LEARNING ANALYTICS DASHBOARD (LAD) TO SUPPORT SELF-REGULATED LEARNING IN FLIPPED CLASSROOM

by

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(Under the Direction of Janette R. Hill)

ABSTRACT

The flipped classroom model has gained prominence as advances in technology afford increasing opportunities for ubiquitous access to a variety of online resources. Despite the benefit of the flipped classroom model, flipped classrooms are not equally advantageous to all students due to its self-regulated nature. This study explored the use of a Learning Analytics Dashboard (LAD) as a means of supporting students' self-monitoring and reflection in the flipped classroom. The LAD was grounded in the literature of self-regulated learning. Students' self-regulated learning, behavioral, emotional, and cognitive engagement, and learning performance were examined through two studies. The results indicated that the LAD group experienced a higher self-regulated learning, behavioral engagement in pre-class sessions, cognitive engagement in in-class sessions, emotional engagement in both pre- and in- class session, learning performance than the non-LAD group. Interviews suggested that the LAD helped students to manage their learning progress. Implications for future research and directions for design and implementation of the LAD are described.

INDEX WORDS: Learning analytics, Learning Analytics Dashboard (LAD), Self-regulated learning, Flipped classroom

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DEDICATION

First and foremost, I thank the Lord my God for all your blessings, for challenging me, and for the strength you give me. I am assured that you are always being with me. You strengthen me, you help me, and you uphold me. God, I love you with all my heart.

This dissertation is dedicated to my father and mother who took care of me and my family throughout this journey. Words cannot express my gratitude and appreciation to you. This dissertation also is dedicated to my husband, Dongho, who encouraged me to pursue my dreams. He is a reviewer, academic friend, and writing buddy, at the same time, best friend, companion, and soulmate. I cannot imagine accomplishing this journey and my life without you. I also dedicate this dissertation to my little boys, Sejun and Sehan, the most precious gifts in my life. Thank you for being you.

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CHAPTER 1

INTRODUCTION

The flipped classroom model has gained prominence as advances in technology have begun affording increasing opportunities for ubiquitous access to a variety of online resources. The students in flipped classrooms are allowed to have flexible access to course materials and proceed at their own learning paces (Huang & Hong, 2016). Unlike traditional face-to-face classrooms in which the students learn from in-class lectures, the flipped classroom allows the students to watch the lectures at home as homework and come to class for student-centered activities (Chen, Wang, Kinshuk, & Chen, 2014). Research has recognized the potential advantages of flipped classrooms as a means by which to improve not only student performances, but also engagement and attitudes toward course topics (Huang & Hong, 2016).

Although prior research has reported that the flipped classroom model is beneficial for student learning in higher education settings (e.g., Ferreri & O'Connor, 2013; Mason, Shuman, & Cook, 2013; Wilson, 2014), evidence exists to show that flipped classrooms are not equally advantageous to all students (Kim, Kim, Khera, & Getman, 2014). Many students report low engagement and satisfaction due to the self-regulated nature of flipped classrooms (Wanner & Palmer, 2015). Students are required to come to class prepared through pre-class sessions and demonstrate what they learned for the in-class sessions (McLaughlin et al., 2014). Students, however, struggle to make a smooth transition from the online to face-to-face mode while progressing toward knowledge construction (Wanner & Palmer, 2015).

Self-regulated learning in the flipped classroom is critical as the students have personal responsibilities for the pre-class sessions (Roach, 2014). The students can fully engage in the main in-class sessions provided for knowledge construction when they are adequately prepared through the pre-class sessions (Roach, 2014). Appropriate support for self-regulated learning should be provided to elicit student commitment and independent regulatory processes in the flipped classroom (Kim et al., 2014).

Self-regulated learning can be facilitated by intentional support (Nückles, Hübner, & Renkl, 2009). Empirical evidence has revealed that structured guidance leads to enhanced self-regulation processes, which, in turn, result in intended learning outcomes (Azevedo & Cromley, 2004; Dignath, Buettner, & Langfeldt, 2008; Kostons, Van Gog, & Paas, 2012; Nückles et al., 2009). Kostons and colleagues (2012) indicated that training students in self-assessment and task-selection skills contributed to their self-regulated learning and performance. Similarly, Nückles et al. (2009) reported the effect of predetermined writing protocols on student self-regulated learning as well as understanding of the subject matter.

Self-monitoring has been recognized as a way by which to support self-regulated learning (Azevedo, Guthrie, & Seibert, 2004; Kauffman, 2004). Through self-monitoring, students can keep track of their learning progress (Cleary & Zimmerman, 2004) and exhibit desirable learning behaviors, such as completing assignments, improving academic performance, and reducing disruptive behaviors (May, George, & Prévôt, 2011). Self-monitoring also enables students to purposefully incorporate information in order to master learning tasks and environments (Hadwin, Nesbit, Jamieson-Noel, Code, & Winne, 2007). Purposeful actions help students gain awareness of the qualities of their learning product (e.g., knowledge) as well as learning processes (e.g., beliefs, motivations, cognitive processing) (Butler & Winne, 1995).

In the online portion of the flipped classrooms, during which students are required to complete learning tasks in an independent manner, internal sources of information obtained from self-monitoring is crucial (Kauffman, Zhao, & Yang, 2011). These internal sources of information, which come from the learners themselves (cf. external source of information from others, for more details, see Butler & Winne (1995)), have a stronger impact in online learning model than in the face-to-face learning mode as the students are not under the instructors' control during the online learning (Kauffman et al., 2011). For flipped learning to be successful, therefore, intentional support should be provided in consideration of the connection between the two modes of learning.

The quality of self-monitoring is largely dependent on the quality of reflection (Azevedo, 2005). Students become aware of their states "by inferring them from observations of their own overt behavior and/or circumstances in which this behavior occurs" (Bem, 1972, p. 2). According to Verbert, Duval, Klerkx, Govaerts, and Santos (2013), learning-related self-knowledge is gained through quantified learning history. Traces of student learning captured in quantitative data, for example, contribute to student self-awareness (Verbert et al., 2013). The observation of the "quantified self" is then followed by reflection and sense-making (Duval & Verbert, 2012).

The quantified self process corresponds to a self-control mechanism described by Carver and Scheier (1981). They found that, when students are prompted to observe themselves during learning, their self-focus and positive behavioral intensity for self-control increase. Providing students with information about their own learning appears to lead to a shift from observation to self-regulatory behaviors. How best to provide that information so that it is most useful and helpful to the learner is an area in need of further exploration.

The current study highlights the potential of a Learning Analytics Dashboard (LAD) as a means by which to support students' self-monitoring and reflection. LADs are defined as emerging tools that visualize and display information derived from traces reflecting student learning processes (Verbert et al., 2014). Stimulated self-monitoring and reflection contribute to enhanced self-awareness, which, in turn, leads to the effective use of self-regulatory strategies.

Conceptual Framework

The current study suggests a LAD as a self-regulated learning support tool that can be used in flipped classrooms. This section is organized around the main concepts relating to the design of the LAD: self-monitoring, self-awareness, and self-reflection.

Self-monitoring is a critical part of self-regulated learning and helps to generate feedback pertaining to learning goal attainment (Ley & Young, 2001). Through monitoring, students can identify discrepancies between their current states and learning goals. Thiede, Anderson, and Therriault (2003) stressed the importance of monitoring as a metacognitive activity that can help students obtain accurate information about their learning. However, students often have inaccurate information about their learning, which adversely impacts their use of self-regulatory strategies (Bruin, Kok, Lobbestael, & Grip, 2016).

Failure in self-regulated learning has often been ascribed to inaccurate monitoring. Inaccurate monitoring leads to overconfidence or maladaptation. Students who are given inadequate monitoring opportunities are likely to fail in subsequent stages of self-regulated learning (Bruin et al., 2016). Self-monitoring behaviors can be facilitated by various types of support, such as note-taking tools or reflective questions in flipped learning settings. Prior research has examined the impact of monitoring tools on student self-regulated learning.

Self-awareness is gained through self-monitoring and leads to a readiness for personal changes in the use of learning strategies (Zimmerman, 2002); therefore, self-monitoring is regarded as a prerequisite for self-awareness. While self-monitoring is a systematic activity by which to keep track of information regarding one's own behaviors and outcomes, self-awareness is related to knowledge about "one's own state of understanding and progress" (Rodriguez Triana et al., 2017, p.5). The lack of awareness of one's learning may be more apparent in flipped learning contexts in which students cannot easily monitor their online activities; therefore, it is important to provide students with opportunities to monitor their learning engagement in addition to an indicator of understanding of the pre-class session.

Reflection allows students to make shifts from non-judgmental observation to actions in specific learning contexts (Carver & Scheier, 1981). Through reflection, students decide how to use learning strategies in future learning events. The quality of reflection is largely influenced by the extent to which students are aware of their current performance. Griffith, Steelman, Wildman, LeNoble, and Zhou (2017) explained reflection as a sense-making process by which students "infer meaning from an event and use that derived meaning to decide on a future course of action" (p. 154). In advance of optimizing learning strategies, reflection is a critical step at which students develop conceptualizations for their future behaviors.

Figure 1 delineates how the LAD works to guide students through the three, main, self-regulated learning steps: monitoring, awareness, and reflection. Once the students begin learning in flipped classrooms, data left after learning activities are extracted and visualized for the LAD to display. The students are prompted to monitor their performances that represent both their learning progresses and outcomes. Through observation, the students are expected to develop self-awareness of their own learning. Student reflection is stimulated as they complete questions

about their plans for subsequent pre- and in-class sessions. After one cycle of this process, the students can adapt their learning strategies.

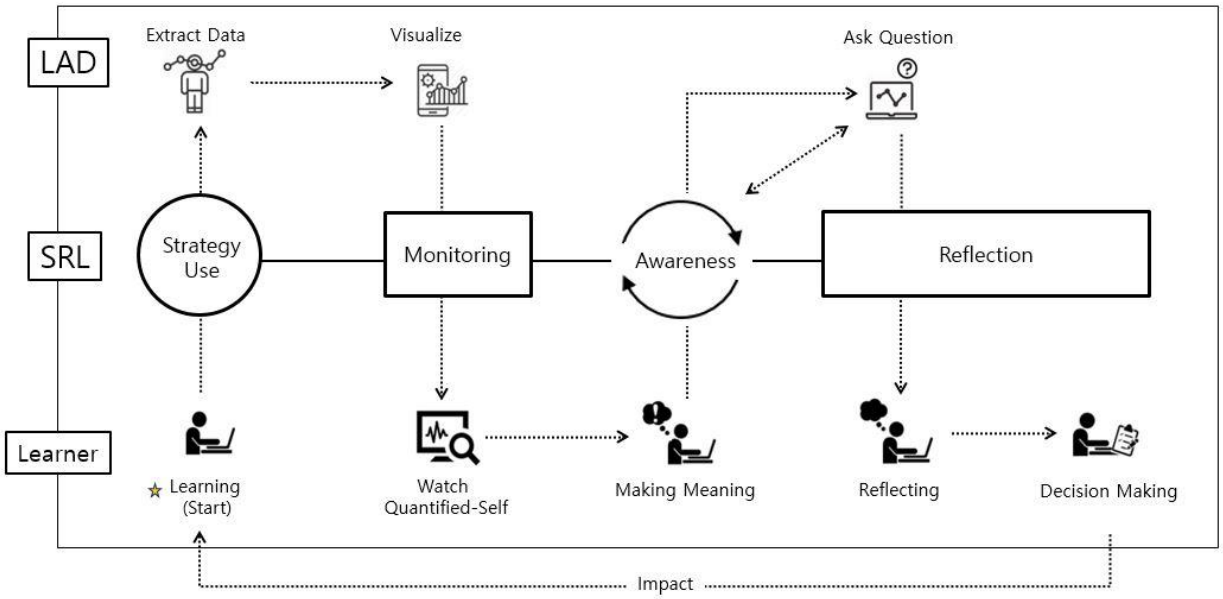

Figure 1. Conceptual framework for the LAD.

Practical Framework

The LAD was developed to address problems that have emerged from students' low engagement in pre-class sessions in flipped classrooms. The goal of the implementation of the LAD was to allow the students to monitor progresses and performances as represented by data collected from an online learning management system. The functionality of the LAD was not restricted to merely showing the students numbers and graphs; rather, it was designed to support the students' sense-making out of their performances through their reflections, which were to lead to self-awareness.

There were two primary advantages from the use of the LAD. First, the LAD enabled students to acquire better knowledge about their selves, an unbiased understanding of their current learning progress. The LAD shows visualized information about student learning

progress using log data students left in the learning management system Combined with a performance score measured by multiple quizzes, the information displayed on the LAD provided the students with a holistic view of their performance in the flipped learning context. Second, the students' reflections were stimulated by pre-determined prompts. Given the continuity between the two modes of learning (i.e., pre- and in-class sessions) in the flipped classroom setting, the guided reflection helped the students "deliberately and consciously process information about their current state from multiple sources" and, in turn, adapt their learning strategies (Griffith et al., 2017, p. 151).

