

Effects of Self-Directed Learning Readiness on Academic Performance and Perceived Usefulness for Each Element of Flipped Learning

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This study aims to examine the effects of self-directed learning readiness (SDLR) on academic performance and the perceived usefulness for each elements of flipped learning. Based on their SDLR scores, 69 students were assigned to a high SDLR group and a low SDLR group. Academic performance was measured by the completion rate of a pre-class online learning and the final exam score, and perceived usefulness for each element of flipped learning was measured by a survey designed by the researcher. For academic performance, the high SDLR group showed a significantly higher completion rate than the low SDLR group, but no significant difference was observed in their final exam scores. Students in the high SDLR group perceived in-class student-centered activities as more useful than those in the low SDLR group. Additional qualitative analyses indicated that students needed more support from instructors and well-prepared peers. Finally, this study suggested that more examination on the various learning characteristics that may influence the effectiveness of flipped learning should be done.

Keywords: Flipped Learning, Flipped Classroom, Self-Directed Learning Readiness, Perceived Usefulness

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Introduction

With significant advances in educational technologies, teaching and learning experiences have changed. Use of new digital tools in educational activities enable learners to be more active in their studies outside the classroom (Holland, 2014), and this has transformed lecture-led learning into student-centered learning. Thus, the act of learning itself is no longer a simple act of information transfer but a form of active participation in which learners themselves develop new ways of thinking and executing through active discovery (Aldrich, 2009). The advent of flipped learning, first attempted in secondary education in the United States (Bergmann & Sams, 2009), reflects this educational trend. Flipped classrooms replace what was previously considered in-class content, such as teacher-led instruction, with what was previously regarded as homework, with students being assigned activities to complete in class (Pierce & Fox, 2012). This approach frees up in-class time for student-centered learning activities.

The educational research literature on flipped learning indicates that it offers a suitable amount of educational value, including correcting the shortcomings of traditional, lecture-based teaching styles and enhancing comprehension, retention, learning performance, and satisfaction (Kurup & Hersey, 2013; Missildine, Fountain, Summers, Gosselin, & Harbutt, 2013; Sharma, Lau, & Doherty, 2015). To make the most of flipped learning and obtain these educational advantages, students must realize the importance and necessity of completing active asynchronous pre-class activities before participating in the later stages of learning, such as face-to-face synchronous activities and post-class activities (Estes, Ingram, & Liu, 2014). More specifically, students in the flipped classroom must use self-directed learning methods to review and critically reflect on learning materials before class, and then actively apply this knowledge in a collaborative, face-to-face environment in class. However, while students' acceptance of their roles as self-directed learners is one of the most significant success factors in flipped learning,

not enough research has as yet examined learners' characteristics in light of active engagement within the flipped learning environment.

Based on this premise, this study aimed to investigate the effectiveness of flipped learning according to learners' individual characteristics, especially, self-directed learning readiness. The followings are two research questions:

- How does learners' academic performance of flipped learning differ according to their level of SDLR?
- How does learners' perceived usefulness for each element of flipped learning differ according to their level of SDLR?

Self-Directed Learning and Flipped Learning

Expressions such as “lecture-less school class” (Prober & Heath, 2012) and “student as a digital native” (Rutkowski & Moscinska, 2015) can summarize the flipped learning concept. Like “digital native” who have little patience for lecture-led step-by-step instruction, students in flipped learning play an active role as actors for their learning rather than as passive audiences (Prensky, 2001). As independent learners, individuals are capable of selecting, managing, and evaluating their own learning processes, which can be performed at will at their choice of time and place using their preferred method. In flipped learning, learners have to watch preparation video or learning materials by self-pace, and have to use their self-directed learning strategies to conduct inquiries through in-class activities and continuously check their learning process. The flipped classroom, which incorporates self-directed learning into a new learning environment, is considered a new format that promotes self-directed learning (Rutkowski & Moscinska, 2015). In the flipped classroom, students should be able to manage learning resources, verify their independence, and be capable of self-directing toward success (Kereluik, Mishra, Fahnoe, & Terry, 2013).

