered approach that puts students in the driver's seat and transforms traditional teaching from unidirectional to multidirectional (e.g., Baepler, Walker, & Driessen, 2014).

The flipped classroom model has been implemented in various disciplines, such as economics, mathematics, and chemistry (Chen, Yang, & Hsiao, 2015; Roach, 2014), and across different educational levels, such as elementary schools, high schools, and universities (Chao, Chen, & Chuang, 2015; Kim, Kim, Khera, & Getman, 2014; Tsai, Shen, & Lu, 2015). In the field of language learning, Hung (2015) found that the flipped classroom model is a promising pedagogical approach that utilizes a holistic integration of technology and active learning strategies to transform language students' learning experiences. In the field of computer-supported language learning, researchers have taken advantage of media attributes to facilitate the acquisition of various languages in flipped classrooms. A computer-based program can effectively assist students' reading strategies and language comprehension (Dreyer & Nel, 2003; Fasting & Lyster, 2005). In addition, Huang and Hong (2015) found that flipped English intervention improved students' information and communication technology and reading comprehension abilities. Other emerging technologies, such as the LINE smartphone app, mobile-assisted learning systems, and student response systems in flipped classrooms, can improve language students' learning outcomes and increase their motivation for learning (Chen Hsieh, Wu, & Marek, 2016; Hung, 2017; Wang, 2016).

Flipped classrooms combined with the appropriate technology offer many advantages. These include the promotion of active learning, more effective use of class time, and the ability for students to move at their own pace (e.g., Fulton, 2012). However, several researchers have cautioned against allowing the adoption of teaching strategies to drive the outcomes of flipped classrooms. Davies, Dean, and Ball (2013) found that the preclass lecture video is essential to the success of the flipped classroom, yet not all students watched the videos. Even if students did watch the video, they generally felt isolated or helpless. Chen, Wang, and Chen (2014) also found that students with low self-regulation had difficulty adapting themselves to the flipped learning model and felt behind in class discussions or hands-on activities because they had failed to watch the required videos before the class. Lai and Hwang (2016) suggest more guidance was required, with a focus on self-regulation skills, to better orient students for successful flipped learning. Only a limited number of empirical studies have examined the effectiveness of flipped classrooms across educational contexts such as English language acquisition (Egbert, Herman, & Chang, 2014). Hao (2016) states that we have just begun to explore some key personal characteristics that interact with learning and motivation in the flipped classroom. Additional studies are required to gather sufficient empirical support for flipped classroom (Abeysekera & Dawson, 2015; Bergmann & Sams, 2012; O'Flaherty & Phillips, 2015).

As described by Bergmann and Sams (2012), the flipped classroom provides greater freedom and opportunity for learning in the classroom. In other words, a variety of in-class activities (e.g., role-playing, debates, problem-based learning, collaborative learning, and peer teaching) and out-of-class activities (e.g., readings, homework, and supplemental videos) can be used in flipped classrooms to improve students' academic achievement and attitude toward learning and encourage them to become active learners (Chao et al., 2015; DeLozier & Rhodes, 2017). One of the instructional approaches that can move from the traditional classroom to a flipped classroom format is to require students to watch prerecorded video lectures or screencasts prior to attending the class (Abeysekera & Dawson, 2015). One may argue that, with the flipped classroom, we must trust students to watch the lectures at home. Unfortunately, there is no way to guarantee students will oblige or cooperate with the flipped model. In addition, if every teacher flipped his or her classroom, students would spend hours in front of a computer watching lectures. This has the potential to cause serious problems for students and their learning processes, because not everyone may be as adept at learning through a computer. Therefore, this study addresses ways to better prepare students for the flipped classroom through the use of technology. In doing so, we utilize the theory of self-regulation to address a development gap, a theory that not only contributes to the immediate need of improving the learning experience but also supports the ongoing development of domain expertise.