Significance of the Study

This study is significant for the following reasons. First, this study showed how self-regulated learning can purposefully be guided using a LAD in a flipped learning setting. Despite the potential benefits of flipped classrooms, students gain little coming unprepared to class. To help students maximize the benefits of flipped classrooms, intentional guidance should be provided. This study presented key principles for the design and development of the LAD as the guidance in Chapter 2, based upon theoretical and empirical evidence provided in relevant literature.

Second, this study tested the self-regulated learning framework from a learning analytics perspective. Although suggestions for effective flipped classrooms have been provided in prior studies, a dearth of research exists that investigates the potential of student traces recorded in online learning systems. Therefore, the lack of evidence showing the pedagogical advantages of learning analytics presented a need for a new approach related to improving flipped classrooms through the use of multimodal data. The learning analytics approach used in this study provided direction for future research.

Last this study reported findings from the implementation of the LAD in a real flipped classroom setting. The findings not only validated the LAD developed for this study, but also provided generalizable knowledge that should lead to the successful implementation of LADs in similar contexts that involves independent online learning. From the point-of-view of design-based research, this study will create new opportunities for researchers and practitioners to continue to improve the proposed design principles.

Research Questions

The purpose of this study was to design and develop a LAD to be used to support students' self-regulated learning in flipped classrooms and examine its impact on student learning processes and outcomes. In order to determine the effect of the LAD, two experimental studies were conducted in a technology integration course offered for pre-service teachers. The following research questions were addressed in the two experimental studies.

1. What is the effect of the LAD on student self-regulated learning?
2. What is the effect of the LAD on student engagement (i.e., behavioral, cognitive, emotional)?
3. What is the effect of the LAD on student learning performance?
4. What are the student experiences with and perceptions of the LAD?

Hypotheses

The main hypothesis of the study was that the participants who used the LAD (i.e., the experimental group) would demonstrate higher levels of self-regulated learning skills, engagement, and performance on a series of learning tasks than those participants who did not use the LAD (i.e., the control group). The following hypotheses were tested in this study:

1. The participants in the experimental group will report higher levels of self-regulated learning than the participants in the control group.
2. The participants in the experimental group will demonstrate higher engagement than the participants in the control group.
    a. The participants in the experimental group will demonstrate greater behavioral engagement than the participants in the control group.
    b. The participants in the experimental group will demonstrate greater cognitive engagement than the participants in the control group.
    c. The participants in the experimental group will demonstrate greater emotional engagement than the participants in the control group.
3. The participants in the experimental group will demonstrate better performance than the participants in the control group.
    a. The participants in the experimental group will demonstrate higher quiz scores than the participants in the control group.
    b. The participants in the experimental group will demonstrate higher video completion rates than the participants in the control group.

Overview of the Chapters

This dissertation is organized into five chapters. This chapter introduced the background of the study and a conceptual framework organized around three concepts relating to the design of LADs: self-monitoring, self-awareness, and reflection. This chapter also described a practical framework, the significance of the study, the research questions, and the hypotheses. Chapter 2 provides a review of the literature on flipped classrooms, self-regulated learning, and LADs. Drawing upon the literature, three principles and four guidelines will be suggested for designing

a LAD to support student self-regulated learning in flipped classrooms. Chapter 3 presents a development and implementation plan for the LAD in this study. In this chapter, details about the research design are provided, including the procedures, data collection methods, and data analysis methods. This chapter concludes with a subjectivity statement. Chapter 4 reports the results from the two experimental studies in which the developed LAD was implemented in a real setting. Chapter 5 presents a summary of the key findings from the two experimental studies and concludes with implications for future research as well as suggestions by which to refine the design and implementation of the LAD.

CHAPTER 2

REVIEW OF THE LITERATURE

Flipped Classroom

Flipped learning is not a new concept; it is considered a type of blended learning in which students are engaged in two modes of learning: online and face-to-face learning (Davies, Dean, & Ball, 2013; Strayer, 2012) The term ‘flip’ comes from the unique flipped classroom context in which the “information-transmission component of a traditional face-to-face lecture” is completed out of the classroom, while the follow-up learning activities are implemented in the classroom (Abeysekera & Dawson, 2015, p. 2). The main course content that would have been delivered in class in conventional settings is covered by pre-class sessions, such as video lectures, relevant materials, and resources online. The students engage in exercises aimed at enhancing and expanding their knowledge in class. The reversed structure allows the students to have sufficient time to engage in inquiry aimed at elaborating on and applying what they learned in the pre-class sessions during the in-class sessions. The flipped classroom, in essence, is defined as a pedagogical model that moves content learning out of the classroom and the application of knowledge into the classroom (Alvarez, 2012).

Although the applications of flipped classrooms vary depending on the disciplines and instructional settings, they share important characteristics. First, flipped classrooms are composed of two modes of learning activities (Pierce & Fox, 2012). The students view recorded lectures and related online resources at their own paces and engage in in-class sessions that facilitate deep levels of learning. Second, flipped classrooms support student inquiry processes

through in-class sessions and knowledge acquired from pre-class sessions, which serve as prior conditions for the in-class inquiries. The two modes of learning are on the same continuum as the in-class sessions serve as opportunities to refine the knowledge and skills learned from the pre-class sessions. Finally, the in-class sessions support the student-centered learning. In many cases, the in-class sessions encourage teacher-student interactions and student-student collaborations for deep learning (Huang & Hong, 2016). The students' completion of the pre-class sessions makes it possible for the instructors to provide individualized help or advice during the in-class sessions (O'Flaherty & Phillips, 2015). The students have the opportunity to elaborate on what they learned from the pre-class sessions, while engaging in the application of knowledge.

One of the important features of a flipped classroom is the continuity between the pre- and in-class sessions (Kim et al., 2014). Although the pre-class sessions and corresponding in-class sessions take place at different times and in different places, both are dedicated to student knowledge construction as a whole. The students, in flipped classrooms, understand the basic concepts and skills related to the course topics and have opportunities to improve their knowledge through collaborations, reflections, and inquiries (DeLozier & Rhodes, 2016). Therefore, the two modes of learning should be closely linked to help students progress toward a mastery of the topics. Pre-class sessions, such as recorded lectures and relevant materials, must be prepared for subsequent in-class sessions so that the students can clearly see how the concepts and knowledge that they studied center around a particular course topic (Conway, Johnson, & Ripley, 2010).

The continuity differentiates flipped classrooms from other forms of blended learning environments. The definition of blended learning, despite its emphasis on its mix of online, media, and traditional face-to-face learning, includes all forms of learning that do not assume

holistic learning environments. According to Margulieux, McCracken, and Catrambone (2016), the term ‘flipped classroom’ or ‘flipped learning’ can only apply to contexts in which the students receive content from technology and apply the content with the instructor. In these situations, ‘content delivery’ and ‘experience and practice’ should be distinct, but mutually supportive. For example, in blended courses where the students both receive and apply content online, the courses cannot be considered flipped classrooms (i.e., replacement blend; for more details, see Margulieux et al. (2016)).

Flipped classrooms are more than just reversing the homework assignments and lectures. Instead, they are holistic learning environments that provide meaningful learning experiences. They utilize pre-class sessions, including low-level learning regarding content acquisition (Gilboy, Heinerichs, & Pazzaglia, 2015), and in-class sessions, which serve to support the student inquiries and reflections under instructor guidance (Roach, 2014). The students in flipped classrooms are put in holistic learning environments in which the two modes of learning nurture different aspects of learning for their mastery of the course topics (Chen et al., 2014). Therefore, flipped classrooms should be structured to help the students shift from content acquisition to knowledge application.

It is important to note that the pre-class sessions are completed independently by the individual student. Online content learning in the pre-class sessions is analogous to the instructors’ lectures in traditional classrooms (McLaughlin et al., 2014); therefore, in many cases, they do not involve collaborations or interactions with others (Margulieux et al., 2016). The pre-class sessions are focused on helping the students learn about descriptive and procedural knowledge related to the course topics. The application of knowledge should, thus, take place during the in-class sessions.

The flipped classroom model commonly highlights the importance of student-centered and inquiry-based approaches for the in-class sessions (Chen et al., 2014). McLaughlin and colleagues (2014) emphasized that in-class sessions should serve to promote student cognitive development and innovation. The in-class sessions need to provide opportunities "for exploring topics in greater depth and creating richer learning opportunities" (Chen et al., 2014, p. 18). The in-class sessions, in this manner, include a range of student-centered learning activities that support student critical reasoning, inquiry, and problem-solving skills.

Self-Regulated Learning in Flipped Classrooms

Self-regulated learning is defined as a process by which students self-generate their "thoughts, feelings, and behaviors that are oriented to attaining learning goals" (Zimmerman, 2002, p. 65). According to the definition, self-regulated learning can be seen as the transformation of individual learners' desires into specific learning behaviors (Barnard-Brak, Paton, & Lan, 2010). Self-regulated learning is neither innate abilities nor academic skills, but a self-directive process that involves the use of regulatory learning strategies (Boekaerts, 1997; Pintrich, Cross, Kozma, & McKeachie, 1986). Self-regulated learning has taken inclusive approaches to explaining what factors affect learning processes; the inclusive perspective encompasses the various aspects of the regulatory processes used in pursuing academic goals (Pintrich, 2004). The notion that self-regulated learning is a multidimensional operation has led researchers to explore cognitive, motivational, and affective factors that impact students' selection of learning strategies (Azevedo, 2005; Dent & Hoyle, 2015).

Self-regulated learning strategies are context specific and responsive to learning environments (Wolters & Hussain, 2015). Success in learning is largely affected by the extent to which students use learning strategies suited to specific contexts in which learning takes place. The malleable nature of self-regulated strategies has led to continued discussions on how to

support student self-regulated learning in new learning environments. It has been suggested that self-regulated learning support facilitates the use of effective self-regulated learning strategies applicable to emerging learning environments.

The emergence of blended learning environments, such as flipped classrooms, therefore, raises a need for new types of support for self-regulated learning because these learning environments lack social interactions between the students and instructors (Broadbent & Poon, 2015; Poitras & Lajoie, 2014). While the students have autonomy over their pre-class sessions, they also have the responsibility for completing online learning tasks in an independent manner (Broadbent & Poon, 2015; De Smet, Van Keer, & Valcke, 2008). Azevedo and Cromley (2004) stressed that students in hypermedia environments have access to information represented as a wide range of multimedia and are required to make decisions about their own learning; the decisions include "what to learn, how to learn it, how much to learn, how much time to spend on it, how to access other instructional materials" (p. 524). Similarly, Lai and Hwang (2016) highlighted the importance of utilizing online resources and seeking relevant information as important self-regulated skills in flipped classrooms. In this study, an experiment was conducted to determine whether a self-regulated learning support system helped student learn in an elementary flipped mathematics classroom. The results showed that students who had a higher level of self-regulatory skills made greater improvements when using the system. This finding indicates that the effectiveness of flipped learning hinges on students' ability to manage and regulate their learning.

Contemporary self-regulated learning models share general assumptions that individual students are active agents who manage their own learning goals as well as construct meanings

and strategies, which enable adaptations toward learning goals (Boekaerts, 1999; Winne & Hadwin, 1998; Zimmerman, 1998).

Researchers have stated that students have the capability of making choices based on their reflections about their learning performances (Barnard-Brak, Paton, & Lan, 2010). However, most students fail to complete online assignments and come to class unprepared (Lai & Hwang, 2016). Their use of self-regulation strategies influences their preparedness before the in-class sessions (Liu, Lan, & Ho, 2014). During the online portion of flipped classrooms, it is hard for students to receive immediate external feedback from their instructors, but students are still required to be prepared through online tasks prior to the in-class sessions (Rahman et al., 2015). Research has indicated that students with high levels of self-regulated learning skills demonstrate better performance in flipped classrooms than those students with low-levels of self-regulated skills (Lai & Hwang, 2016).

Online Self-Regulated Learning Supports

The online portion of flipped classrooms serves to deliver the main content that should be addressed in subsequent classes (Pierce & Fox, 2012). The students are required to elaborate on what they learned from the online sessions through in-class sessions that entail the application of basic knowledge and skills. Therefore, online learning in flipped classrooms may not only affect student learning, but also learning outcomes.

The students' use of self-regulated learning strategies can be improved through intentional support (Bruin, Kok, Lobbestael, & Grip, 2016). The rapid growth of online learning has given rise to various online self-regulation support. These methods of support are designed to support the students' independent self-observations and subsequent reflections, which, in turn, lead to proper adjustments of self-regulated learning strategies (Azevedo, 2005). Compared to

support in traditional forms of learning, online self-regulated learning support methods are intended to help students with their independent study with little or no physical interaction with the instructors. Dabbagh and Kitsantas (2012) suggested that students are considered active information seekers who are motivated to address problems in online learning environments and support should be provided to help them aggregate and share online resources. In the review of literature on social media and self-regulated learning theories, the authors developed a framework by synthesizing ideas derived from these two theories. The framework was intended to guide instructors on how to prepare students for using social media in personalized online learning environments. The guidelines were sorted by different types of social media at three different levels: personal information management, social interaction and collaboration, and information aggregation and management. The authors emphasized that students' self-regulatory skills can be enhanced by well-planned instruction.