Previous research has revealed a positive correlation between the learning environment and success factors in self-directed learning. Guglielmino (1977), for example, indicated that certain learning contexts such as reading and discussion or pre-programmed instruction tapes, promote self-directed learning. Furthermore, characteristics of learning environment are critical elements for self-directed learning to flourish (Confessore & Kops, 1998). More recently, Abdullah (2002) asserted that when properly supported by information and communications technology, many benefits would follow, including responsibility toward one's own learning process, motivation for initiating and maintaining learners' efforts, collaboration with teachers and peers, a capacity for developing domain-specific knowledge as well as conceptual knowledge of new situations, and responsibility for self-monitoring and making learning meaningful. In this context, it is difficult to determine whether self-directed learning is a representative of flipped learning that employs new technology and learning environments or flipped learning is a representative of self-directed learning. However, it is apparent that flipped learning provides significant opportunities to reconsider self-directed learning and vice versa.

Much literature has found that flipped learning reestablishes how time is spent both before and in class and shifts the autonomy of learning from instructors to learners. It has also found that flipped learning can be an effective self-directed learning component (Rutkowski & Moscinska, 2015). Teresa, Sheryl, and Katie (2012), who argued that faculty members and instructors attempt to unite the central tenets of self-directed learning with technology and learning activities to create a flipped classroom suited for the needs of developmental learners, also support this. According to Fulton (2012), students in flipped classrooms will learn how to employ self-directed learning skills and move at their own pace. The flipped classroom has also been reported to improve self-directed learning ability, expand the depth and breadth of learning, and bridge the knowledge-practice gap (Cheng, Lee-Hsieh, & Huang, 2015). The flipped classroom promotes students' self-

directed learning skills and behaviors by granting them ownership of learning as they decide how and when to watch videos and how much time to devote to reviewing content they feel they need to learn. Classroom activities are also designed to enable student-directed decisions on the accomplishment of tasks.

Based on the promise of flipped learning for facilitating instructional and technological methods to enhance learning outcomes at the university level (Deslauriers, Schelew, & Wieman, 2011; Marlowe, 2012), efforts have been made to verify the growing evidence supporting flipped learning, such as student satisfaction and course grades (Mason, Shuman, & Cook, 2013; Estes, Ingram, & Liu, 2014). For instance, flipping the classroom was shown to produce significant learning gains at Vanderbilt University (Deslauriers, Schelew, & Wieman, 2011), and Montana State University experienced positive effects of the flipped classroom on student achievement and stress (Marlowe, 2012). However, none of the previous studies examined the learning enhancement effects of flipped learning in conjunction with self-directed learning improvement. As Rutkowski & Moscinska (2015) suggested in their study, only when learners achieve high levels of self-directed learning readiness are the benefits of flipped learning observed, such as improvement in learning performance and satisfaction. So a tentative inference that improvement of self-directed learning readiness is important factor for successful flipped learning can be drawn. Furthermore, we cannot overestimate the role of design and implementation of flipped learning, as well as the importance of enhancing SDLR in the pre-class synchronous activities. This study builds upon the above assumption by providing an empirical data that explores whether SDLR is an important factor affecting successful flipped learning. In addition, this study tried to find out that do learners think that which element of flipped learning is useful for their learning.

Structural Elements and Supporting Systems of Flipped Learning

Flipped learning inverts traditional teaching methods and requires students to prepare theoretical content before class and engage in problem solving in the classroom. Bloom's taxonomy of cognitive domains (Anderson, Krathwohl, & Bloom, 2001) provides a useful framework for identifying the technologies that can be applied to engage students both before and in class. Students are expected to remember, understand, and recall subject matter by watching prepared lectures asynchronously and at their own pace at home and then use higher-concept engagement to apply, analyze, evaluate, and create new material in the classroom's synchronous environment. Hence, further in-depth learner-content interaction is required to achieve important learning outcomes. According to Reiser (2001), both pre- and in-class activities are essential learning environments for students to demonstrate knowledge construction as evidence of learning. For the purpose of fulfilling this goal, various technologies and instructional designs have been used to connect the learning environment, creating and facilitating learning tasks in pre-, in-, and post-class learning in flipped learning. Since flipped learning is a change of educational paradigm that traditional education changed to student centered, it is expected that the role of teachers and students who support individual learners will also be changed. Therefore, we will explore the role of instructors and students who support individual learners and the structural elements of flipped learning.