2.2 | Theory of self-regulated learning

Self-regulation is important in all human learning and performance. Bandura (1986) has noted self-regulation involves three component processes: (a) self-observation or behavioral monitoring; (b) self-evaluation of progress or self-judgment; and (c) self-reaction, including both affective and tangible self-initiated consequences. The absence of these cognitive skills severely limits the ability of individuals to construct meaningful paths to determined personal value goal. In light of the problems that might arise, more empirical interventions should be conducted to improve SRL (Miller & Brickman, 2004). To design an intervention that has a lasting impact on student SRL is the primary goal of this study. The past research has conducted experiments aimed at improving student motivation and self-regulation to learn in different disciplines (Chen & Chou, 2015; Matuga, 2009; Sansone, Fraughton, Zachary, Butner, & Heiner, 2011). These researches have suggested helping students to set goals, monitor their progress, evaluate their progress against reasonable standards, and provide themselves with appropriate self-reactive consequences has proven valuable and revealed context-specific improvements.

Past literature has shown that students are not always successfully in regulating their own learning, especially in technology-based learning environments (e.g., Lee, Lim, & Grabowski, 2009). In fact, students need intensive instructional support, such as modeling, coaching, and scaffolding for the development of SRL in technology-based learning environments (e.g., Azevedo & Hadwin, 2005; Chen, Wu, & Jen, 2013). One way to do so is to provide students with cognitive tools to facilitate specific kinds of cognitive processing (Lajoie & Azevedo, 2006). The use of technologies as cognitive tools for teaching and learning becomes inevitability nowadays. Yet how to create appropriate supportive technology-based environments for flipped classroom requires further exploration. What is more, which features in the technology-based environments are primarily responsible for the improvement of self-regulated skills, which in turn, contribute to the success of flipped classroom is scant in the current literature. Next, we conceptualize a technology-enhanced SRL system for flipped classroom that directs our design rationale and development for technology-enhanced flipped language learning system (Flip2Learn).

2.3 | Technology-enhanced self-regulated learning

Over the past decades, we have witnessed growth of technology as a medium for delivering and supplementing classroom instruction. Despite the widespread popularity of the technology for education, there are a number of potential problems associated with technology-based learning environments. Many students, for example, find it is difficult to be self-regulated or to complete tasks in technology-based environments without the external supports (Kauffman, 2004). A particular concern is that students often lack of self-regulation abilities, for instance, to control behaviors, emotions, and thoughts. When students do not regulate themselves in technology-based environments, the consequences may include anxiety, frustration, and even failure (Azevedo, 2005). Therefore, it seems critically important for teachers to develop techniques that support SRL while students are working in technology-based environments.

So can we scaffold students' self-regulation in technology-based environments? The answer to this question may be found from examining one key assumption of generative learning theory—students need to control their learning process (Wittrock, 1974). Students' self-regulation particularly cognitive and metacognitive control is critical. Students must be accountable and responsible for how they generate their own knowledge (Barab & Squire, 2004). Cognitive control refers to how students regulate the use of cognitive strategies to accomplish learning goals; metacognitive control refers to how students monitor and modify their cognitive strategies in order to make any adaptive changes while they are learning (Schunk, 1995). Therefore, scaffoldings to improve students' cognitive and metacognitive control in technology-based environments is necessary.