Although the forms of online self-regulated learning support appear to vary, they can be summarized as follows. First, self-regulated learning support leads students to gain awareness of learning progresses and learning outcomes (Zimmerman, 2002). Student awareness has been associated with metacognitive skills, and many self-regulated learning tools have been intended to support students' metacognitive learning activities. For example, Narciss, Proske, and Koerndle (2007) designed and developed an authoring tool intended to promote students' metacognitive strategies in hypermedia environments. The tool guided the participants through self-regulated learning steps that involved the navigation of, elaboration on, monitoring of, and review of feedback. The ninety-one university students who used the tool spent most of their time on texts whereas metacognitive features were rarely used. This observational study revealed that students' monitoring should be deliberately supported with well-designed components. In a

study that investigated the effects of monitoring training on student metacognitive skills, Bruin et al. (2016) had undergraduate students learn how to use monitoring strategies to assess their knowledge. The study revealed that the participants who received the training reduced their overconfidence and maladaptation in terms of using monitoring strategies to enhance their understanding of the given topics.

Second, such tools help students make decisions regarding adjustments to learning situations. Most self-regulated learning tools assist students in identifying what they are lacking in terms of content understanding and performance. Azevedo and Cromley (2004) noted the critical role of self-regulated learning strategies in hypermedia environments and argued that students are required to decide whether they have sufficient understanding of the topics or need to modify their learning plans and strategies. They conducted a study in which two groups of students were randomly assigned to either a self-regulated learning training or control condition. Prior to the experiment, students who participated in a 30-min training (i.e., experimental group) learned how to regulate their own learning of the circulatory system with the hypermedia environment. The authors found that the students who received training on how to learn with hypermedia exhibited better performances in regard to using self-regulated learning skills, including planning, monitoring, and strategy use, than those students who did not received the training.

Third, self-regulated learning support positively affects students' academic motivations and attitudes toward learning. A large body of research has reported a positive relationship between the use of self-regulated learning support and motivational factors related to student learning (e.g., Chen, 2009). Online self-regulated learning support has also led to student enhanced engagement and interest in learning with multimedia (Azevedo & Cromley, 2004).

Despite the ample evidence of its positive impact, contemporary support for self-regulated learning has revealed several limitations. First, existing self-regulated learning support is not apt to allow students to obtain a comprehensive view of their learning paths and patterns. Self-regulated learning has been conceptualized as a process that involves cognitive and metacognitive activities (Poitras & Lajoie, 2014). The activities involve not only learners' judging their own understanding of subject matters, but also their own learning progress. However, most self-regulated learning support does not allow the students to look at the representations of their learning patterns, although reflections and adjustments should be based on their own interpretations of information related to their ongoing performances (Verbert et al., 2013).

Students' self-regulated learning is composed of multiple components in a sequential manner (McCardle, Webster, Haffey, & Hadwin, 2016); however, traditional tools have revealed their weaknesses in terms of presenting students with their performances. Some self-regulated learning tools help students identify what they might be missing in advance so that the students can properly adjust their strategies. However, students are often not able to monitor their behaviors. For example, although students use checklists to anticipate what they will have to accomplish toward their learning goals (e.g., Kramarski & Michalsky, 2009), the lists do not display what specific aspects of their performances should be improved; they are blinded to what learning paths led them to their current status. Similarly, while note-taking tools may enable students to visualize and organize what they are thinking, the students are not allowed to observe how and in what ways they are engaged in their learning tasks.

The limitations of the conventional ways of examining and supporting self-regulated learning in online learning should be addressed. Azevedo (2005) suggested that self-regulated

learning could be supported when we understand how students regulate their learning. This argument presents a need by which to investigate student online behaviors that have not been much examined in the past. Schunk (2008) also stressed the importance of the investigation of student learning behaviors to obtain a complete understanding of self-regulated learning processes. Despite the importance of students' use of specific learning strategies represented as their online behaviors, traditional ways of measuring them (e.g., surveys) have not been effective in terms of revealing the invisible and unconscious behaviors of students.

Second, many of the existing online self-regulated learning tools rely on learner factors (Winters, Greene, & Costich, 2008). Students demonstrate different levels of regulatory strategies and their effects vary depending on their characteristics, prior experience, and understanding of the topics (Bell & Kozlowski, 2008). Moos and Azevedo (2008) indicated that prior domain knowledge largely affected student self-regulated learning processes as the students' prior knowledge was found to be positively related to their monitoring and planning skills. Furthermore, the quality of the self-regulated learning may differ depending on the students' abilities to identify what they are lacking regarding their own learning processes. Self-regulated learning tools that do not show a learning path may be minimally beneficial to students with poor monitoring skills. In fact, many students have overconfidence in terms of their performance, which leads to inaccurate regulatory processes (Bruin et al., 2016). A need exists for allowing students to see the learning process for better reflection and adjustment.

The quality of self-regulated learning is largely determined by the students' abilities and conscientiousness (Bruin et al., 2016). Inaccurate monitoring leads to a "failure to recognize when to actively regulate or experiment with strategies to increase the likelihood of achieving goals" (Hadwin & Webster, 2013, p. 38). Particularly, online learning environments that involve

minimal interventions on the part of the instructors require the students to make extensive efforts to accurately monitor and reflect on their performances. It may be also problematic that the quality of the self-regulated learning may be inconsistent within the individual students depending on the characteristics of the learning tasks, student interests in the particular topics, and other external factors, such as time constraints. In order to ensure that the students consistently engage in self-regulated learning throughout the course of their learning, accurate information about their learning should be provided as a primary source of self-reflection.

Third, self-regulated learning support may come as a cognitive burden to students who have limited time for completing the learning tasks. Existing self-regulated learning tools require the students to accomplish specific tasks (e.g., Azevedo & Cromley, 2004; Bruin et al., 2016). While separate training sessions can instruct students on how to proceed through desirable self-regulated learning steps, students are deprived of time assigned for their learning. Students, in fact, often feel burdened when they are required to complete separate self-regulated learning steps that are not inherently relevant to the learning tasks (Pontari & Schlenker, 2000). When not properly designed, self-regulated learning tools can be perceived as distractions. A need exists for self-regulated learning support that minimizes the unnecessary cognitive load imposed on students in online learning.

Learning Analytics Dashboard

Definition of Learning Analytics Dashboards

A dashboard is defined as "a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance" (Few, 2013, p. 26). The term 'dashboard' originated from a panel placed in the front of the driver of a vehicle. The panel is intended to show the driver information

to help his or her driving (Park & Jo, 2015). For example, if, at a speed limit sign of 65 miles per hour, you notice that you are driving 85 miles an hour, you would slow down your car. If you did not see your speed on the dashboard, you would not take this action. Educational dashboards work in the same way; they inform students of how they are performing in such a way that they can respond appropriately to adapt their learning strategies. Learning dashboards show key performance indicators so that learners can receive alerts with regard to their current performances. These indicators function as a source of information by which to determine discrepancies between performance and predefined targets (i.e., learning goals).

The Learning Analytics Dashboard (LAD) is an emerging tool designed to support learners' self-regulated learning in online learning contexts (Coffrin, Corrin, de Barba, & Kennedy, 2014). LADs apply learning analytics in order to transform learning-related data into meaningful information. Learning analytics is defined as "the measurement, collection, analysis, and reporting of data about learners and their contexts" (Chatti, Dyckhoff, Schroeder, & Thüs, 2012, p.2) and is primarily concerned with discovering meaningful information from a variety of educational data sources. Therefore, the sources of learning analytics are not restricted to conventional educational data, such as student academic records or demographic information, rather they can include any types of data that represent student learning (Ferguson, 2012).

The proliferation of techniques for data analytics makes it possible to aggregate raw data extracted from online learning systems. For example, traces of student online learning activities are widely used as a primary source of learning analytics (e.g., Simens & Long, 2011). LADs use such raw data to reflect important information about student online learning.

Learning Analytics Dashboards for Learners

Various types of LAD have been developed to support online learning. They provide visual representations of students' learning progresses and performances so that students and instructors can make timely decisions to enhance learning performances (Few, 2006). LADs can be categorized into three types based on their target users: dashboards designed to support an instructor only (e.g., Ali, Hatala, Gašević, & Jovanović, 2012; Dollár & Steif, 2012; Podgorelec & Kuhar, 2011), both an instructor and learners (e.g., Govaerts, Verbert, Duval, & Pardo, 2012; Santos, Govaerts, Verbert, & Duval, 2012), or learners only (e.g., Kerly, Ellis, & Bull, 2008; Park & Jo, 2015; Pistilli & Arnold, 2010; Verbert et al., 2013).

Since this study proposed a LAD to support learners in flipped classroom contexts, the literature review focused on existing LADs intended to support learners (see Table 1 for an overview). Dashboards for learners have common features that inform learners about their learning patterns for the purpose of helping them monitor and reflect on their learning as well as modify their learning strategies. For example, Course Signals (Pistilli & Arnold, 2010) was designed to increase university student retention rates and learning performances by alerting students to potential learning problems. Indicators on the dashboard are associated with student academic performances, such as their cumulative GPAs and learning traces recorded in the learning management system. Similarly, a learning analytics dashboard proposed by Park and Jo (2015) displayed visual representations of students' learning patterns as measured by students' log traces, such as login frequency and login interval regularity, recorded in a learning management system. These visual indicators provide students with opportunities to monitor their learning engagement and performance in comparison to their peers.

The application of LADs extends to mobile learning contexts. Tabuenca, Kalz, Drachsler, and Specht (2015) also proposed a mobile learning tracking system where students' time investment in different learning activities was displayed. The system was found to influence the students' awareness of online learning and lead them to enhanced time management practices. The LAD used in Melero, Hernández-Leo, Sun, Santos, and Blat (2015) operated on mobile devices and the students were able to monitor their teams' progress, while solving given problems at different locations. The system helped the students not only know their current performances, but also achieve a better score on a subsequent test.

Data tracked for LADs are not limited to log traces, but can include other types of learning traces, such as physiological data. For example, Chen and Huang (2014) used student brainwave data via Electroencephalography (EEG) to capture students' temporal attention in a web-based reading annotation system. The students in the experimental group attended a 12-hour flipped English classroom while the control group participated in their regular English classroom. The students in the experimental group were able to monitor their attention levels along with information about study time. According to the analytics of the multimodal data including EEG, student survey responses, observations, and interviews, the authors concluded that the experimental group showed significantly better performance and more positive emotions than the control group.

Table 1
Learning Analytics Dashboard for Learners

Dashboards	Goal	Tracked data	Target learner	Visual indicators	Effectiveness (compared to those participants who did not use the dashboard)
Course Signals (Arnold & Pistilli, 2012)	To improve college student retention and academic achievement To alert students to their academic problems	Prior academic history (e.g., high school GPA) LMS usage data (e.g., attendance, interaction with resources) Current test scores Student characteristics (e.g., residency, age, credits attempted)	University students	Traffic light-like signals that indicate different statuses of student learning	Students sought more help Student motivation increased
Attention-based Self-Regulated Learning Mechanism (ASRLM) (Chen & Huang, 2014)	To help students monitor their attention levels and learning progress, while studying annotated English text	Learning time, number of completed learning units measured by log traces Sustained attention level measured by brainwave data (i.e., EEG)	High school students	Radar chart that shows whether students achieved pre-set goals and attention levels	Students exhibited better sustained attention and reading comprehension
QuesTinSitu (Melero et al., 2015)	To support student self-assessment during location-based learning activities with mobile devices	Log traces that indicate time spent to answer questions and reach target areas and scores obtained per area Student location during learning activities	High school students	Pie chart that shows time spent on navigation and answering questions Line chart that shows attempts made to answer each question A map containing the route of each group	Students achieved higher quiz scores Students made better diagnoses of their learning performances

Learning Analytics for Prediction and Action (LAPA) dashboard (Park & Jo, 2015)	To support students' self-regulated learning To increase students' awareness of learning in comparison of their peers	Log traces recorded in a learning management system	University students	Dot plot that shows students' positions relative to different types of online activities Bar graphs combined with trend lines that show students' participation in online activities over time	Students demonstrated higher achievement (Kim et al., 2016)
LearnTracker (Tabuenca et al., 2015)	To support students' self-monitoring using personal mobile devices	Log traces that indicate time spent on learning	University students	Line chart that illustrates number of hours devoted to each learning activity compared to peers	Students demonstrated better time management

Principles and Guidelines for Designing Learning Analytics Dashboards to Support Self-Regulated Learning in Flipped Classrooms

LADs have the ability to reveal student learning progress as captured by data (Kim, Jo, & Park, 2016). The term quantified self explains that LADs serve as a type of personal informatics utilizing traces of learning that students leave through online activities (Verbert et al., 2013). Importantly, LADs serve to provide a comprehensive view of students' learning progress because data used for LADs indicate students' fine-grained behaviors (e.g., learning patterns over time). Using online behavior data is critical for students' self-regulated learning because the self-regulated learning process involves implementing and adapting regulatory strategies in an ongoing manner (Sitzmann & Ely, 2011).