Pre-class asynchronous learning

Numerous studies focused on the types of resources that helped pre-class flipped classroom activities. Instructors have designed pre-recorded materials in various media formats. In a relatively recent literature review by O'Flaherty & Phillips (2015), the most widely used formats for pre-class asynchronous learning activities

were pre-recorded lectures in the form of podcasts, screencasts, vodcasts, annotated notes, and captured videos (Gannod, Burge, & Helmick; 2007; Kim, Khera, & Getman, 2014; Lage, Platt, & Tregila, 2000; Mason, Schuman, & Cook, 2013; Missildine, Fountain, Summers, & Gosselin, 2013; Pierce & Fox, 2012; Prober & Khan, 2013). Additional resources not included in recorded form were pre-readings (Ferrerri & O'Connor, 2013), readings from specific texts (Wilson, 2014), and automated tutoring systems and study guides (Strayer, 2012). Many studies employed interactive videos from online repositories such as the Khan Academy suite of resources (Wilson, 2014) and case-based presentations and simulations (Martin, Farnan, & Arora, 2013). The common aspect observed in all previous studies was the requirement that learners be able to navigate and use these learning materials without enough instructor assistance or guidance (Dahlstrom, Walker, & Dziuban, 2013). For this reason, learners are reluctant to do pre-class online learning and are bored. The pre-class online learning requires self-directed learning ability of learners (Hong, 2016).

Face-to face synchronous in-class activities

When students engage in face-to-face synchronous activities, typically a team-based or social and highly collaborative approach is required for further knowledge transfer (Estes, Ingram, & Liu, 2014), which is characteristic of in-class flipped learning instruction. The recent scoping review by O'Flaherty & Phillips (2015) indicated that activities conducted during in-class flipped learning comprised the following: team-based discussions (Prober & Khan, 2013), expert or panel-led discussions (Young, Bailey, Guptil, Thorp, & Thomas, 2014), case-based presentations (Ferrerri & O'Connor, 2013), role-playing and group presentations (Kim, Khera, & Getman, 2014), and discussions and debates (Pierce & Fox, 2012). Many face-to-face synchronous activities employ tools such as tablets, smartphone apps, and clicker questions to collect information about real-time formative a

assessments, with the aim of providing students immediate feedback on any misconceptions or gaps in their knowledge. These activities enable students to experience higher conceptual engagement as they apply, analyze, evaluate, and create new material in the classroom (McLaughlin, et al., 2014; Martin, Farnan, & Arora, 2013; Ferreri & O'Connor, 2013; Yeung & O'Malley, 2014). Furthermore, cumulative assessment to encourage students to attend class was also employed (Yeung & O'Malley, 2014). To summarize, in flipped learning, instructors and students commit themselves to being active facilitators and participants who efficiently exploit their time together in class.

Post-class learning

Before and after the pre-class asynchronous activities and face-to-face synchronous class, instructors have the opportunity to motivate learners' commitment to learning outside class time and to evaluate their growth (Estes, Ingram, & Liu, 2014). During this process, less self-directed students requiring immediate feedback and reinforcement can receive extrinsic and intrinsic motivation for engaging in asynchronous out-of-classroom learning tasks.

Instructor support in flipped learning

In each structural element of flipped learning, the support of the instructor is slightly different. In pre-class learning activities, the instructor will help learners to do self-directed learning through on-line learning materials. In this case, instructor and learner are not able to face-to-face interaction, so instructors mainly provide direct teaching through online lectures, and online support to help learners' understanding learning contents. In classroom session, main roles of instructor are that supporting and facilitating learner-centered activities (Kim, 2017). However, they can check the understanding of the pre-class learning contents or give mini-

lecture to wrap-up the whole class through directly teaching activities (Lim, 2016).

Peer support in flipped learning

In the flipped learning, in-class activities are the primary step of peer support. In-class activities consist mainly of a variety of learner involvement activities based on collaborative learning with peers. Common teaching and learning strategies of this stage include team-based problem solving, peer tutoring, reciprocal teaching, and team projects (Lee, Kim, & Lim, 2018). Therefore, the peer support in in-class activities is a very important element of flipped learning (Herreid & Schiller, 2013).

Method

Participants

Participants were 69 pre-service teachers enrolled in the “Introduction to Educational Technology” course at a private university in Korea. The mean age of the sample was 20.56 years ($SD = 2.3$). Majority of the participants were freshmen and sophomores, 52% male and 48% female.

Research design and procedures

The experiment was conducted for one semester. In the first week of the 2017 fall semester, the instructor introduced students to flipped learning: what flipped learning is, how it was to be applied in the class, and what the students needed to do for class every week. In particular, the instructor emphasized the importance of pre-class self-directed learning with online video learning materials. The instructor uploaded approximately twenty-minute weekly online content on the web for pre-

class online learning, and students were supposed to study it before class. However, no special penalty was given for not taking the preparation.