Scaffoldings can be generally divided into hard scaffolds and soft scaffolds. Hard scaffolds, also called fixed scaffolds, are static and are not adaptable to meet individual student learning needs (Saye & Brush, 2002). Hard scaffolds for self-regulation development can be valuable if the needs of individuals are better taken into consideration. As a result, students need to commit themselves to self-regulation so that they can fully benefit from their learning experiences. Existing research have found that hard scaffolds can be provided to help students monitor their own comprehension and guiding their learning activities, yet how students actually adopt hard scaffolds in the development of their self-regulation stays unknown (Azevedo & Hadwin, 2005). Soft scaffolds, also called adaptive scaffolds, are spontaneous and timely support that can diagnose the problems as occurring. Ge and Land (2004) perceive student–student or teacher-student interaction can make up of soft scaffolds, which alternates the shortcomings of hard scaffolds. Undoubtedly, learning is a social process in which meaning is negotiated, goals emerge from social processes, and success is taken within context. Social constructivists argue that learners' internal cognitions emerge as a result of an intentionally driven agent interacting with an information-rich environment (Langer, 2009). Therefore, in addition to hard scaffolds, we recognize the impact of social interaction or feedback on advancing students overall performance. In a recent empirical study conducted by Tsai (2013), teacher initiation for the collaborative learning and the provision of teacher feedback during the development of self-regulation skills can help students develop regular learning behaviors, promote collaboration, and further contribute to their practical computing skills for website design. We explain how we execute hard and soft scaffolds into the system design and development that sets ground for the flipped classroom in the methodology section.

3 | PURPOSES OF THE STUDY AND RESEARCH QUESTIONS

The purpose of this study is to understand the critical factors for the success of the flipped classroom on the basis of the cognitive psychology and instructional technology standpoints. A recent study used a short survey and open-ended questions to see how students and teachers used technologies in the flipped classroom (Kim et al., 2014). Although this study involved the investigation and definition of design specifications for flipped learning, this study did not include the participants' performance and changes in motivation. As a result, we propose the design and development of a technology-supported flipped language learning system (Flip2Learn) that provides facilitation and guidance for knowledge gaining and self-regulation development. We also propose that, as students experience the Flip2Learn system, they will adopt new learning strategies and change developmentally (in knowledge, skills, perceptions, and practice) and these will better acquaint students with flipped classrooms. In this study, the following questions were examined:

1. Did the students who used Flip2Learn have better performance gains than those who learned with the conventional flipped classroom approach?
2. How did different levels of prior knowledge affect students' performance gains differently after the use of Flip2Learn and the conventional flipped classroom approach?
3. Did the students' use of Flip2Learn increase their readiness for flipped classroom learning and help them become better self-regulated learners than those who learned with the conventional flipped classroom approach?

4 | METHODOLOGY

4.1 | Design and participants

A quasi-experimental quantitative intervention was conducted for this study. The participants were 81 sophomore university students enrolled in a required Applied English course. They were recruited from two intact classes of the same course, taught by the same instructor in the spring semester of 2016 at a public university in central Taiwan. The participants were mostly male, and their ages ranged from 19 to 23. All the participants were non-English majors, from the Department of Industrial Education and Technology, and their English proficiency levels were estimated to be preintermediate as measured by a placement examination administered by the university.

4.2 | Learning environment

Two main learning materials were included in this study: (1) the design of the flipped classroom and (2) the Flip2Learn learning system. The design of the flipped classroom was guided by the design principles proposed by Hamdan, McKnight, McKnight, and Arfstrom (2013). During the flipped classrooms, students had varying degrees of flexibility with regard to class attendance and/or in-person participation. The course had the characteristics listed below.