Azevedo (2005) stated that self-regulated students "construct their own meanings, goals, and strategies from the information available, both their own internal environment (i.e., cognitive system) and the external environment (i.e., task conditions, learning context)" (p. 202). This conceptualization highlights a critical role of information sources that assists students in self-monitoring: seeking and utilizing information has been regarded as a core part of online self-regulated learning (Lai & Hwang, 2016). However, the online mode of flipped classrooms is not favorable for students to obtain accurate information; the students are required to independently study the course materials. Many students fail to perform self-regulation during pre-class sessions and come to class unprepared (Kim et al., 2014; Lai & Hwang, 2016). Consequently, they struggle to switch between the two modes of learning in flipped classrooms (Wanner & Palmer, 2015). For flipped learning to be successful, instructional support should be provided in consideration of the connection between the two modes of learning.

The present study proposed principles and guidelines for the design of LADs in flipped classrooms based on the self-regulated learning theory. Theoretical and empirical evidence provided in prior studies directed the creation of these principles. Based on the proposed principles, design guidelines were formulated. The guidelines were intended to provide clear directions for designing LADs that can be used in the flipped classroom. Specifically, this study integrated the proposed principles into the unique characteristics of a flipped classroom.

LADs designed using these guidelines are expected to promote students' self-awareness of their learning progress through self-monitoring. Once the students gain this self-awareness in the pre-class sessions, they are prompted to reflect on their preparation for subsequent in-class sessions (Rodriguez-Triana et al., 2017). The process recursively takes place until the completion of all flipped classroom tasks. In essence, LADs contribute to the transformation of students' observation of their own learning into their use of learning strategies. The LAD developed in this study displayed information about students' learning progress and outcomes, followed by reflection prompts about a main topic in each flipped classroom module. The flow of learning organized around the LAD was expected to lead to the effective use of self-regulated learning strategies. Additional information is presented in the Methods chapter.

Self-regulated learning principle 1: Have the students set simple, but realistic goals for the pre-class sessions

According to Zimmerman (2002), self-regulated learners are characterized by their commitment to setting their own learning goals. Goal setting is a fundamental activity in that subsequent self-regulatory actions occur around established goals. As indicated by existing self-regulated learning models, goal setting influences the use of learning strategies and evaluations of performances. Empirical evidence exists to show that self-set goals lead to higher motivations

and academic achievements than assigned goals (Schunk, 1990). Hadwin and Webster (2013) stressed that self-set goals can facilitate these self-regulated behaviors because they motivate students to use self-oriented metacognitive strategies. Self-set goals make students feel self-efficacious and intrinsically motivated to accomplish learning tasks (Schunk, 1995). More importantly, self-set goals more strongly commit students "to specific grade achievements for positive self-evaluation" than assigned goals (Zimmerman, Bandura, & Martinez-Pons, 1992, p. 673). Learning goals set by learners positively impact their pursuits of higher goals in a recursive manner.

In flipped learning, the students are required to study the content prior to the in-class sessions, with little or no interactions with the instructors. As such, self-regulatory strategies are critical to engaging the students in both the pre- and in-class sessions. The self-regulated nature of the pre-class sessions in flipped classrooms necessitates students' awareness of what should be achieved. Through independent goal setting, the students can engage in self-oriented actions, such as self-monitoring, self-evaluations, and self-regulations, toward their learning goals. When allowed to set their own goals, the students may feel autonomy and be motivated to take control of their learning. Allowing the students to set learning goals leads them to initiate the recursive self-regulated learning process toward attaining their ultimate goals. It is important to make the students begin with simple, but realistic goals so that they can have the opportunity to calibrate their goals as they progress. The students' self-efficacy, fostered by their success in prior performances, will, in turn, affect their later self-set goals (Phillips & Gully, 1997). The following LAD design guideline was suggested to apply Principle 1: have students set a learning goal for a next pre-class session based on their performance in a previous pre-class session.

Self-regulated learning principle 2: Help the students accurately monitor their engagements in the pre-class sessions

Monitoring is a critical part of self-regulated learning and helps generate feedback pertaining to learning goal attainment (Ley & Young, 2001). Through monitoring, students can identify discrepancies between their current states and self-set goals. (Thiede et al., 2003) stressed the importance of monitoring as a metacognitive activity that can help students obtain accurate information about their learning. However, students often have inaccurate information about their learning, which adversely impacts their use of self-regulatory strategies (Bruin, Kok, Lobbestael, & Grip, 2016).

Inaccurate monitoring leads to overconfidence or maladaptation. Students who are given inadequate monitoring opportunities are likely to fail in subsequent stages of self-regulated learning (Bruin et al., 2016). Self-monitoring behaviors can be facilitated by various types of support, such as note-taking tools or reflective questions, in flipped learning settings. Prior research has examined the impact of monitoring tools on student self-regulated learning. For example, Flynn (2015) implemented an online monitoring tool in flipped organic chemistry courses to promote student engagement and success. In the study, the participants were required to monitor their own progress based on periodic questions asked about their understanding of the course content. The findings showed that the students exhibited significantly higher achievements and lower withdrawal and failure rates than students who studied in traditional face-to-face classes.

The importance of monitoring engagement has been addressed in research in the area of learning analytics. Studies on LADs have commonly noted the potential advantages of displaying student information about engagement in order to increase their awareness of learning

activities. For example, Park and Jo (2015), in a flipped learning setting, allowed students to monitor their own learning progresses through a LAD that visualized their online behaviors using their log data. The study revealed that the opportunity to obtain information about their learning progress had a positive impact on the students' academic performances.

Two LAD design guidelines were developed to apply Principle 2: use visualizations that show learning activity completion after each pre-class session and use visualizations to show both student progress and performance.

Self-regulated learning principle 3: Foster student motivation by highlighting task values

Evidence exists to show that students who perceive the value of learning tasks use self-regulatory strategies more often (Zimmerman & Schunk, 2011). Task value affects students' motivations to accomplish tasks. When students perceive tasks to be valuable, they are likely to persist in the face of barriers in regard to attaining their learning goals (Joo, Lim, & Kim, 2013). Metallidou and Vlachou (2010) stated that students' task values are directly associated with their efforts, time investment, and cognitive engagement. Joo and colleagues (2013) revealed that students' perceived task values had significant impacts on their satisfaction, achievement, and persistence. More importantly, perceived task value is known to be an important predictor of students' intentions to participate in particular learning activities (Xiang, McBride, Guan, & Solmon, 2003).

According to the expectancy-value theory (Eccles & Wigfield, 2002), subjective task values are categorized into four major classes: attainment value (i.e., personal importance of doing well on a task), intrinsic value (i.e., genuine interest or enjoyment), utility value (i.e., usefulness for future goals), and cost (i.e., loss of time, loss of effort, or expected stress). In flipped classrooms, students are required to acquire foundational knowledge by studying the

given materials at home without the instructors' explanations as to why the materials are useful (i.e., utility value) and what benefits they can have when they successfully complete the task (i.e., attainment value). No explicit description of the content at the initial stage of flipped learning can lead to the students' low awareness of the task value.

The lack of initial explanation as to why the students should study particular content is partly derived from the fact that the instructors use online resources as content to be studied. In flipped learning, the learning materials include not only lectures recorded by the instructors, but also any resources relevant to the course topics. In many cases, the instructors utilize the resources without explaining their value. Despite the importance of perceiving the task value, few studies have explored strategies for enhancing students' perceptions of the value of these learning tasks. For example, Hulleman, Godes, Hendricks, and Harackiewicz (2010), in an introductory psychology class for university students, attempted to make the students perceive a utility value by asking them to explain how the problem-solving techniques taught in the course were related to their lives. The results indicated that the students who received the intervention showed higher interest and performance than those students who did not receive it.

One LAD design guideline was created regarding Principle 3: have the students ponder ways to transfer what they learned from the pre-class sessions to new contexts.

CHAPTER 3

METHODS

Two empirical studies were conducted in order to examine the impacts of the LAD on student self-regulated learning, engagement, and learning performances. These studies were also used to examine the students' experiences with the LAD. The first study (Study 1) was conducted in order to examine the effects of the LAD on student self-regulated learning, engagement, and learning performances in a flipped classroom. In Study 1 utilized quantitative data, such as survey responses, quiz scores, and video completion rates, for the inferential statistical analyses. While the results from Study 1 revealed the positive impacts of the LAD on the students' self-regulated learning, engagement, and learning performance, the students' experiences with the LAD remained unexplored. As such, the second study (Study 2) was conducted in order to obtain an in-depth understanding of the students' experiences with the LAD through individual interviews. In addition, descriptive statistics obtained from surveys, quiz scores, and log data during Study 2 revealed changes in the students' self-regulated learning, engagement, and learning performances as a result of using the LAD.

Data Collection Methods

In Study 1, the data were collected from the participants' responses to the surveys, quiz scores, and video completion rates. The video completion rates were measured using student log traces recorded in the university's learning management system. In Study 2, the primary focus was on exploring the participants' experiences with and perception of the LAD. Table 2 lists the data collection methods and data analysis strategies for each research question.

Table 2

Data Collection Methods, Reference, and Data Analysis Strategies per Research Question

Research question	Data collection method	Reference	Data analysis strategy	Study
Research Question 1: What is the effect of LAD on student self-regulated learning?	The Student Learning Strategies Questionnaire (SLSQ)	Abrami and Aslan (2007)	ANCOVA	Study 1
Research Question 2: What is the effect of LAD on student engagement (behavioral, emotional, cognitive)?	Student self-reported engagement	Fredricks, Blumenfeld, & Paris (2004) Jang, Reeve, & Deci (2010)	ANCOVA	Study 1
Research Question 3: What is the effect of LAD on student performance?	Student quiz scores Student video completion rates		Repeated measures ANCOVA	Study 1
			Descriptive analysis	Study 2
Research Question 4: What are the student experience with and perception of the LAD?	Interviews guided by pre-determined, open-ended, interview questions		Thematic analysis	Study 2

Measures and Instruments

The Student Learning Strategies Questionnaire (SLSQ) developed by Abrami and Aslan (2007) was used in the this study to measure the degree by which the participants used self-regulated learning strategies, including goal setting, performance observation and modification, and reflection on learning outcomes. The self-report survey asked the students to choose, on a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), the extent by which they were able to use self-regulated learning strategies in a particular class. The SLSQ consists of 20 items containing six subscales: (1) goal setting, (2) strategy planning, (3) self-

observation, (4) self-instruction, (5) feedback from adults, and (6) self-evaluation. An example item for strategy planning was “I identify strategies for achieving my goals.” The questionnaire has reported stable reliabilities as the Cronbach’s alpha values for the six subscales ranged from .81 to .88 (Abrami, Venkatesh, Meyer, & Wade, 2013). Previous studies used the average of the 20 items in the questionnaire to measure the students’ levels of self-regulated learning strategies (e.g., Alexiou & Paraskeva, 2010).

The participants’ engagement was measured using a questionnaire consisting of three sub-scales for behavioral, emotional, and cognitive engagement in the two different modes of flipped learning: pre- and in-class sessions. The questionnaire was developed based on Fredricks, Blumenfeld, and Paris' (2004) work. In the study, the Cronbach’s alpha value was .92. The questionnaire began with the stem “During this class…” and the students were asked to indicate their levels of engagement. The participants responded on a seven-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The two items for behavioral engagement stated, “I paid attention to (a task)” and “I worked very hard to (do a task).” An item for emotional engagement stated, “I enjoyed (a task).” The item for cognitive engagement stated, “I tried to learn as much as I could (from a task).”

The students’ performances were represented by their weekly quiz scores and video completion rates. During the three week-experiment, the participants completed weekly assignments, including watching two video clips and taking quizzes. Each of the weekly quizzes had 10 questions that prompted the participants to recall brief facts and concepts addressed in the video clips Example items included “Which of the following cannot be inferred from the interview with Russell?” and “How would you prevent students from being distracted by digital devices? Provide one or more strategies.” The participants’ quiz scores were assessed after the

due dates of the assignments. The weekly video completion rates were computed using the student log traces recorded in the learning management system. Since the students were required to watch two video clips each week, a completion rate for each week was calculated by averaging the completion rates for the two video clips.

Interview Protocol

In Study 2, semi-structured interviews were conducted using an open-ended interview protocol (see Table 3). The interviews were initiated with pre-determined questions and the interviewers asked follow-up questions as needed. The follow-up questions prompted the participants to clarify their responses and allowed the researchers to obtain additional information (Turner, 2010; Merriam, 2015).

The interview questions were intended to examine the participants' experiences with and perceptions of the LAD. Table 3 shows the interview questions and their categories. The protocol contained a total of 11 questions focused on the participants used (i.e., experienced) and perceived the LAD (i.e., perception).

Table 3

Interview Questions and the Focus of Each Question

Interview question	Category	Foundation for the question
• Do you think you were provided with information when you saw the LAD? • Do you think that the LAD provided information that shows you are understood? • What do you like about the LAD? • What do you dislike about the LAD?	Perception	(Deci, Eghrari, Patrick, & Leone, 1994; Edmunds, Ntoumanis, & Duda, 2008)

• Did you examine the LAD information in depth? Why or why not? • When you saw the LAD, did you understand it? • Did you think about how you can improve your own work after watching the LAD? • Do you think you can use the LAD in your future assignments? • What is your overall experience with the LAD in this course?	Learning experience	(Fredricks & McColskey, 2012)
• What do you think the instructor could or should have done differently (or additionally) for the LAD activities? • Is there anything that I have not asked that you want to share about your experience with the LAD in this class?	General questions	(Zimmerman, 1990)

Data Analysis

Quantitative Data Analysis

In Study 1, inferential statistical analyses were performed in order to compare the LAD and non-LAD groups in terms of self-regulated learning, engagement, and performances. Multiple Analyses of Covariance (ANCOVA) and repeated measure ANCOVAs were employed. The participants' responses to the surveys were analyzed using ANCOVAs. Changes in their quiz scores and video completion rates over time (Week 1, Week 2, and Week 3) were analyzed using repeated measures ANCOVAs in order to determine the differences between the two groups. In these two analyses, the participants' quiz score and video completion rates in Week 1 were used as the baselines (i.e., covariates).