After providing the information on flipped learning, students were asked to fill out and submit SDLR scales. Based on the median scores of these scales, the students were assigned to either the higher SDLR group or the lower SDLR group. The students were not informed which group they were assigned to.

From the second week of the class, students were supposed to prepare next class

Table 1. Pre-, In-, Post-class A activities

Week & Topic	Pre-class activities	In-class activities	Post-class activities
2. Theories of learning	Listening to lectures on learning theories	Problem solving based on learning theories	Reflection note on the topic
3. Structures and procedure of instruction	Listening to lectures on structures and procedure of instruction	Applying keys concepts of learning outcomes and 9 events	Reflection note on the topic
4-6. Instructional Design	Listening to lectures on instructional design	Conducting their own instructional design	Reflection note on the topic
8. Various instructional theories	Listening to lectures on various instructional theories	Experiencing actual Anchored instruction with Jasper series	Reflection note on the topic
9. Various instructional models	Listening to lectures on various instructional models	Jigsaw activities and reciprocal teaching to learn various instructional models	Reflection note on the topic
10. Instructional media	Listening to lectures on instructional media	Exploring various instructional media including VR & AR to find proper instructional media	Reflection note on the topic
11. Multimedia	Listening to lectures on cognitive load theories	Finding cognitive load theory is misapplied in instructional materials	Reflection note on the topic
12. Micro-teaching	Listening to lectures on micro-teaching	Writing their own lesson plan & doing micro-teaching	Reflection note on the topic
13. Class observation & consultation	Listening to lectures on class observation & consultation	Observing other's micro-teaching and doing consultation	Reflection note on the topic

by using pre-class online video lecture materials. The preparation was a mandatory class activity and students' learning status remained a record on the learning management system. Almost all learning activities designed for in-class learning were student-centered, collaborative learning activities such as jigsaw, reciprocal teaching, group discussions, or team game tournaments. Most activities were intended to help knowledge construction and improve students' in-depth knowledge application skills. Without completing the pre-class online learning, students would not find it easy to participate in the collaborative learning activities. Every week, after completing the in-class learning, students returned home and were asked to reflect on everything they had learned that day and submit their reflection notes to the instructor. This was a post-class learning activity. The instructor reviewed the students' reflection notes every week and gave overall feedback to the students during the next class meeting (see Table1).

At the end of the semester, the students took a paper-based final exam and filled out an exit survey on their opinions about flipped learning experience.

Measures

Self-directed learning readiness

SDLR was measured with a self-report questionnaire (Self-Directed Learning Readiness Scale: SDLRS) with five-point Likert-type items developed by Dr. Lucy M. Guglielmino and was designed to measure the multifaceted attitudes, skills, and characteristics that comprise an individual's current level of readiness to manage his or her own learning. To assess learners' SDLR, the SDLRS-A (for the general adult population) comprising 58 items was used. The reliability of the SDLRS-A for this study (Cronbach's alpha) was .78. The SDLR scale ranged from 58 to 290, and participants were divided into two groups based on the median of the scores of participants (The median was 196).

Academic performance

Each individual's academic achievement was measured according to two metrics: (a) the pre-class online learning completion rate and (b) the final exam score. Pre-class online learning completion rate was automatically recorded in learning management system. The exam items comprised several open-ended questions and two essay-type questions. The questions required in-depth understanding or application knowledge of course topics. Students' final exams were scored by two raters (the researcher and the research assistant) on the basis of a scoring rubric. Inter-rater reliability (Cohen's kappa) was measured and all disagreements were discussed until 100 percent agreement was reached.

Perceived usefulness for each element of flipped learning

The survey on the perceived usefulness for each element of flipped learning was designed by the researcher and was based on the structural elements of flipped learning and its supporting systems. The structural elements of flipped learning in this study included pre-class online learning, in-class activities, and post-class reflection. And supporting systems included instructor's support and peer supports. Thus, students were asked about each learning element's usefulness. The perceived usefulness survey comprised 15 items on a five-point Likert-type scale. In order to obtain the content validity of the developed survey, I was consulted by three educational technologists who've had enough experience of running flipped classroom currently. The response reliability of the survey was .78. Furthermore, five open-ended questions collected information on how students felt about each element of flipped learning. For example, what were the good points during the pre-class (in-class, post-class) learning activities and what were the bad points? What were the good and bad aspects of the instructor's support (peer's support) during the flipped learning?