1. The flipped classroom had weekly class meetings of 100 min. Face-to-face lectures were delivered in the class meeting but were not recorded for later online viewing. The students were informed in the beginning of the course by the instructor that the course structure was a flipped learning approach, in which students were required to view the online lecture prior to the class meetings in order to fully participate in the class activities. Students were given a progress schedule at the beginning of the course showing the pace that was to be followed. The schedule specified the online lectures that were to be viewed. Quizzes were given prior to the exercise of English-learning tasks. The quizzes worth 100 points being given, and there was a comprehensive final exam. The students were also informed that no formal lectures were delivered during the class meetings. Lectures were only available online in the form of slides accompanied by audio narrations. Topics in the online lectures were organized as the breakdown of chapters found in the course textbook. Students could find section numbers within textbook chapters. The class was situated in a traditional room with moveable tables and chairs. Class meetings were 100 min in length and held weekly. In the beginning of class meeting, students were randomly assigned to a group of four members. The students would work in stable groups in the weekly class meetings. Activities during the class meetings included quiz and solving of English-learning tasks collaboratively. The classroom was equipped with Wi-Fi, allowing students to access the Internet at any time. In the class, students were given weekly quizzes to test whether they had comprehended the instructional content. The instructor implemented a total of eight tasks over the study duration; these were English-language tasks intended to improve students' vocabulary acquisition and listening and speaking skills through teamwork, collaboration, and problem-solving. The samples of learning tasks are listed in Table 1. Each task took approximately 30 min depending on the type, complexity, and structure of the task. Group members played an important role in taking the initiative to organize and complete tasks and seeking help when needed.
2. The course was divided into seven successive modules with a quiz worth 100 points being given during the concluding class meeting of each module. Quizzes were similar in terms of format and coverage in the modules.

Depending on the experimental group, some students had access to the learning system in addition to the flipped classroom. A technology-enhanced flipped language learning system (Flip2Learn) was developed and built using Microsoft SQL Server 2005 (the database structure of Flip2Learn), as depicted in Figure 1. When students entered Flip2Learn for the first time, the system directed them to complete some background information (for example, their prior knowledge, learning beliefs, self-efficacy, and cognitive preferences). This information was automatically stored in the user account database so it could be retrieved later for subsequent analysis. The database of learning tasks contained learning materials, activities, and information for the students to select from various forms of multimedia as shown in Figure 2. The tasks were presented in three modes. First, the system gave students a choice of suitable learning tasks (system control mode). Next, it presented them with a subset of suitable learning tasks (shared control mode). Finally, it presented them with the complete task database, from which to choose their own tasks (learner control mode). In learner control mode, students selected tasks from this database, which had descriptions of all available learning tasks. Each task was characterized by metadata with regard to (a) the difficulty of the task, as part of the description of the task class to which it belonged, (b) the level or type of task format (e.g., problem-solving task and strategic task), and (c) its other features, such as skills in English or practical tasks, for the real world. After learners selected and performed tasks, they used available support to monitor their performance. Learners eventually began to judge the quality of their own performance, either by self-assessment or by asking others such as peer or teachers. The assessment results were added to a development portfolio, which contained an overview of all learning tasks performed and their assessment results. Finally, the next learning task was selected based on the information in the portfolio, and so on.

TABLE 1 Samples of learning tasks

Task	Types	Descriptions
Translating vocabulary	Interacting/deciding/transacting	Read aloud the vocabulary and translate into Chinese.
Jeopardy	Judging/evaluating/responding	Task includes into listening, filling in the blank, reading, and grammar. The members had to complete within the time frame. The number of correct answers constituted a win.
Speed and sandwich	Interacting/deciding/transacting	Each student had four cards, each with one vocabulary word. Students opened the card and pronounced the vocabulary correctly.

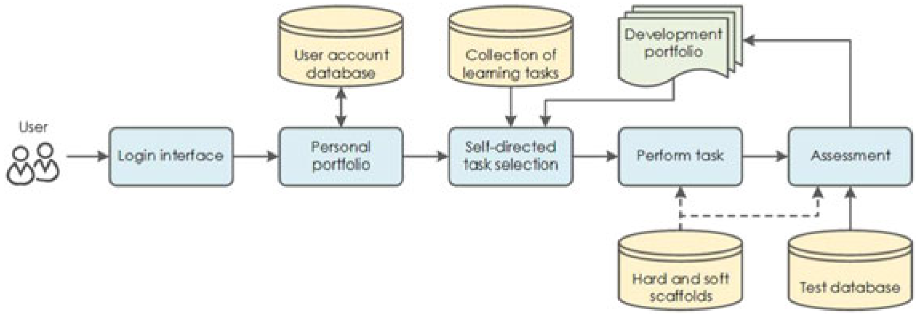

FIGURE 1 Flip2Learn database structure [Colour figure can be viewed at wileyonlinelibrary.com]