The Cronbach's alpha values for the sub-scales of the survey were assessed as reliability measures. The reliability and validity of the questionnaires have been acknowledged in prior studies. Previous research presented the reliability measures of the sub-scales used in the current

study. Abrami et al. (2013) reported that the Cronbach's alpha values of the sub-scales of SLSQ ranged from .81 to .88. The engagement questionnaire was used in Jang et al. (2010) and the Cronbach's alpha value was reported to be .92.

Qualitative Data Analysis

In Study 2, the individual participants' responses to the interview questions were analyzed in order to answer the Research Question 4: What are the student experience with and perception of the LAD? All of the interviews were audio-recorded and transcribed verbatim. Thematic analyses were carried out in order to analyze the interview transcripts. A thematic analysis is a method used to identify, analyze, and report patterns found in data that minimally describes and organizes observations in rich detail (Boyatzis, 1998). It requires researchers to discover emerging themes from data beyond the semantic content (Braun & Clarke, 2006). Theme development is a process of "data reduction" and "conclusion drawing and verification" (Miles & Huberman, 1984, p. 10-11) for generating the level of abstraction by comparing the data and reading the literature (Tuckett, 2005).

While a theme captures patterns that have emerged as being important across the data (Green et al., 2007), deriving a theme is not necessarily dependent on quantifiable measures (e.g., frequency) (Braun & Clarke, 2006). A theme could be something important in relation to the research question (Fereday & Muir-Cochrane, 2006). When determining a theme, the researcher's judgment is informed by his or her research questions (Clarke & Braun, 2013).

The method chosen for this study was a data-driven thematic analysis approach incorporating the conceptual framework to designing the LAD (see Figure 1). This approach was used to capture emerging themes directly from the data, while focusing what the LAD was aimed. In this study, the interviews were analyzed using the five main steps of thematic analysis

suggested by Braun and Clarke (2006): (a) becoming familiar with data, (b) generating initial codes, (c) searching for themes, (d) reviewing themes, and (e) defining and naming themes.

Two coders, the author and another researcher who has expertise in instructional design and had an internship experience in the course where this study was conducted, analyzed the interview transcripts in order to secure inter-rater reliability (Armstrong, Gosling, Weinman, & Marteau, 1997; Saldaña, 2015). Cohen's kappa, a robust static useful for inter-rater reliability (McHugh, 2012), was computed to determine the coding reliability. In regard to interpreting a Cohen's kappa value, values under 0 indicate that no agreement exists between the two coders, while a value between 0.01 and 0.20 indicates no agree to a slight agreement, 0.21 to 0.40 indicates a fair agreement, 0.41 to 0.60 indicates a moderate agreement, 0.61 to 0.80 indicates a substantial agreement, and 0.81 to 1.00 indicates an almost perfect agreement. Generally, researchers consider a value of 0.7 or higher as an acceptable level of inter-rater agreement (Fletcher, LoBiondo-Wood, Haber, Cameron, & Singh, 2005; Heale & Twycross, 2015).

This study took the following steps in order to analyze the interview data. First, the two coders met to construct an initial coding scheme that listed the potential keywords based on the literature and interview protocol. Second, the two coders analyzed two interview transcripts separately using the initial coding scheme and discussed their discrepancies. Based on the preliminary analysis, the coding scheme was refined with new codes and revisions. Third, the two coders analyzed another transcript separately and refined the codes until the inter-reliability reached 0.7. Fourth, the author analyzed the rest of the transcripts separately using the final coding scheme.

Study 1

Setting and Participants

The participants in Study 1 were 45 undergraduate students recruited from three sections of an elective course titled *Introduction to Computers for Teachers* offered at a large public university in the southeastern United States. The purpose of the course was to prepare pre-service teachers to use technologies in classroom settings. The course was offered for undergraduate students interested in teaching in the future but was also open to students who wanted to learn about how to use technology for learning. Among 45 participants who participated in Study 1, 21 students (46.7%) were education majors. The remaining participants came from various majors, such as communication sciences, economics, finance, management, and political science. Thirty-two of the participants were female (71.1%) and their average age was 20, within the range of 18 and 23. The average years that participants spent at the university where this study was conducted were 2.76.

This study adopted a quasi-experimental design as two sections were assigned to the control group, while the other section was assigned to the experimental group. Both the control and experimental groups participated in the project-based flipped classroom for three weeks. During this time, they learned about the Bring Your Own Device (BYOD). As a pre-class assignment, the participants were required to watch two video clips and complete a quiz every week. In total, the participants watched six videos and completed three quizzes. The content of the videos addressed the definition, benefits, and potential disadvantages of the implementation of BYOD in K-12 classrooms. Only the participants in the experimental group had access to the LAD. On the LAD, the students were able to see visualized graphs representing their quiz scores and video completion rates, followed by prompts for reflection.

Intervention

Both the control and experimental groups participated in the weekly pre-class sessions that required answering a quiz after watching two video clips about BYOD. Only the participants in the experimental group were given access to the LAD that displayed their quiz scores and video completion rates.

The LAD was intended to facilitate student self-regulation and provided the participants with opportunities to monitor their learning progress and quiz scores as well as reflect on their understanding of the video content. Student log data indicated that all of the participants in the LAD group viewed the LAD.

Figure 2 shows the course page in the learning management system by which the participants in the experimental group accessed the LAD. By clicking on the "View Dashboard" button, they were able to access their personal dashboard (see Figure 3). On the dashboard's main page, there was a link that took the participants to the prompts for reflection on the content of the videos (see Figure 4). The page for the control group did not have the "View Dashboard" button, while all of the other arrangements in the learning management system were the same.

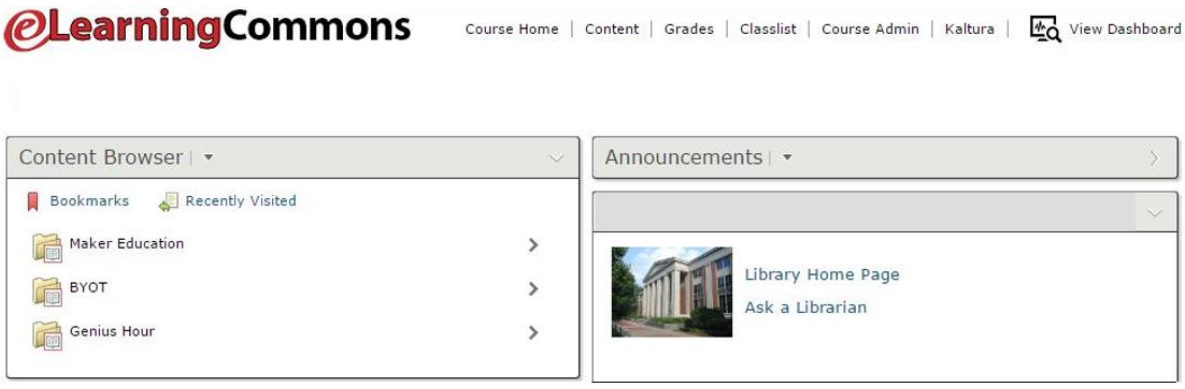

Figure 2. An example screenshot of the course page for the experimental group.

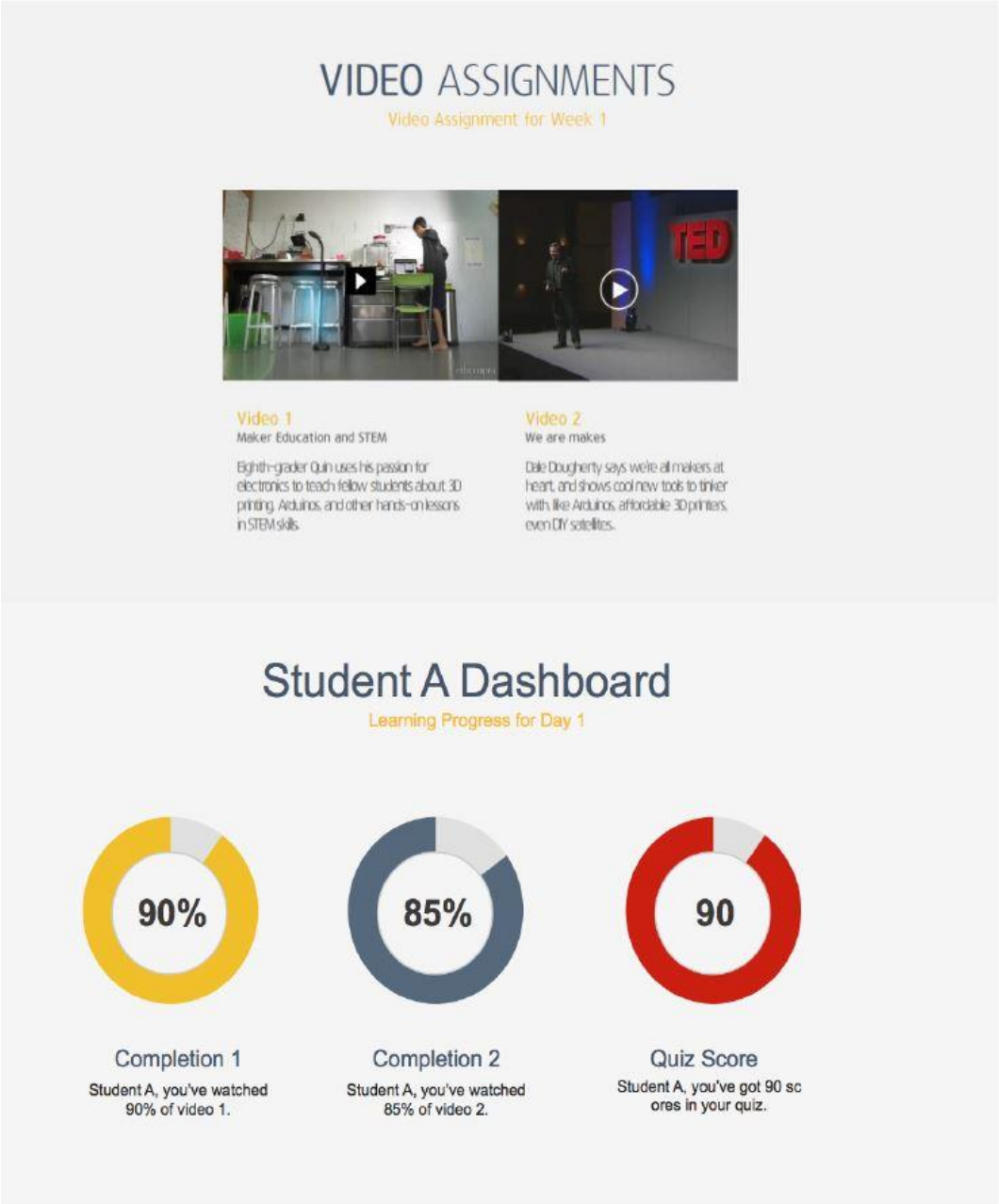

Figure 3. An example screenshot of the learning analytics dashboard on the course page.