Data analyses

Since the study employed an independent, two-group comparison design, it was necessary to investigate the equivalence between the two groups (high SDLR and low SDLR). Independent-sample t-tests setting the alpha level at .05 were conducted to compare two dependent variables (performance and perceived usefulness).

Qualitative data from the open-ended questions in the perceived usefulness survey were analyzed separately. Coding categories were constructed based on the themes that emerged from the students' answers. Two raters reviewed the coding of the open-ended questions by blind review; students' names and classes were removed from the documents to reduce raters' subjective judgments of the different groups.

Results

Descriptive statistics

The descriptive statistics for dependent variables are presented in Table 2. As shown in Table 2, the high SDLR group had a higher completion rate ($M = 76.56$, $SD = 20.28$) than that the low SDLR group ($M = 64.10$, $SD = 22.44$). On the final exam, the scores of the high SDLR ($M = 95.40$, $SD = 5.10$) and low SDLR ($M = 93.15$, $SD = 8.26$) groups were almost identical. On the perceived usefulness survey, the high SDLR group gave its highest scores to "In-class learning activities" ($M = 4.86$, $SD = .43$). In contrast, the low SDLR group ranked "instructor support" the most highly ($M = 4.64$, $SD = .42$). Interestingly, in the category "peer support," the high SDLR group ($M = 4.17$, $SD = .95$) gave lower scores in the category "peer support" than the low SDLR group ($M = 4.33$, $SD = .84$).

Table 2. Descriptive statistics for each measure

		Low SDLR group (n = 34)	High SDLR group (n = 35)
Independent variable			
Self-directed learning readiness ^a	M(SD)	186.41(6.49)	210.00(12.66)
Dependent Variables			
Academic Performance			
• Pre-class learning completion rate ^{b*}	M(SD)	64.10(22.44)	76.56(20.28)
• Final exam score ^c	M(SD)	93.15(8.26)	95.40(5.10)
Perceived Usefulness ^d			
• Pre-class online learning	M(SD)	4.53(.66)	4.33(.84)
• In-class learning activities	M(SD)	4.38(.77)	4.86(.43)
• Post-class reflection	M(SD)	4.52(.63)	4.69(.47)
• Instructor support	M(SD)	4.68(.42)	4.72(.45)
• Peer support	M(SD)	4.33(.84)	4.17(.95)

^a possible range for SDLR score (58–290)

^b possible range for pre-class online learning completion rate (0–100)

^c possible range for final exam score (0–100)

^d possible range for perceived usefulness (1–5)

* Statistically significant

Academic performance

Since none of the students reported having any learning experience with educational technology topics before registering for the course, we assumed that the two groups' prior level of academic achievement did not differ significantly. Academic achievement of each individual was measured according to two aspects: (a) pre-class online learning completion rate, and (b) the final exam score. An independent-sample t-test setting the alpha level at 0.05 was conducted to compare the achievement scores of the two groups.

An analysis of the pre-class online learning completion rates showed a statistically significant difference between the groups ($t[67] = .02, p < 0.05$).

However, an analysis of the final exam scores indicated no statistical significance in academic achievement ($t[67] = .18, p > 0.05$).

Perceived usefulness for each element of flipped learning

An independent-sample t-test with the alpha level set at .05 was conducted to compare the two groups' scores for perceived usefulness for each element of flipped learning. No significant difference was observed between the groups, except for the perceived usefulness of in-class learning activity; the high SDLR group showed significantly higher scores for the perceived usefulness of in-class learning activities ($t[67] = 3.15, p < .05$).

The results of the qualitative analyses indicated that many students found pre-class online learning helpful for enhancing their understanding of class material (e.g., "It was good to learn the class topic before coming to class. So, it was a good way of preparing for the class") and that taking online lessons in advance was a good way of cultivating their self-directed learning skills (e.g., "As I have planned every week's online learning schedule and abided by the rules, I feel I have become a self-directed learner"). In addition, some students cited the benefits of online learning as being positive aspects of pre-class online learning (e.g., "Repeated studying was possible"). In contrast, some students found pre-class online learning to be boring, time-consuming, and difficult to complete due to their laziness or lack of discipline. Many students found the length of the pre-class online content too long (it was about an hour). Since the two groups did not differ notably in their responses, chi-square analyses revealed no significant differences in the frequencies represented by these categories ($\chi^2 = .57, df = 6, p > .05$).

