JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 18, No. 1 (2022), pp. 94-100

Does teaching metacognitive skills through peer-conducted flipped classroom improve high school students' self-regulation?

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(submitted: 12/4/2021; accepted: 19/4/2022; published: 27/4/2022)

Abstract

Obtaining metacognitive skills is crucial for enhancing self-regulation. So, this quasi-experimental study aimed to assess the effect of teaching metacognition through peer-conducted flipped classroom on high school students' self-regulation. 107 students filled out Self-Regulation Questionnaire as the pre-test. Both control and intervention groups received a package of four-session multimedia e-content about metacognition during four weeks. Each week, the students in the intervention group participated in a face-to-face session during which peers handled the instruction, while participants in the control group had teacher conducted sessions. Finally, the same questionnaire was answered as the post-test. The results showed a significant increase from pre to post-test scores in the intervention group, in contrast to the control one with no significant increase. Between groups comparison of post-test scores resulted in a significant higher score in the intervention group. So, the findings showed the positive effect of teaching metacognition through this method on students' self-regulation.

KEYWORDS: Metacognition, Self-Regulation, Flipped Classroom, Peer Learning, High School.

DOI
https://doi.org/10.20368/1971-8829/1135489

CITE AS
Mohammadi,A., Mohammadi, M., Keshvari, N.Z., Mojtahedzadeh, R., Asadzandi, S., Tehrani, B.R. (2022). Does teaching metacognitive skills through peer-conducted flipped classroom improve high school students' self-regulation?. *Journal of e-Learning and Knowledge Society*, 18(1), 94-100. https://doi.org/10.20368/1971-8829/1135489

1. Introduction

1.1 Metacognition and self-regulated learning

The term metacognition implies thinking about thinking (Flavell, 1979) and addresses monitoring and controlling of cognitive processes like effective learning, rational thinking, comprehension and problem solving (Credé & Phillips, 2011; De Stasio & Di Chiacchio, 2015). Since metacognition is considered as one of the predictive factors for successful learning (Jaleel & Premachandran, 2016; Perry et al., 2018), some studies have focused on understanding the process of deploying metacognitive abilities by learners to control and adjust cognitive process. In fact, many aspects of learners' development, from academic skills to self-awareness, are affected by their level of metacognitive abilities, that is the extent they think about not only themselves, but also their assigned tasks and related contexts (Cleary & Chen, 2009). Effective learners are conscious of their own strengths and weaknesses and try to resolve the latter through being aware, possessing knowledge, and controlling of cognition. For this purpose, metacognitive self-regulatory tasks comprise of planning, monitoring and regulating. So, metacognition is supposed to be the crucial part of self-regulation (Pintrich & Zusho, 2002).

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Self-regulated learning (SRL) is defined as the process through which learners deploy and maintain cognition and behaviors that systematically help them in achieving learning goals (Zimmerman & Schunk, 2008). Self-regulated learners are active ones that are metacognitively, motivationally, and behaviorally focused on their own learning process (Wolters, 2003; Zimmerman & Schunk, 2008). These learners are familiar with various cognitive learning strategies, so that they are capable of choosing and regulating a proper strategy while performing a learning task (Asikcan & Saban, 2018; Geres-Smith et al., 2019). In other words, self-regulated learners reflect on their own cognitive process through monitoring their learning which helps them to adjust their learning behaviors in accordance with putative changes (Wolters, 2003). Moreover, SRL process consists of the following phases and their relevant sub processes:

- Forethought: goal setting, strategic planning, self-efficacy, learning goal orientation, and intrinsic interest in the task
- Performance: focusing on the learning task, using self-instruction, imagery, and self-monitoring
- Self-reflection: self-evaluation, attributions, and self-reactions (Zimmerman, 1998).

In contrast to proactive learners who are good at forethought and performance phases, reactive ones are able to self-reflect on their performed tasks which results in their better self-regulation as well (Zimmerman & Schunk, 2008). In other words, self-regulated learners are skillful in applying a wide range of cognitive strategies for performing their learning tasks. They can not only efficiently rehearse, organize and elaborate their learning, but also attain and keep knowledge in a structured manner (Zimmerman, 1998) and gain better academic achievement (Al Mulhim, 2021; Pintrich, 2004; Wang, Shannon & Ross, 2013).