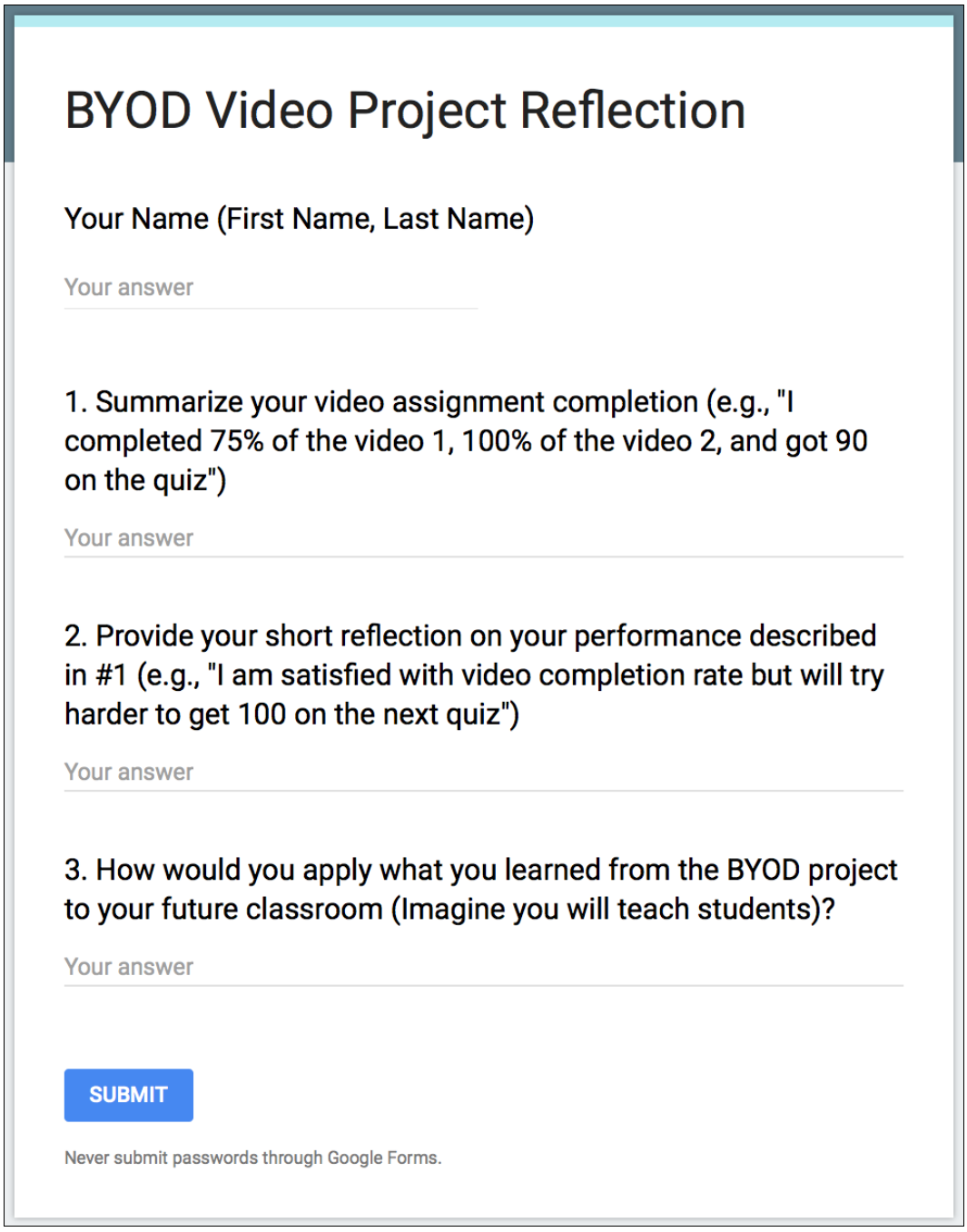

Figure 4. An example screenshot of the questions provided for reflection.

Study Procedures

The participants were recruited in the 10th week of the 2016 fall semester (see Appendix A for the Consent Form). During recruitment, the participants were asked to complete a pre-

survey (see Appendices B, C, and D). The pre-survey included questions about the participants' demographic information, self-regulated learning, and engagement.

The flipped learning component of the class was implemented between the 11th and 13th weeks of the semester, both in the control and experimental groups. In the control and experimental groups, the instructor asked the students to watch videos and complete quizzes prior to each class meeting. During the in-class activities, the students engaged in a project that was intended to help them elaborate their understanding of BYOD. Specifically, they were required to (a) interview in-service teacher about how the teachers were implementing BYOD in their classrooms, (b) write reports making suggestions to address issues and challenges mentioned by the teacher, and (c) create lesson plans that incorporated the suggestions. While both groups engaged in the same flipped classroom activities, only the experimental group was given access to the LAD. This group was also prompted to reflect on what it learned from the videos. During the last class, the participants in both groups took a post-survey (see Appendices C and D).

Study 2

Study 2 was conducted during the semester following Study 1. The purpose of Study 2 was to reconfirm the effects of the LAD as well as investigate the students' experiences with and perceptions of the LAD on their learning. In Study 2, changes in the students' self-regulated learning, engagement, and learning performances were also assessed. In order to explore the students' experiences with and perceptions of the LAD, semi-structured interviews were conducted in addition to surveys.

Setting and Participants

For Study 2, 11 students were recruited from two sections of the same course with different students in which Study 1 was conducted. All of the participants engaged in the same pre- and in-class sessions as the participants in Study 1's experimental group (i.e., they were required to watch two video clips and complete a quiz each week during the pre-class sessions and were given access to the LAD showing their progress and quiz scores after the due date for each assignment). However, unlike in Study 1, Study 2 involved only one group so as to examine the changes in the students' self-regulated learning, engagement, and performance as well as their experiences with and perceptions about the LAD. Out of the 11 participants who participated in Study 2, four students (36.4%) were education majors. The remaining participants came from different majors, including the biological sciences, criminal justice, early childhood education, economics, finance, management, and political science. Nine of the participants were female (82%) and their average age was 20, within the range of 18 and 23. On average, the participants had spent 2.45 years at the university where this study was conducted.

Study Procedures

The procedure carried out for Study 2 was the same procedure that was applied to the experimental group in Study 1. The only differences were that, in Study 2, only one group was utilized, and interviews were conducted in order to examine the students' experiences. As in Study 1, the students were required to watch two video clips about BYOD each week and answer a quiz. During the three-week BYOD project, the participants watched a total of six video clips and completed three quizzes. One week ahead of the BYOD project, the students completed the same pre-survey as was used in Study 1. The responses were used to determine the baselines for the students' self-regulated learning and engagement. After completing the project, the students

were asked to complete the same post-survey as was used in Study 1. In the week that the students finished the project, several students agreed to participate in individual interviews.

Subjectivity Statement

My passion about educational technology was shaped back when I was an undergraduate student in the social studies education program at a university in Seoul, South Korea. When I became a junior, I took an online course designed to help pre-service teachers explore multiple perspectives on global citizenship and multicultural education. In this class, we were connected to other pre-service teachers in different regions of South Korea for collaborative projects. I was impressed by how online learning encouraged a large number of pre-service teachers from all over the country to openly share their thoughts and ideas on various social issues, which would not have been easy in traditional classroom settings.

My experience with the class made me fascinated by educational technology and, a year later, I decided to attend graduate school to learn more about how technology can enhance student learning. Pursuing a master's degree in educational technology for two years at the same school where I completed my bachelor's degree, I acquired insight into how technology help students learn better. Thanks to my academic advisor, I learned about learning analytics as a way by which to understand student learning processes in various technology-enhanced environments. The learning analytics approach helped me to see educational phenomena from multiple angles with multimodal data, such as student learning traces recorded in learning management systems.

My enthusiasm for learning analytics made me continue my journey in educational technology via a Ph.D. degree. During my doctoral studies, I was fortunate to teach a technology integration course for undergraduate students who were interested in using technology for

teaching. I was excited about the opportunity, anticipating that the course would be a place where I could see how emerging educational technologies could successfully benefit students as I had experienced myself as a student. I was confident that my students would be highly motivated by innovative course components, such as flipped learning. As the first semester was coming to an end, however, I found that the students were not as motivated as I had expected. During a project that adopted the flipped classroom model, most of the students barely completed the required assignments and often came to class unprepared, which adversely affected their participation and engagement with the subsequent in-class activities. The embarrassing experience helped me recall important lessons that I learned in my early Ph.D. years. "That is, technologies as context alone are not enough," but "should enable learners to build more meaningful personal interpretations and representations of the world" (Jonassen, 1995, pp. 62-63). I had long forgotten that educational technologists should be mindful of student learning experiences with technologies. I found myself blindly following a step-by-step manual for implementing a flipped classroom with the expectation that the technology itself would automatically work out.

Witnessing student low engagement during the project, I was confused and disheartened. Until then, I had been involved in numerous learning analytics projects and was full of confidence about my technological knowledge. It was frustrating to see most of the students superficially participating in the project. After a few months of careful reflection, it suddenly occurred to me that the students may benefit from monitoring their own learning progress as represented by their learning traces: learning analytics brought into their real lives. My expectation was that, with the monitoring opportunity, the students would be able to self-regulate, even without an instructor's direct interventions. As such, I started reviewing literature

on flipped classrooms and self-regulated learning. I found it reassuring that LADs display information about the students' learning progress, which, in turn, should empower them to engage in self-reflection and, eventually, self-regulated learning.

The goal of this dissertation was to materialize my idea about LADs in my own course. The course I was teaching was a perfect setting because I knew why some of the students had failed and what they needed. This time, I tried not to be obsessed with fancy technologies and went back to the basics, exploring extensive literature in order to obtain insights into how to support the students' self-regulated learning in flipped learning contexts. This dissertation study reflects not only my enthusiasm as the instructor of the course, but also my feeling of obligation as an educational technologist who wished to do research that could contribute to practice.

CHAPTER 4

RESULTS

The purpose of this study was to examine the impact of LAD, as a self-regulatory support, on student learning in a flipped classroom. The LAD was designed and implemented in order to enhance the students' self-regulated learning, engagement, and performance in an undergraduate course. Specifically, the purpose of Study 1 was to determine whether a positive learning effect was associated with a LAD in a flipped classroom context. Although Study 1 revealed the effectiveness of the LAD, the students' perceptions of the LAD remained unrevealed. The purpose of Study 2 was to replicate the first study in the same course, while exploring the students' experiences in using the LAD. The data were collected from four sources: (1) surveys, (2) quiz scores, (3) video completion rates, and (4) interviews. Statistical analyses were conducted using SPSS version 20 software and the interviews were analyzed using NVivo version 11. This chapter reports the results of the quantitative and qualitative analyses.

Study 1

ANCOVA Assumptions

Multiple ANCOVAs were conducted in order to examine the effects of the LAD on the students' self-regulated learning and their behavioral, cognitive, and emotional engagement. Before conducting a one-way ANCOVA for each of the variables, the assumptions of independence of cases and equality of variance were tested.

First, the independence of cases was assumed to be satisfied since the students were able to enroll in only one section of the course during the semester and each case that was analyzed

represented a different person. Moreover, even though multiple sections of the course had the same curriculum, the students may not have had an opportunity to communicate with students in different sections. None of the cases were connected in between and within group.

Second, the Shapiro-Wilk normality test was performed to test whether the observations were normally distributed within each group. In addition, Levene's test, a test for equality of variances, determined whether the LAD and non-LAD groups had equal variances for the self-regulated learning and three types of engagement (see Table 4). In performing Levene's test, the null hypothesis was that the population variances were equal, so if an F value resulting from the test was insignificant, it was concluded that no differences existed between the variances in the population (Bast, Wilcke, Graf, Lüscher, & Gärtner, 2015).

Table 4

Results of Levene's Test of Homogeneity of Variance

	F	df1	df2	Sig.
Self-regulated learning	1.013	1	43	.320
Behavioral engagement with pre-class sessions	.479	1	43	.493
Behavioral engagement with in-class sessions	.369	1	43	.547
Cognitive engagement with pre-class sessions	.005	1	43	.943
Cognitive engagement with in-class sessions	.307	1	43	.582
Emotional engagement with pre-class sessions	.794	1	43	.378
Emotional engagement with in-class sessions	.512	1	43	.478

Repeated Measure ANCOVA Assumptions

The repeated measures ANCOVAs were conducted in order to investigate the differences between the two groups in terms of changes in quiz scores and video completion rates over time (Week 2 vs. Week 3) after controlling for the quiz scores from Week 1. Three

assumptions for the repeated measures ANCOVAs (i.e., independences of cases, normality, and sphericity) were tested.

First, it was assumed that the independence of cases assumption was satisfied since the participants were enrolled in only one session and each case in the subsequent analyses represented a different person. Moreover, no opportunities existed for the participants to communicate with participants in other sections. All of the cases were independent in between and within groups.

Second, sphericity was assumed without a separate test because only values at two-time points were analyzed with values in the first week used as baselines. Sphericity refers to the equality of the variances of the differences between all pairs of within-subject conditions (Gueorguieva & Krystal, 2004). In this regard, only one pair of within-subject condition does not require a test for the assumption of sphericity.

Descriptive Statistics

Prior to the main analyses, the means and standard deviations of each variable were computed per group. In the LAD group, out of the 23 participants, eight were male (34.8%) and 15 were female (65.2%). In terms of race, a majority of the participants identified as multiracial (n=17, 73.9%). Three were White (13.0%), two were Black (8.7%), and one was Asian (4.4%). In the non-LAD group, out of the 22 participants, four were male (18.2%) and 18 were female (81.8%). There were 17 participants who identified as multiracial (77.3%). Two were White (9.1%), one was Black (4.5%), and two were Asian (9.1%). The means, standard deviations, and confidence intervals for the other variables are summarized in Table 5.