FIGURE 2 The collections of learning tasks [Colour figure can be viewed at wileyonlinelibrary.com]

During the time the students were selecting and solving the learning tasks, they had access to a database of hard and soft instructional scaffolds. The scaffold database contains prompts that assist students in understanding the learning task better and engage in a process of self-regulation. The main purpose of the hard and soft scaffold database is for students to orient themselves to learning opportunities, plan their own learning tasks, and monitor, adjust, and assess their own performance. The hard scaffolds are static and scripted to foster the development of self-regulation skills. The hard scaffolds include three phases of learning. In the first phase, *starting the learning process*, students are guided to diagnose and confront the task, themselves, and the context and design an action plan for study and settings. Samples of hard scaffolds for the first phase were

- Please describe the goals and sub-goals for this task.
- What information or prior knowledge can you infer before performance of this task?

In the second phase, *performing the learning process*, the system prompts students to monitor their own learning progress and make any adjustment during the process. Samples of hard scaffolds for the second phase were

- What have you learned from performing this task?
- What content helped you accomplish your goals, as stated previously?
- Have you met previously set goals?

In the third phase, *finishing the learning process*, students were prompted to assess their own understanding of the knowledge and evaluate overall efficiency and effectiveness upon the completion of the task. Samples of hard scaffolds for the third phase were:

- What could have made you perform the task differently?
- Did you learn anything from the task?
- What impact did the task have on your knowledge?

All responses to hard scaffolds were recorded in the development portfolio and made available to students.

In addition to the hard scaffolds, which are automatically provided by the system, students also had access to the soft scaffolds. The soft scaffolds included peer learning and teacher feedback. For the peer learning, students reviewed their peers' response to the tasks. If students encountered problems, they could raise questions in the forums or through videoconferencing and online messengers. They were encouraged to request help from more capable peers. In addition to peer learning, students received teacher feedback. The teacher guided or directed students' attention to the important aspects of learning, and students could develop their skills and knowledge rather than being left to learn on their own. The teacher provided feedback about students' learning. Students could read their feedback from the teacher.

4.3 | Instruments

The instruments used for this study included a learning performance test, weekly quizzes, a flipped classroom readiness survey, and a self-regulated survey. An L2 learning performance test composed of 20 multiple-choice questions with only one correct answer was taken from the textbook used for the classroom. The questions included the parts of speech (i.e., noun, adjective, verb, and adverb) and vocabulary words used in everyday activities. Each question was worth one point, and the students had 20 min to complete the test. The reliability coefficients were .81 and .84 for the pretest and posttest, respectively. Weekly quizzes consisted of multiple-choice questions with one correct answer that reflected the content from that week of learning. The maximum score for the learning performance test and weekly quizzes were 100.

To measure students' readiness for learning in a flipped classroom, we adopted and modified the Online Learning Readiness Scale by Hung, Chou, Chen, and Own (2010). Our scale included the following dimensions: computer/Internet self-efficacy, self-directed learning, learner control, motivation for learning, and online communication self-efficacy. The students responded to an 18-item flipped classroom readiness survey with a 5-point Likert scale from *completely disagree* (1) to *completely agree* (5). The reliability of this survey was .87.

A self-regulated survey was used to assess students' awareness of their knowledge and control of their own cognition. We adopted the items from a self-reported Motivated Strategies for Learning Questionnaire that focused on the control and self-regulation aspects of metacognition by Pintrich, Smith, Garcia, and McKeachie (1991). There are three general processes that make up metacognitive self-regulatory activities: planning, monitoring, and regulating. Planning activities, such as goal setting and task analysis, help to activate or prime relevant aspects of prior knowledge that make organizing and comprehending the material easier. Monitoring activities include tracking one's attention as one reads and self-testing and questioning. These assist the learner in understanding the material and integrating it with prior knowledge. Regulating refers to the fine-tuning and continuous adjustment of one's cognitive activities. Regulating activities are assumed to improve performance by assisting learners in checking and correcting their behavior as they proceed on a task. Students responded to 12 items on a 5-point Likert scale from *not all at true of me* (1) to *very true of me* (5). The reliability of this survey was .82.