1.2 Improving metacognitive and SRL skills

In order for learners to successfully achieve and apply metacognitive and SRL strategies, they need to be aware of the processes that are correlated with better educational performance (Bol & Garner, 2011; Pintrich & Zusho, 2002). In this way, they become able to apply appropriate strategies in their learning experiences (Zimmerman, 1998). In fact, metacognitive skills can be explicitly taught (Bae & Kwon, 2019; Kramarski & Mevarech, 2003; Voskamp et al., 2020) and different learner centered strategies could be used for teaching metacognition. In this regard, it is recommended to support secondary education students in order to obtain better SRL skills (Ramdass & Zimmerman, 2011; Voskamp et al., 2020) through not only explicitly teaching metacognitive strategies, but also providing the chance of learning them in groups. However, it is necessary to examine certain instructional strategies for this purpose (Dignath & Büttner, 2018).

Peer conducted flipped classroom, as a learner centered teaching strategy, could be applied for covering both the direct teaching of metacognition through multimedia contents, and group learning through face-to-face sessions that are led by peers.

1.3 Flipped classroom

Flipped classroom is considered as a student-centered strategy, in which traditional teaching-learning process is inversed (Avery et al., 2018; Elian & Hamaidi, 2018). In this method, teacher presents the information to the students before the class via technology tools such as recorded multimedia, social media, websites, educational games or a variety of open resources. Students are supposed to study these materials before the class. Then, the class time is devoted to a variety of learning activities that focus on problem solving and gaining deeper insight into the subject. Hence, the role of teacher is being a mediator and a motivator for helping the students to learn (Elian & Hamaidi, 2018; Valizadeh & Soltanpour, 2020).

This strategy enhances students' SRL, promotes their thinking skills, helps in treating their academic weaknesses (Elian & Hamaidi, 2018), results in higher academic achievement and motivation, improves metacognitive awareness (Al Mulhim, 2021; Kozikoğlu, 2019), and provides the chance for self-directed and collaborative learning. At the same time, it provides greater teacher-student interaction. Students experiencing flipped classroom are more prone to become autonomous and cooperative learners who are able to learn in collaboration with others (Avery et al., 2018). In fact, in addition to cognitive domain, flipped strategy promotes developing other skills like knowledge-gaining competency and communication skill as well (González-Gómez et al., 2016). Moreover, it is shown that students and teachers have positive viewpoints toward this strategy (Al Mulhim, 2021; Kozikoğlu, 2019).

The teaching contents in most flipped classroom researches were subjects like mathematics, science, biology, chemistry, information and communication technologies, educational technologies, programming, English learning, business administration, health sciences, social sciences, psychology and engineering-architecture courses (Kozikoğlu, 2019). No study was found examining teaching meta skills like metacognition using this strategy. On the other hand, although flipped classroom has been the focus of many studies during the recent years, limited researches were performed on high school students (Avery et al., 2018), Among the recent studies related to this level, a study showed the increase in academic achievement in students in science subject (Elian & Hamaidi, 2018). Another one was performed on seventh grade students in an English course that led to higher levels of students' engagement in the course activities (Ayçiçek & Yanpar Yelken, 2018).

As most evidence on flipped pedagogy is directed to the university level and it is gaining more interest in elementary and secondary school, it is suggested to perform researches at these levels to explore different

aspects of this strategy (Kozikoğlu, 2019). In addition, blending other approaches such as peer learning, with flipped pedagogy could be of interest for further research (Graziano, 2017).

1.4 Peer learning

One of the teaching methods mentioned in the literature as a proper technique for enhancing self-regulation is peer learning. In this teaching-learning strategy, groups of students work together to solve a problem, perform a task, or develop a product (Johnson et al., 1994). Generally, peers may have almost the same demographic characteristics such as being coeval or studying the same courses. They also play significant role in each other's development and behavior especially when they are adolescents. Hence, peer learning is an appropriate teaching strategy for providing the chance of better communication and adopting intended behaviors in a group. This strategy is demonstrated to be effective for attaining SRL skills in young students (Meusen-Beekman et al., 2015; Pintrich, 2004; Whitebread et al., 2007).

This approach concentrates on group learning rather than personal one (Ayçiçek & Yanpar Yelken, 2018). Hence, peer interaction is the main reason for successful cooperative learning through enhancement of cognitive understanding and engagement of students in teaching-learning process. This results in improving students' critical thinking, reasoning, problem-solving skills (Bilgin & Geban, 2006) and motivation through forcing students to be active and work together (Lim, 2014).

1.5 Aim of the study

The primary research question for this study was raised by two high school students who are among the authors of this article. They wanted to know how to help themselves and their classmates in order to learn school courses more effectively. Then, they started their search and became familiar with metacognition and SRL concepts and decided to perform a research project to find an effective way for improvement of those skills.