Table 5

Means, Standard Deviations, and 95% Confidence Intervals

		LAD			Non-LAD		
		N	*M (SD)*	95% CI	*n*	*M (SD)*	95% CI
Age[a]		23	20.27(1.78)	[19.48, 21.06]	22	20.76 (1.22)	[20.21, 21.32]
Semester[b]		23	2.68 (2.12)	[1.74, 3.62]	22	3.76 (2.66)	[2.55, 4.97]
Pre-test							
Self-regulated learning[c]		23	4.02 (0.47)	[3.82, 4.23]	22	3.902 (0.63)	[3.62, 4.18]
Behavioral engagement[d]	Pre-class sessions	23	5.20 (1.11)	[4.80, 5.75]	22	5.48 (1.10)	[4.99, 5.96]
	In-class sessions	23	5.52 (1.20)	[5.00, 6.04]	22	5.77 (1.043)	[5.31, 6.24]
Cognitive engagement[d]	Pre-class sessions	23	5.48 (1.04)	[5.03, 5.93]	22	5.41 (1.40)	[4.79, 6.03]
	In-class sessions	23	5.43 (1.27)	[4.88, 5.99]	22	5.73 (1.42)	[5.10, 6.36]
Emotional engagement[d]	Pre-class sessions	23	5.04 (1.11)	[4.56, 5.52]	22	4.64 (1.89)	[3.80, 5.47]
	In-class sessions	23	5.70 (1.11)	[5.22, 6.17]	22	5.18 (1.89)	[4.34, 6.02]
Post-test							
		n	*M (SD)*	95% CI	*n*	*M (SD)*	95% CI
Self-regulated learning		23	4.60 (.62)	[4.34, 4.87]	22	4.03 (0.65)	[3.74, 4.31]
Behavioral engagement	Pre-class sessions	23	6.35 (1.02)	[5.91, 6.79]	22	5.68 (1.35)	[5.08, 6.28]
	In-class sessions	23	6.46 (.90)	[6.07, 6.85]	22	6.09 (1.02)	[5.64, 6.54]
Cognitive engagement	Pre-class sessions	23	6.39 (1.08)	[5.93, 6.86]	22	5.86 (1.13)	[5.36, 6.36]
	In-class sessions	23	6.52 (0.85)	[6.16, 6.89]	22	5.91 (1.27)	[5.35, 6.47]
Emotional engagement	Pre-class sessions	23	6.17 (0.98)	[5.750, 6.60]	22	4.91 (1.34)	[4.31, 5.50]
	In-class sessions	23	6.52 (0.95)	[6.11, 6.93]	22	5.59 (1.26)	[5.03, 6.15]
Quiz score[e]		23	57.10 (23.79)	[46.81, 67.39]	22	38.64 (25.25)	[27.44, 49.83]
Video completion rate (%)[e]		23	62.39 (30.44)	[49.23, 75.55]	22	42.96 (24.59)	[32.06, 53.86]

Note.
CI=confidence interval
[a]Possible range of age: 18-25
[b]Possible range of semester: 0-7
[c] Possible range of self-regulated learning: 1-5
[d]Possible range of behavioral engagement, cognitive engagement, and emotional engagement: 1-7
[e]Possible range of quiz score, video completion rate (%): 0-100

Hypotheses Testing

Hypotheses 1 and 2 were tested by conducting two separate one-way ANCOVAs. The results are summarized in Tables 6 to 9. Hypothesis 3 was examined using repeated measure ANCOVAs, the results of which are summarized in Table 11.

Hypothesis 1: The participants in the experimental group will report higher levels of self-regulated learning than the participants in the control group.

A one-way ANCOVA was conducted in order to examine the differences in the participants' self-regulated learning between the LAD and non-LAD groups, while controlling for their pre-test scores on the self-regulated learning questionnaire (see Table 6). The results showed that a statistically significant difference existed in the self-regulated learning scores between the LAD and non-LAD groups ($F(1,42) = 8.581$, $p = .005$, $\eta^2 = .17$). The participants in the LAD group demonstrated a higher self-regulated learning score ($M = 4.60$, $SD = 0.62$) than the participants in the non-LAD group ($M = 4.02$, $SD = 0.65$). Therefore, Hypothesis 1 was supported.

Table 6

Self-Regulated Learning Analysis Results

	LAD		Non-LAD				Effect
	M	*SD*	*M*	*SD*	*F*	*p*	size (η^2)
Self-regulated learning[a]	4.60	0.62	4.02	0.65	8.581	.005	.17

Note.

[a]: Possible range of self-regulated learning: 1-5

Hypothesis 2: Participants in the experimental group will demonstrate higher engagement than those in the control group.

Hypothesis 2.a: Participants in the experimental group will demonstrate higher behavioral engagement than those in the control group.

Two separate one-way ANCOVAs were conducted in order to examine the differences in the participants' behavioral engagements between the LAD and non-LAD groups, with the pre-test scores as a covariate (see Table 7). The results revealed that a statistically significant difference existed in engagement with the pre-class sessions between the LAD and non-LAD groups ($F(1,42) = 4.63$, $p = .037$, $\eta^2 = .099$). The participants in the LAD group had greater behavioral engagement ($M = 6.35$, $SD = 1.22$) than the participants in the non-LAD group ($M = 6.46$, $SD = 0.90$). However, no difference existed in behavioral engagement with the in-class sessions between the LAD and non-LAD groups ($F(1,42) = 2.63$, $p = .112$, $\eta^2 = .059$). Therefore, Hypothesis 2.a was partially supported in the pre-class sessions.

Table 7

Behavioral Engagement Analysis Results

	LAD		Non-LAD				Effect size (η^2)
	M	*SD*	*M*	*SD*	*F*	*p*	
Behavioral engagement with pre-class sessions[a]	6.35	1.22	5.68	1.35	4.63	.037	.099
Behavioral engagement with in-class sessions[a]	6.46	0.90	6.09	1.02	2.63	.112	.059

Note.

[a]: Possible range of behavioral engagement: 1-7

Hypothesis 2.b: Participants in the experimental group will demonstrate higher cognitive engagement than those in the control group.

As shown in Table 8, two separate one-way ANCOVAs revealed that no difference existed in behavioral engagement with the pre-class sessions between the LAD and non-LAD groups, $F(1,42) = 2.51$, $p = .121$, $\eta^2 = .056$. A significant difference was found in terms of cognitive engagement with the in-class sessions between the LAD and non-LAD groups ($F(1,42) = 4.0$, $p = .024$, $\eta^2 = .116$). The LAD group reported greater cognitive engagement with the in-class sessions. Therefore, Hypothesis 2.b was partially supported by the in-class sessions.

Table 8

Cognitive Engagement Analysis Results

	LAD		Non-LAD				Effect
	M	*SD*	*M*	*SD*	*F*	*p*	size (η^2)
Cognitive engagement with pre-class sessions[a]	6.39	1.07	5.86	1.13	2.51	.121	.056
Cognitive engagement with in-class sessions[a]	6.52	0.85	5.91	1.27	5.50	.024	.116

Note.
[a]: Possible range of cognitive engagement: 1-7

Hypothesis 2.c: Participants in the experimental group will demonstrate higher emotional engagement than those in the control group.

According to two separate one-way ANCOVAs, a statistically significant difference existed in emotional engagement with the pre-class sessions between the LAD and non-LAD groups, $F(1,42) = 11.82$, $p = .046$, $\eta^2 = .220$. The participants in the LAD group demonstrated greater emotional engagement with the pre-class sessions ($M = 6.17$, $SD = 0.98$) than the participants in the non-LAD group ($M = 4.91$, $SD = 1.34$). The results also showed that a statistically significant difference existed in emotional engagement with the in-class sessions between the LAD and non-LAD groups, $F(1,42) = 6.37$, $p = .015$, $\eta^2 = .132$. The participants in

the LAD group exhibited greater emotional engagement with the pre-class sessions (M = 6.52, SD = 0.95) than the participants in the non-LAD group (M = 5.59, SD = 1.27). The results are summarized in Table 9. Hypothesis 2.c was supported for both the pre- and in-class sessions.

Table 9

Emotional Engagement Analysis Results

	LAD		Non-LAD				Effect size (η^2)
	M	*SD*	*M*	*SD*	*F*	*p*	
Emotional engagement with pre-class sessions[a]	6.17	0.98	4.91	1.34	11.82	.001	.220
Emotional engagement with in-class sessions[a]	6.52	0.95	5.59	1.27	6.37	.015	.132

Note.

[a]: Possible range of emotional engagement: 1-7

Hypothesis 3: Participants in the experimental group will demonstrate better performance than those in the control group.

Hypothesis 3.a: Participants in the experimental group will demonstrate higher quiz score than those in the control group.

Hypothesis 3.b: Participants in the experimental group will demonstrate higher video completion rate than those in the control group.

Hypothesis 3 stated that the participants in the LAD group would exhibit higher quiz scores and video assignment completion rate over time than the participants in the non-LAD group. Two separate repeated measures ANCOVAs were performed in order to examine the differences in the changes in the quiz scores and video assignment completion rates between the LAD and non-LAD groups, with the first week's values as the baseline. The descriptive statistics for the quiz scores and video completion rates are presented in Table 10.

Table 10

Descriptive Statistics for the Quiz Scores and Video Completion Rates in Study 1

	LAD (*n* = 23)			Non-LAD (*n* = 22)		
Measurement time point	Week 1 (baseline)	Week 2	Week 3	Week 1 (baseline)	Week 2	Week 3
Quiz score [a]	46.09	58.70	66.52	46.82	40.91	28.18
Video completion rate [a] (%)	49.00	73.26	64.89	59.00	42.61	27.27

Note.
[a]: Possible range of quiz score, video completion rate (%): 0-100

As shown in Figure 5, the LAD group's quiz scores showed an upward trend, whereas the quiz scores of the non-LAD group rapidly dropped by Week 3. In terms of video completion rates, the LAD group maintained high completion rates despite a slight drop between Weeks 2 and 3; the non-LAD group showed a consistent drop over time (see Figure 6).

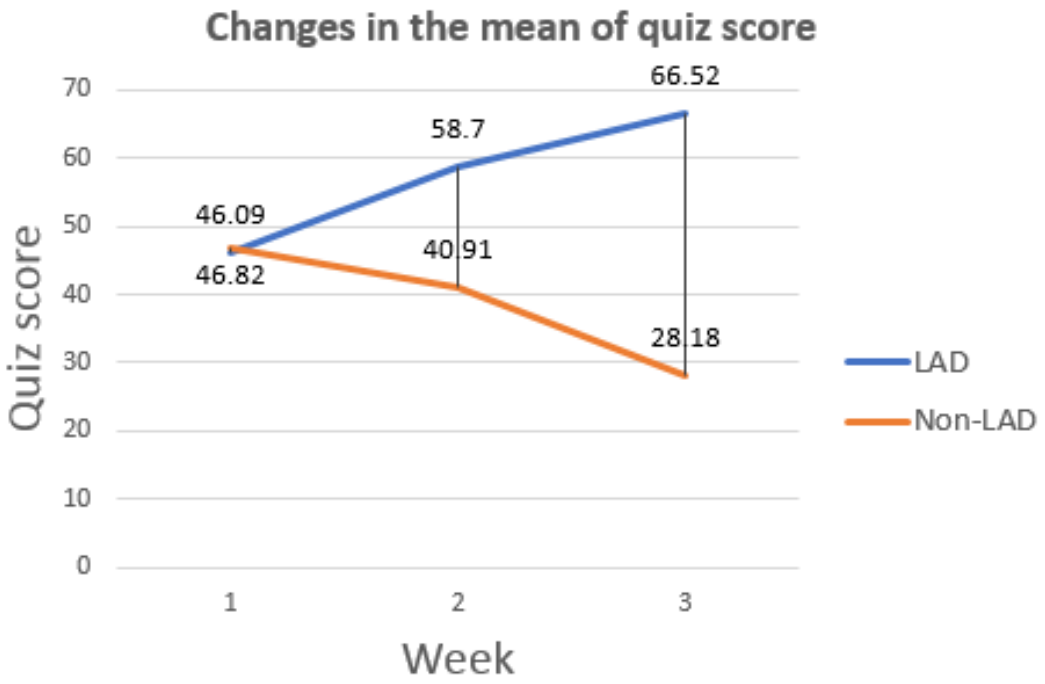

Figure 5. Changes in the quiz score mean in Study 1.

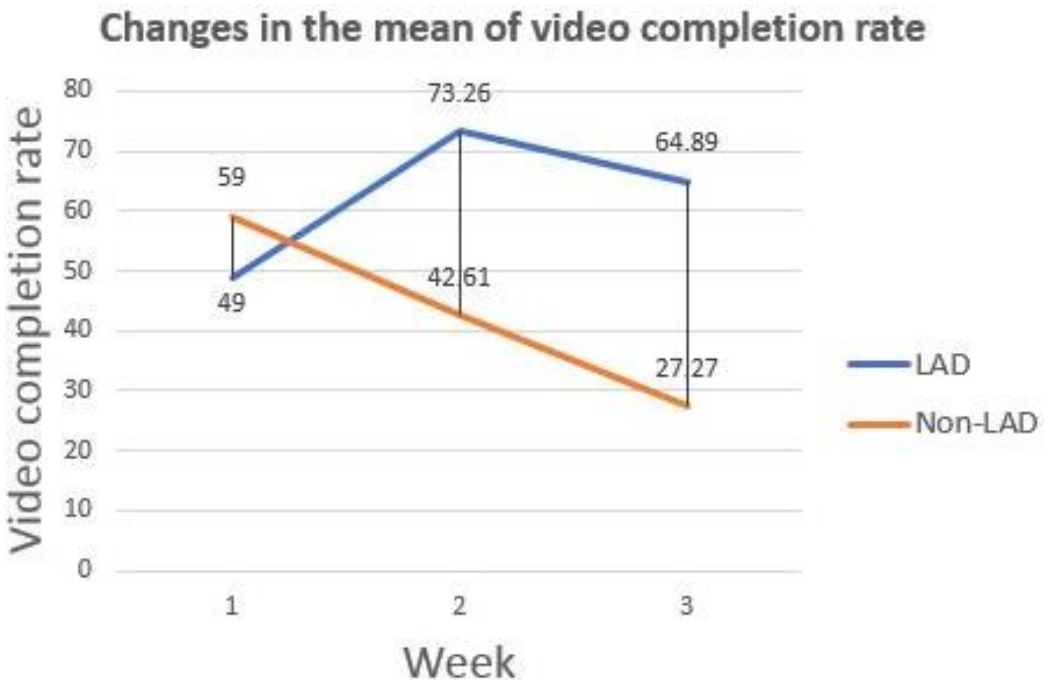

Figure 6. Changes in the video completion rate mean in Study 1.