4.4 | Procedure

As depicted in Figure 3, prior to the start of class, students were asked to complete a flipped classroom readiness survey and a learning performance pretest. In the first week, the researcher informed all the students about the class's flipped classroom structure and described the model in detail. The flipped classroom took place for 8 weeks, and then students were asked to complete another flipped classroom readiness survey and a learning performance posttest. For the Flip2Learn group, a brief tour of the Flip2Learn system was given to train students in regulating their English language learning in the hypermedia environment. Students were required to select and complete at least one task in Flip2Learn weekly, after their participation in the flipped classroom.

5 | RESULTS

Learning gains were reflected in the change that occurred between the pretest and the posttest. The pre-post performance variables were the difference scores (posttest-pretest), with an increase indicating a greater amount of the performance variable at the posttest and a

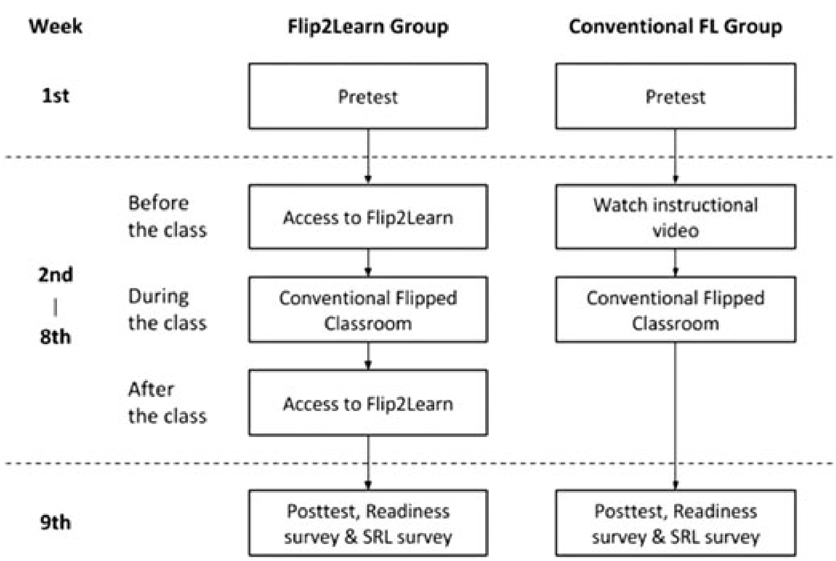

FIGURE 3 Research procedure. SRL = self-regulated learning

negative score indicating a decrease of the performance variable. As shown in Table 2, students in the Flip2Learn group gained significantly more than those in the conventional FL group, $F(1, 83) = 23.21$, $p = .000$.

We went on comparing whether students' prior knowledge can be a factor that influences students' performance gains for each condition. Overall, students with low prior knowledge improved significantly as compared to those with high prior knowledge in both conditions. Yet we would like to know further details about the differences in performance gains under each condition for students with both high and low levels of prior knowledge. As shown in Tables 3 and 4, the gain mean score for low prior knowledge in the Flip2Learn was significantly higher than those counterparts in the conventional FL. As to the interaction between learning approach and students' prior knowledge, no significant effect was observed.