Considering the nature of filliped classroom and peer learning, the combination of these two approaches may be beneficial; as shown in a study performed on preservice teachers, in which participants reported that lessons delivered by peers through flipped pedagogy were interactive and fun and made them more enthusiastic about the subject (Graziano, 2017). In fact, applying peer learning in interactive sessions of flipped model could be of interest for further research. So, on one hand, we couldn't find any study investigating peer conducted flipped pedagogy on high school students; and on the other hand, no study was found assessing the effect of teaching metacognitive skills at this level through flipped classroom. So, this study aimed at assessing the effect of teaching metacognitive skills through peer-conducted flipped classroom on high school students' SRL.

2. Materials and Methods

2.1 Study design

This was a quasi-experimental study with pre and post-test design including intervention and control groups, performed in a high school within a four-month period. The ethical permission was obtained from school's authorities and the study was approved in School's Research Project Committee to be performed under the supervision of a mentor.

2.2 Participants

Participants were 107 tenth grade high school students. They were all identified as females who were studying the same curriculum in four classes. These four classes were randomly allocated to the intervention (two classes with 55 students) and the control (two classes with 52 students) groups.

2.3 Instrument

In this study, we used Self-Regulation Questionnaire developed in 2001 (Hong & O'Neil, 2001) that was validated for Persian language in 2013 (Borjalilu et al., 2013). The questionnaire consists of 34 items in the form of 4-point Likert scale questions ranging from 1 (almost never) to 4 (almost always). The Cronbach's alpha score was 0.87 for the total questionnaire.

2.4 Getting prepared

Those two students who raised the question for this research, started to learn metacognitive and SRL skills in order to become capable of teaching these concepts to their peers. For this purpose, they studied a concise course of "How to improve your learning by promoting metacognitive skills?" hold by an expert faculty member of the field.

2.5 Creating multimedia e-contents on metacognition

Then, those students recorded the voice of the above-mentioned course' instructor and created four multimedia e-contents using Articulate Storyline software, which were totally about 2 hours. They developed e-contents considering educational and technical standards of multimedia development under the supervision of a skilled instructional designer. The e-contents covered these topics: metacognition definition and its role in learning, learning process and practical strategies for enhancing metacognitive skills. The team used school's Learning Management System (LMS) to deliver the e-contents to the participants.

2.6 Design in the control group

Firstly, we started the research in the control group to avoid participants' contamination. The participants of this group responded to Self-Regulation Questionnaire as the pre-test. They received the above mentioned four

multimedia within a month (each week one topic) via the LMS. We encouraged and reminded them to study the contents for each week. At the end of each week, one of the school's teachers held a 40 to 60-minute face-to-face session to briefly review and discuss the topic, and answer students' questions. Finally, the participants filled out the questionnaire again two weeks after the end of the instruction.

2.7 Design in the intervention group

The participants in the intervention group filled out the Self-Regulation Questionnaire and then participated in a peer-conducted flipped classroom model. They received the multimedia via the LMS (each week one topic for one month), just the same as the control group. Then two of the researchers, the students, held 40 to 60-minute face-to-face classes in each week during which they started with a brief 5-minute review of the topic followed by discussion and question and answer. In these classes the participants reflected on their positive and negative learning experiences and discussed useful strategies to improve their learning. During the following week, the participants were encouraged to study the multimedia content and reflect more for the next session. Afterwards, the intervention group answered the post-test questionnaire two weeks after the end of the instruction.

Finally, the same instruction was delivered to the control group to follow ethical issues.

2.8 Data analysis

The data was analyzed using SPSS version 21.0 (IBM Corp., Armonk, N.Y., USA). Analysis included paired t-test, independent t-test and one-way analysis of variances (ANCOVA).

3. Results

3.1 Participant Characteristics

From 107 participants, 97 filled out both pre and post-tests (response rate = 90.65%). Table 1 shows the participants' age and total average mark of the previous semester in both intervention and control groups.

3.2 Main results

Table 2 shows a significant difference between the pre and post-test SRL mean scores in the intervention group (p-value<0.001). In contrast, no significant difference was found between these two scores in the control group (p-value =0.453).

Between group comparison of pre-test and post-test scores using independent t-test showed that although no significant difference was found between the pre-test scores (p-value =0.471), the mean score for the post-test in the intervention group was significantly higher than the control group (p-value =0.001) (Table 3). In addition to this analysis, considering the pre-test score as the covariant, the intervention and control groups as the independent variables and the post-test scores as the dependent variables, the difference of post-test scores between two groups still remained significant (Table 4).

4. Discussion and Conclusion

In this study, we instructed metacognitive skills to the tenth-grade high school students through peer-conducted flipped classroom and assessed its effect on participants' SRL. The results demonstrated that two weeks after the instruction, SRL was significantly higher in the intervention group compared to the control one. Furthermore, in contrast to the control group, a significant increase was found between pre and post-tests in the intervention group. This showed the effect of peer-conducted flipped classroom for teaching metacognitive skills on enhancing students' self-regulation.