The students also shared their opinions on in-class activities. Qualitative analysis found that many students reported that in-class activities were very helpful for improving their understanding of the class material (e.g., "I like most class activities because they let me understand not only the surface knowledge of the class topic

but also how the knowledge is applied”). The two groups shared this common view. In contrast, the two groups showed somewhat different opinions regarding the relation between pre-class online learning and in-class activities. In particular, the low SDLR group expressed more regret at not completing their online learning. They also said that they sometimes could not understand class materials and activities easily owing to the lack of preparation. Despite this interesting difference, chi-square analyses revealed no significant differences among the frequencies represented by these categories ($\chi^2=.52$, $df = 6$, $p > .05$).

Many students reported post-class reflection to be helpful for reviewing class material and reflecting on what they had learned in class. However, some students mentioned that post-class reflection was a tedious task. Chi-square analyses revealed no significant differences among the frequencies represented by these categories ($\chi^2=.87$, $df = 3$, $p > .05$).

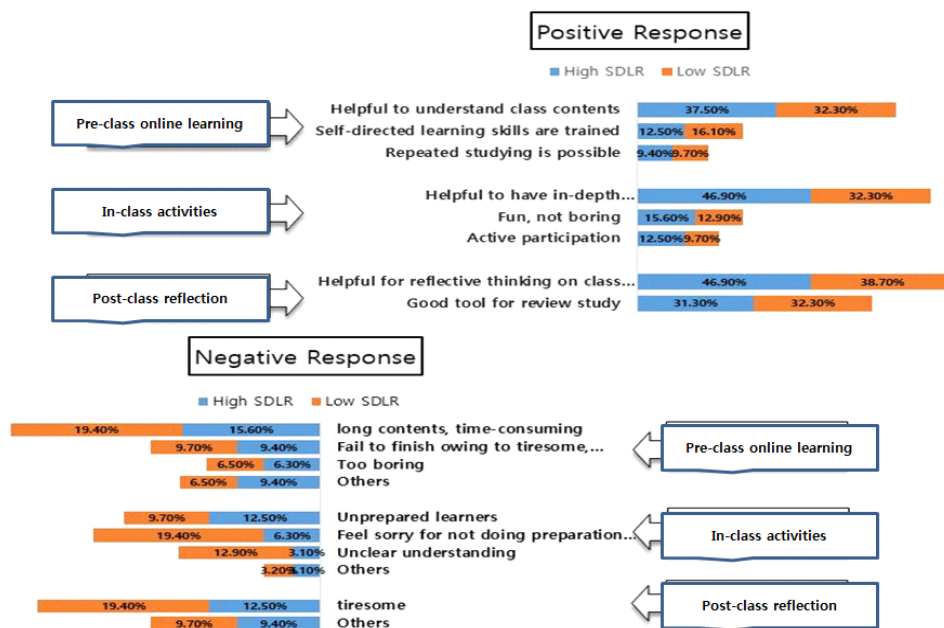


Figure 1. Percentages of categorical responses for each flipped learning stage by groups

Qualitative analyses of students' responses on support systems during flipped learning showed that many students thought instructor support was beneficial in elaborating their understanding of class material and in learning how to study independently (e.g., "the professor helped us by giving easy explanations and examples of class topics when we were struggling with class activities," "There is a lot of uncertainty when I study online content, so I asked the instructor," and "As I did not know how to study for online learning and how to prepare for the next day's class, I was confused. At that time, my instructor gave me clear instructions"). However, they also mentioned that they would prefer further instructor support ("If there were more instructor lecturing during in-class sessions, it would be better," and "I really enjoyed the instructor's direct comments and advice on our work, but it was not enough because of the large size of the class and multiple groups"). Since no notable differences were observed in the two groups' responses, chi-square analyses revealed no significant differences among the frequencies represented by these categories ($\chi^2=.98$, $df = 4$, $p > .05$).

In contrast to their responses on instructor support, the two groups' views on peer support were more negative. As Figure 2 shows, students preferred peer support since it gave them opportunities to see other perspectives, which produced enjoyment and participation. However, they disapproved of some students not being prepared for class activities and being passive (e.g., "I hated that some group members did not study the pre-class online learning content, because they did not actively participate in class activities. It ruined our team work"). Since notable differences were not observed in the two groups' responses, chi-square analyses revealed no significant differences among the frequencies represented by these categories ($\chi^2=.99$, $df = 6$, $p > .05$).