The results of the readiness for flipped classroom survey showed that students exposed to Flip2Learn showed better preparation for the flipped classroom as compared to those without such exposure, $F(1, 83) = 32.93$, $p = .00$. Descriptive statistics for the readiness and SRL for different learning approach are shown in Table 5. The results of the comparison of SRL survey also showed that students exposed to Flip2Learn reported higher SRL ability than those who only participated in the conventional FL, $F(1, 83) = 54.64$, $p = .00$. With regard to students' SRL from the survey, we also conducted repeated measure analysis of variance on the weekly quizzes to test if the students followed the SRL scheme and if there was an interaction effect between time and prior knowledge or time and condition. The results showed that there was a main effect between prior knowledge and time, and learning approaches and time. A repeated measures analysis of variance with a Greenhouse–Geisser correction determined that there was an interaction between learning approach and time, $F(2, 162) = 20.31$, $p < .00$. There was also an interaction effect between prior knowledge levels and time, $F(2, 162) = 8.69$, $p < .00$. Therefore, we can conclude that learning approach and prior knowledge elicit statistically significant performance gains.

TABLE 2 Descriptive statistics and ANOVA for conditions on performance gains

	N	Mean	*SD*	Min	Max	*df*	*F*	*p*
Flip2Learn	40	40.55	10.90	14	58	1	23.21	.000
Conventional FL	44	24.27	18.66	−8	58			

Note. ANOVA = analysis of variance.

TABLE 3 Descriptive statistics of performance gains of low and high prior knowledge students' performance for learning approach

	Learning approach			
	Flip2Learn		Conventional FL	
Prior knowledge	*N*	Mean (*SD*)	*N*	Mean (*SD*)
High	14	34.00 (11.39)	15	17.33 (15.22)
Low	13	47.84 (6.02)	19	27.79 (20.50)

TABLE 4 The two-way ANOVA result of the learning gains of the two groups

	SS	*df*	MS	*F*	*p*
Learning approach	5407.53	1	5407.53	24.49	.00
Prior knowledge	1143.66	2	1143.66	5.18	.00
Learning approach x prior knowledge	97.99	2	97.99	.45	.64
Error	17222.95	78	220.80		

Note. ANOVA = analysis of variance.

TABLE 5 Descriptive statistics of the readiness and SRL for different learning approach

		Mean	*SD*	Min	Max
Flip2Learn	Readiness	3.98	.29	3.39	4.87
	SRL	4.03	.33	3.41	4.12
Conventional FL	Readiness	3.60	.32	3.00	3.98
	SRL	3.51	.30	3.00	3.85

Note. SRL = self-regulated learning.

6 | DISCUSSION

The overall results of this study led us to conclude that exposing students to the technology-enhanced Flip2Learn system does offer more effective and engaging learning than only that which involved the conventional flipped classroom. With regard to the first research question, the results of this study showed that, at posttest, there was a statistically significant association between the students who used the Flip2Learn system and performance gains. This initial findings suggested the effectiveness of the Flip2Learn system in that it employed a suite of tools and functions to support a series of cognitive activities, which are sequenced, coordinated, and integrated to fulfill the purpose of SRL processes. These findings supported previous research with respect to the effects of learning system supplemented with external scaffolds, such as goal setting and self-evaluation, show significant learning gains (Lai & Hwang, 2016). More importantly, this finding contributes to the literature on learning with hypermedia by demonstrating that regulating learning externally through the use of varying degrees of scaffolding is associated with superior gains in student performance (e.g., Azevedo, Moos, Greene, Winters, & Cromley, 2008; Feng & Chen, 2014). In our study, students with lower prior knowledge, when exposed to Flip2Learn, demonstrated the greatest performance gains in comparison with those who experienced conventional flipped classrooms. This result indicates that enabling students with low prior knowledge to regulate their learning in the presence of external regulation will lead to superior gains in learning performance. From the standpoint of cognitive psychology, this finding is consistent with previous research, which indicates that students who are provided with external regulating agents show significant learning gains in a variety of domains and tasks (Azevedo & Hadwin, 2005; Chi, Siler, & Jeong, 2004).