The results in the intervention group were consistent with some studies that have focused on teaching metacognitive strategies for improving self-regulation (Harandi et al., 2013; Karaoğlan Yilmaz et al., 2018; Kostons et al., 2012). One of these studies was performed on secondary students who were trained to evaluate their own task performance and use this information for selecting a new one. This led to a more effective self-regulated learning (Bae & Kwon, 2019; Kostons et al., 2012).

In opposite to this consistency, the control group that received multimedia e-contents and participated in instructor-led sessions, showed no significant increase in SRL. This may be interpreted through paying attention to the instructional strategies. While studying multimedia is shown to have no effect on metacognition (Norman & Furnes, 2016), flipped classroom is proved to improve non-cognitive attitudes and competencies (González-Gómez et al., 2016). At the same time, peer instruction has the same goals of enhancing students' engagement and learning as in flipped classroom model. Each of these two strategies are shown to be flexible and effective. Hence, some evidence focusing on higher education has demonstrated that combining flipped model and peer learning leads to higher positive effects (Nerantzi, 2020; Rowley & Green, 2015). This is aligned with the results of this study which is performed on high school students.

In this study, peer conducted sessions provided the chance of students' engagement with the topic. Reviewing the literature supports the effect of peer learning in this study. In fact, peer learning has been used for enhancing metacognitive or SRL skills in some studies (King et al., 2018; Meusen-Beekman et al., 2015; Whitebread et al., 2007). In another study performed on high school students, the opportunity of working together for performing educational tasks resulted in higher SRL and learning achievement (Bol et al., 2012).

Group	Number	Age mean (SD)	Total average mark mean (SD)	p-value for total average mark
Control	50	16 (0.32)	17.5 (2.7)	0.775
Intervention	47	16 (0.37)	18.2 (3.5)	

Table 1 - Comparing age and total average mark between the control and intervention groups.

Group	Test	Number	Mean (SD)	t*	Sig. (2-tailed)
Control	Pre-test	50	2.85 (0.41)	-0.756	0.453
	Post-test	50	2.88 (0.45)		
Intervention	Pre-test	47	2.79 (0.35)	-6.283	0.000
	Post-test	47	3.17 (0.39)		

* Paired t-test

Table 2 - Within group comparison of the pre-test and post-test scores in the control and intervention groups.

Test	Group	Number	Mean (SD)	t*	Sig. (2-tailed)
Pre-test	Control	50	2.85 (0.41)	-0.724	0.471
	Intervention	47	2.79 (0.35)		
Post-test	Control	50	2.88 (0.44)	3.455	0.001
	Intervention	47	3.17 (0.39)		

* Independent t-test

Table 3 - Between groups comparison of the pre and post-test scores fpr the control and intervention groups.

Source	Type III Sum of Squares	Df	Mean Square	F*	Sig.
Type	2.606	1	2.606	21.348	.000

* One-way analysis of variances

Table 4 - Tests of Between-Subjects Effects.

Hence, when students become familiar with metacognitive hints through this teaching method, they have the chance of receiving feedback from their peers and consequently involve more in educational duties (Teng & Reynolds, 2019). In this way, the support they obtain while collaborating with their peers enhances their SRL skills (Hadwin et al., 2011). The results of this study showed the same and there was a significant improvement of SRL skills in the intervention group. In addition, comparing both groups demonstrated higher SRL skills in intervention group. On the other hand, a study performed on secondary students showed that shy students didn't ask questions from teachers in instructor-led flipped classes and preferred getting help from their classmates (Della Sciucca & Fochi, 2016). This can be another evidence supporting the results of this study.

The combination of these strategies in our study had some advantages. We overcame time limitation for holding face-to-face sessions during school working time for delivering lectures. E-contents were accessible for students all over the study period, so that they could study them at their own pace and intervals. On the other hand, this study had some limitations. The participants were all females and we didn't assess the long-term effect of the intervention. So, it is suggested to perform future studies on participants with more demographic variety and consider follow up post-tests in order to investigate the maintenance of SRL skills. Moreover, participants of this study self-reported their level of SRL skills that could be a source of bias. We recommend conducting studies in which SRL skills are observed more objectively.

In conclusion, since students' progress in all aspects of their education is an ultimate goal of any educational system, programs that aim to promote SRL skills should be delivered in order to train effective, responsible and competent learners. Therefore, teaching metacognitive skills to the students could be beneficial because it leads to the improvement in their SRL and learning achievement. (Norman & Furnes, 2016). In this regard, appropriate educational strategies play an important role. In this study, peer-conducted flipped model was shown to be an effective strategy of teaching metacognition for enhancing SRL in high school students.

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