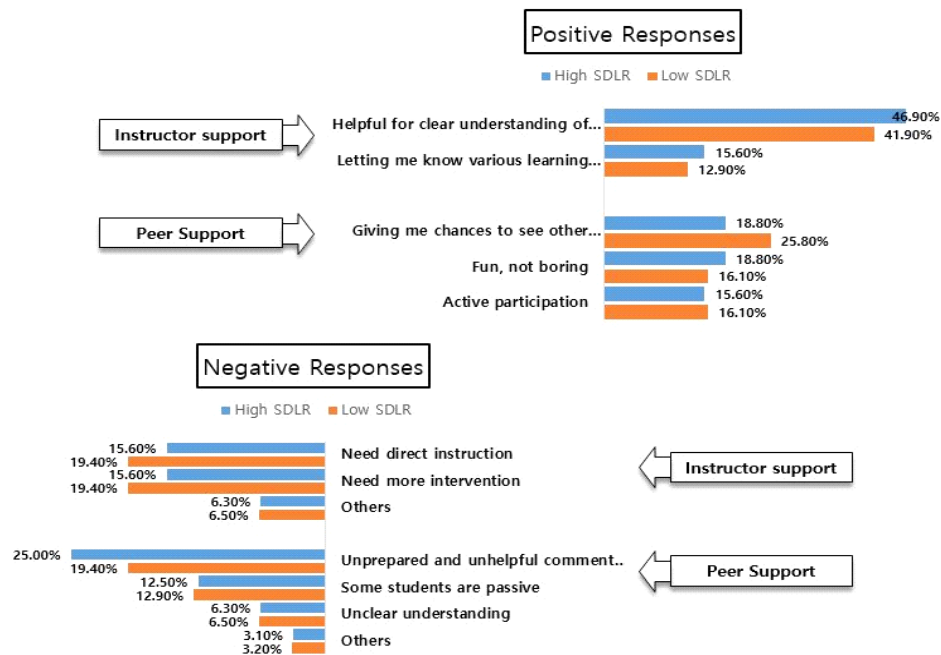


Figure 2. Percentages of categorical responses according to each support for flipped learning by group

Discussion

Effects of SDLR on academic performance

In this study, academic achievement was measured by the pre-class online learning completion rate and the final exam score. The students in the high SDLR group showed significantly higher scores for the pre-class online learning completion rate as compared with those in the low SDLR group. Pre-class online learning requires students to be independent learners capable of selecting, managing, and evaluating their own learning processes, which can be performed at the time and place of their choice, using their chosen strategies. This concept is closely related to the eight factors of learning that consists of eight factors, including love

of learning, an effective self-independent learner, tolerance of risk in learning, creativity, view of learning as a beneficial process, initiative in learning, self-understanding, and responsibility for one's own learning (Guglielmino, 1989; Wang, 1989). This could be the reason for the completion rate of pre-class online learning in the high SDLR group being significantly higher than that of the low SDLR group.

However, students in the high SDLR group did not show significantly higher scores in the final exam than those in the low SDLR group. The result contrasts with previous studies that reported the promise of flipped learning as a facilitating instructional and technological method for enhancing learning outcomes (Deslauriers, Schelew, & Wieman, 2011; Marlowe, 2012). One possible explanation for this is the exam score's ceiling effect. As Table 2 showed, the exam scores of the two groups were both very high and similar. Unlike the statistical results, a majority of the students' qualitative responses about the flipped learning experience indicated that it was helpful for enhancing their learning.

Effects of SDLR on perceived usefulness for each element of flipped learning

Perceived usefulness was measured by the survey asking the aspects of structural components of flipped learning and its supporting systems. The structural components of flipped learning in this study were pre-class online learning, in-class learning, and post-class reflection and its supporting systems were instructor support and peer support. The results indicated a significant difference between the two groups (high SDLR and low SDLR) only in the perceived usefulness of in-class learning activities. In particular, the high SDLR group perceived in-class learning activities as more useful than low SDLR group did. An explanation for these results can be interpreted from the students' qualitative responses. Many students in the high SDLR group said that in-class activities were very helpful for enhancing their

understanding and expanding their knowledge in pre-class online learning sessions and they liked the relation between pre-class online learning and in-class activity. This is consistent with previous studies reporting that exploring online materials in a self-directed manner activates previously acquired related knowledge and facilitates its application to in class activities (EDUCAUSE Learning Initiative, 2012); furthermore, increasing the number of self-directed assignments significantly influences the efficiency and quality of the learning process (Sparks, 2011; EDUCAUSE Learning Initiative, 2012; Kronholz, 2012; Demski, 2013; Johnson, Becker, Estrada, & Freeman, 2014). As Table 2 shows, the high SDLR group showed significantly higher completion rates for pre-class online learning, and therefore a strong relation between pre-class online learning and in-class activities may be important in determining its perceived usefulness.