Although all students in the current study gained significant knowledge, as measured by the posttest, our results revealed that students who experienced the Flip2Learn system reported higher SRL abilities and readiness for the flipped learning approach than those in the conventional flipped classrooms. This finding indicated that the facilitation of SRL within the Flip2Learn system prior to or after the flipped classroom had positive effects in supporting students' SRL abilities and better prepare themselves for the flipped classroom activities. This finding adds to the current literature that providing more guidance to assist students in self-paced learning can help improve readiness for flipped classrooms (Hao, 2016). Although the existing research on the evaluation of the flipped classrooms appeared that performance gains by flipped classroom implementation is diverse, as different effects (positive, neutral, or negative) of flipped classrooms are reported (e.g., Missildine, Fountain, Summers, & Gosselin, 2013; Strayer, 2012). Based on the results of this study, the integration of SRL in the flipped classroom seems to improve the flipped learning experience and points to more satisfying outcomes.

With regard to instructional technology, this study examined a SRL system as a means to engage students in a flipped classroom and promote active learning. This approach addresses some of the problems that arise when students are faced with a flipped learning environment, including disorientation in the flipped classroom, lack of self-regulation, and lack of adequate class preparation. Although the integration of new technology applications in the flipped classroom is well established in previous research (e.g., Hung, 2017; Li et al., 2014; Sohrabi & Iraj, 2016), this study contributes to the literature by examining the extent to which the technology application can be used and implemented as a metacognitive tool to enhance student learning.

7 | IMPLICATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

This study has both theoretical and practical implications. Theoretically, it extends the current research on flipped classrooms to maximize their benefits for student learning and motivation. In addition to the flipped classroom model, this study demonstrated that a focus on SRL can advance and deepen the learning in flipped classrooms. Practically, the complementary learning mechanism that incorporates hard and soft scaffolds to provide students with instant help and guidance can help students avoid feelings of isolation or a lack of motivation to learn. Teachers who adopt the flipped classroom model should train their students to regulate their learning with hypermedia using the specific embedded scaffolds in this study, which were designed to foster students' learning abilities.

Although the results provided some interesting insights in the flipped classroom, modified replication of the study is necessary. For example, random sample assignment and equivalent study load between conditions. It is suggested to use a mixed methodology with design-based research to detect, trace, and monitor learners' learning behaviors. Students' class attendance and in-personal participation should be measured in addition to the performance gains and readiness for flipped classrooms. Future study should also investigate teachers' experience with flipped classrooms and their perspectives on the implementation of SRL to support the flipped learning.

Additionally, further research may build upon the initial results of this study by investigating the nature of task design in classroom activities; in particular, we recommend empirical examination of how different levels of task involvement load influence students' participation and engagement (DeLozier & Rhodes, 2017). Variations in pedagogical practices may help to expand the scope and depth of a flipped classroom context. Other research efforts should involve examining the transfer effect of an experienced Flip2Learn approach to English language learning and its effect on motivation to learn. More research is also needed to determine how different learning approaches can enhance students' ability to regulate their learning. In the meantime, continued flipped classroom research should be taken into consideration if teachers are to meet the diverse needs of students when flipping. Although some evidence-based research shows that attending to personal characteristics, such as instrumentality of motivation and language belief, can influence the outcomes of a flipped classroom (Chuang, Weng, & Chen, in press), tailoring instructional design to best suit learner needs remains a topic for more extensive future study.

8 | CONCLUSIONS

This study contributes to research on flipped classrooms and builds on work on SRL. Our results reveal that the Flip2Learn learning system design is beneficial for students of different levels, particularly for low vocabulary acquisition students who have made significant improvements. We found that externally facilitated regulated learning is a desired attribute of learning with hypermedia that later enhances students' self-regulated skills and increases their readiness for flipped learning. Without a doubt, guidance with a focus on self-regulation skills should be implemented to better assist students in the self-pace learning process necessary for successful flipped learning. It is also anticipated that students' development of self-regulation skills while learning with hypermedia can play an essential role to language learning in a flipped classroom.

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