Though not statistically significant, some notable issues were found from students' open responses. Overall, students' displayed positive perceptions of the usefulness of flipped learning. However, the three stages of flipped learning (pre-class, in-class, and post-class) raised issues that deserve consideration. First, students thought pre-class online learning was a good self-study method for preparing for in-class activities, but it was not easy for all students to study independently. Thus, it is necessary to provide some training on SDLR to those who need it. These findings are consistent with those of previous studies, which found that unless students were given assistance or guidance on how to utilize and study the learning materials, they will find pre-class activities challenging and be unsure of their success in flipped class activities (Dahlstrom, Walker, & Dziuban, 2013).

Second, students liked in-class activities because they were fun and required active participation. However, students disliked unprepared peers because they hindered team activities. To ensure students are prepared, helpful instructional strategies must be developed. Previous research on instructional design for in-class flipped learning reported that the use of examples and strategic skills enabled better

knowledge application and participation by students (Clark & Mayer, 2011). Therefore, setting mandatory rules for preparation or attempting a pre-class quiz to check the students' degree of preparation can be considered examples of such instructional strategies.

Finally, students in this study recognized the benefits of the after-class reflection activity, but they still considered it tedious. In the study, this reflection activity involved writing a reflection note, which could be regarded as a boring task. Adapting various methods of reflection could be beneficial in making this reflection a pleasurable rather than tiresome experience for students. In addition, learners' post-reflection activities give instructors time to devise and adopt technological methods to enhance the process of flipped learning and instructional outcomes (Talbert, 2014).

The students' responses also highlighted a couple of important issues about the support system in flipped learning. While many students thought instructor support was helpful for developing their understanding of class material and knowing how to study independently, they needed more instructor support. This idea is similar to previous findings that state that success in flipped learning depends on the mutual relationship between instructors and learners in terms of managing and maintaining their motivation for pre-, in-, and post-class activities (Estes, Ingram, & Liu, 2014). Some students even require instructor-led lectures rather than student-led activities. One possible explanation for this observation can be inferred from the students' opinions on peer support. Some students expressed negative opinions about unprepared or passive peers whose work was likely to be ineffective and whose understanding was likely to be insufficient. Therefore, such students might need more instructor intervention. To overcome these shortcomings, some instructional strategies to support peer preparation are needed. Among the many possible factors influencing peer preparation, one of the most important is SDLR. Therefore, training sessions in self-directed learning for pre-class online learning or for student-centered learning for in-class group participation should be designed and

implemented in flipped learning.

Implications, Limitation, and Future studies

The findings of this study have instructional implications for those interested in flipped learning course design. The overall results of this study suggest that students' SDLR is an important factor in supporting flipped learning because it prepares students for student-centered learning or activities, and the greater students' perceived SDLR, the more useful in-class student-centered activities can be. These findings are notable because many current studies have considered the effects of flipped learning on students' learning processes and learning outcomes but have not focused on student-based factors that can influence the success of flipped learning, an aspect that this study takes into consideration. The findings suggest that the consideration of student factors such as SDLR while designing flipped learning may augment the benefits of flipped learning.

The levels in the SDLR were intentionally divided into two groups, but there was no significant difference between the groups. This is because participants in this study are relatively homogeneous groups. This is one of the limitations of this study. Subsequent studies are needed to reconfirm the statistical significance of populations with sufficiently different levels of SDLR. In addition, the results of this study suggest a few directions for future research. Exploring more varied student factors that may influence flipped learning, as well as existing research on those factors, is recommended. Although this study presented the effects of SDLR on academic achievement and perceived usefulness, it did not investigate in-depth the various student factors influencing flipped learning. Moreover, a replication of this study using different data collecting methods is recommended. In this study, the researcher mainly used quantitative data collection methods for each dependent variable. Although some qualitative data was collected via open-ended questions, it was insufficient to capture students' full perceptions of flipped learning and their

own learning. Therefore, collecting and analyzing in-depth qualitative data is recommended to reconfirm the findings of this study and to understand students' perceptions more accurately.

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