The results of the repeated measures ANCOVAs showed that the means of the quiz scores and video completion rates differed significantly between the LAD and non-LAD groups (Table 11).

Table 11

Summary of Repeated Measures ANCOVAs

	Group effect		Time effect		Time×Group effect	
	F	*P*	*F*	*P*	*F*	*P*
Quiz score [a]	14.305	.000	0.678	.415	4.210	.046
Video completion rate [a]	12.029	.001	0.005	.944	.120	.731

Note.
[a]: Possible range of quiz score, video completion rate (%): 0-100

The two 3 (time) × 2 (group) repeated measures ANOVAs were conducted with the quiz scores and video completion rates to determine whether statistically significant differences

existed between the LAD and non-LAD groups. The results of Box's Test of Equality Covariance Matrices yielded $p = 0.092$ and $p = 0.201$ for the quiz scores and video completion rates, respectively, providing satisfaction of the equal covariance assumption, an important assumption of a repeated measures ANCOVA.

On the main analysis of the repeated measures ANCOVA with the quiz scores, no significant main effect of time existed, Wilks' Lambda = .984, $F(1, 43) = 0.678$, $p = .415$; a significant main effect of group existed, $F(1, 43) = 14.305$, $p < .001$; and a significant time×group interaction effect existed, Wilks' Lambda = .909, $F(1, 43) = 4.21$, $p = .046$.

Another 3 (time) × 2 (group) repeated measures ANCOVA was conducted on the video completion rates. The preliminary analysis results showed that the groups did not differ on their video completion rates in the first week. The results of the repeated measures ANCOVA with the video completion rates showed a statistically significant main effect of the group, $F(1, 43) = 12.029$, $p = .001$; no significant main effect of time, Wilks' Lambda = 1.00, $F(1, 43) = 0.005$, $p = .944$; and no significant main effect of the time×group interaction effect, Wilks' Lambda = .997, $F(1, 43) = 0.120$, $p = .731$. The LAD group showed an increasing trend between Weeks 1 and 2. Therefore, the statistical data supported both Hypotheses 3.a and 3.b.

Study 2

Descriptive Statistics

A total of 11 students agreed to participate in Study 2. All of the participants completed the pre- and post-surveys and participated in the individual interviews. Due to the small sample, inferential statistical analyses were not conducted. Instead, descriptive statistical analyses were carried out to determine the differences in the scores between the pre- and post-surveys. The descriptive statistics revealed how the participants' self-regulated learning and engagement

changed after using the LAD as well as how their quiz scores and video completion rates changed over time.

As presented in Table 12, the participants' scores in the self-regulated learning and engagement sub-scales increased across the board. According to the mean differences calculated by subtracting the pre-survey scores from the post-survey scores, behavioral engagement with the pre-class sessions increased the most, while emotional engagement with the pre-class sessions increased the least.

Table 12

Means and Standard Deviations for Self-Regulated Learning and Engagement

		Pre-survey (N = 11)		Post-survey (N=11)		Mean difference (Post – Pre)
		M (SD)	95% CI	*M (SD)*	95% CI	
Self-regulated learning[a]		4.02 (.49)	[3.69, 4.35]	4.45 (.51)	[4.10, 4.79]	0.42
Behavioral engagement[b]	Pre-class sessions	5.91 (1.02)	[5.22, 6.60]	6.59 (.74)	[6.10, 7.09]	0.68
	In-class sessions	6.14 (.74)	[5.64, 6.64]	6.64 (.55)	[6.27, 7.00]	0.50
Cognitive engagement[b]	Pre-class sessions	6.18 (.98)	[5.52, 6.84]	6.73 (.47)	[6.41, 7.04]	0.55
	In-class sessions	6.14 (.83)	[5.53, 6.65]	6.64 (.51)	[6.30, 6.98]	0.55
Emotional engagement[b]	Pre-class sessions	5.45 (1.29)	[4.59, 6.32]	5.73 (1.95)	[4.41, 7.04]	0.27
	In-class sessions	6.09 (.94)	[5.46, 6.73]	6.18 (1.25)	[5.34, 7.02]	0.09

Note.

[a]: Possible range of self-regulated learning: 1-5

[b]: Possible range of behavioral, cognitive, and emotional engagement: 1-7

Table 13 shows that both the means of the participants' quiz scores and video completion rates drastically increased between Weeks 1 and 2. In Week 2, their quiz score were 31 points higher than in Week 1 and their video completion rate was 39% higher. Conversely, both the quiz scores and video completion rates decreased by 11 points and 11% respectively between Weeks 2 and 3. Figures 7 and 8 visualize the changes in the participants' quiz scores and video completion rates.

Table 13

Means and Standard Deviations for Quiz Score and Video Completion Rate

	Week 1 (N=11)	Week 2 (N=11)	Week 3 (N=11)
	M (SD)	*M (SD)*	*M (SD)*
Quiz score[a]	30.91 (38.59)	61.82 (35.16)	50.91 (31.13)
Video completion rate[a] (%)	38.64 (46.76)	78.41 (38.80)	67.05 (43.91)

Note.[a]: Possible range of quiz score, video completion rate (%): 0-100

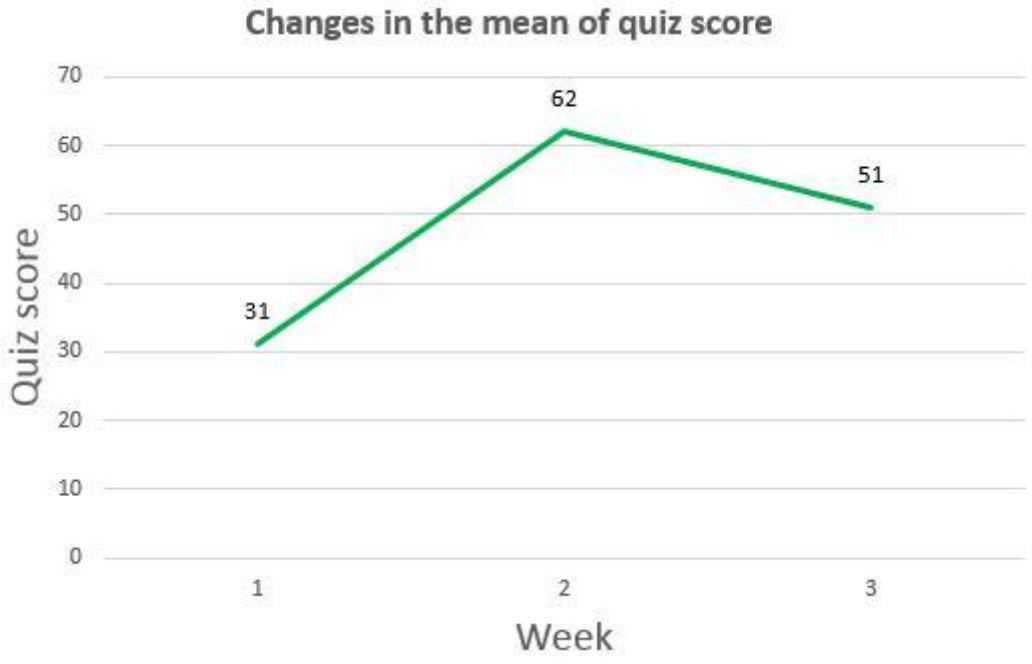

Figure 7. Changes in the quiz score mean in Study 2.

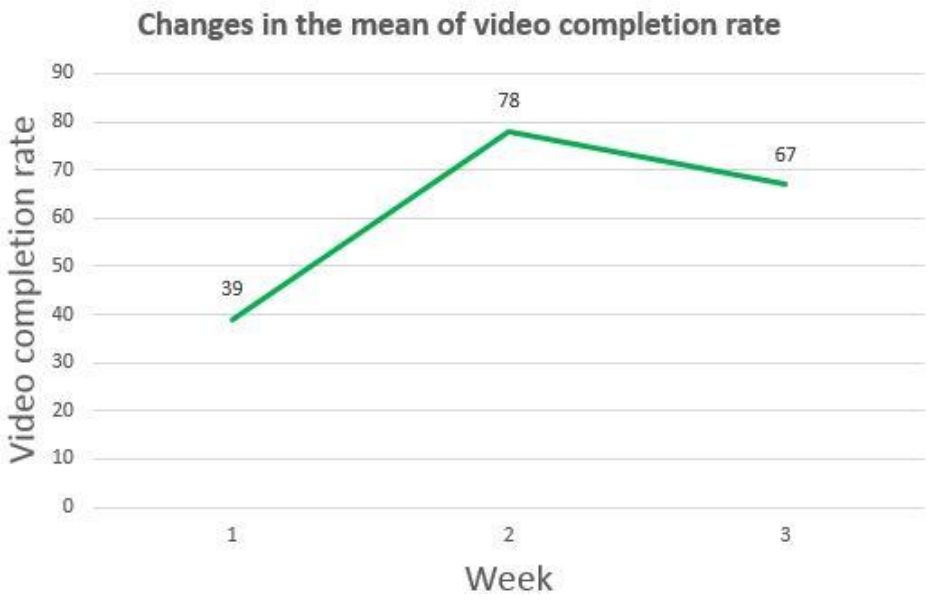

Figure 8. Changes in the video completion rate mean in Study 2.

Open-Ended Interviews

All 11 students consented to participate in open-ended interviews about their experiences with and perception of the LAD. The length of the interviews ranged from 15 to 25 minutes. Two coders coded transcripts using the pre-determined thematic codes. The interview results are summarized in Table 14.

Table 14

Interview Themes and the Frequency of the Participants Reporting the Themes

Interview theme	Description	Frequency
Goal setting	Identified goal while using the LAD	4 (36%)
Strategic planning	Planned strategies for next assignment	2 (18%)
Self-monitoring	Obtained information about a video completion	9 (82%)
	Obtained information about a quiz score	9 (82%)
	Identified discrepancies between current status and goal	4 (36%)
	Monitoring progress	5 (45%)
Reflection	Reflect their learning based on the LAD	4 (36%)
Challenge	Described challenges while using the LAD	2 (18%)
Suggestion	Mentioned suggestion to improve the LAD	4 (36%)
Future intention to use	Showed intention to use the LAD in the future	9 (82%)

Although the frequencies of each theme largely varied ranging from 18 to 82%, all were included to illustrate how the proposed LAD principles and guidelines were represented in the data. This approach corresponds to Braun and Clarke's (2013) suggestion that a theme not only emerges from frequent occurrences of events but can also be derived from the researchers' judgment or research questions.

Goal setting.

Four participants (36%) reported that the LAD was helpful in setting their learning goals. For example, one participant said that she felt reassured that she was on the right track when she saw her score and wanted to make more of an effort: "I made 90 for the first time. I was satisfied Highlight strong findings from interviews (e.g., 2 in self-monitoring, future intention to use) with my score and I wanted to keep my score, and I got 90 (quiz score) again." Another participant mentioned that the LAD helped keep her focused on her goals throughout the project: "It helps me to keep goals in mind and track them." The advantage of the LAD as a reminder of learning goals was stated in another participant's comment: "I didn't watch the videos and saw a zero percent on it. I was freaked out just because I feel that's who I am. So, I wanted to watch the videos and I found them interesting." The LAD served to alert the participants to what they were supposed to do during the pre-class sessions. The participants' comments represented their appreciation for being able to keep up with their learning progress toward set goals.

Strategic planning.

Two of the participants (18%) mentioned that the use of the LAD led to strategic planning to enhance their learning performances. One participant, for example, stated that she used the LAD in order to identify tasks to be done: "It made me, at least, kind of more recognize what I needed to do in order to do well on the quizzes and also hold myself accountable. I think

it makes you think about what you can do to improve your score or what you are doing right now to keep your score." Another participant stated that "it makes me think about what I can do to improve my score or what I am doing right now to keep the score. For the first videos, I watched the whole videos, but I got 70 on the quiz. I thought I needed to pay attention more in the videos." Not only did the LAD help the participants, but it also made them think about next steps. Given that self-regulated learning requires the use of self-regulatory strategies, it is encouraging that the LAD led the students to take action beyond self-awareness.

Self-monitoring.

Four types of self-monitoring were reported by the LAD: (a) obtaining information about quiz scores, (b) obtaining information about completion rates, (c) identifying discrepancies between current status and goals, and (d) monitoring progress over time. The most common self-monitoring type that the interviewees mentioned was obtaining information about their quiz scores and video completion rates. Nine of the participants (82%) highlighted the advantage of using the LAD to monitor their quiz scores. For example, one participant stated that "…the LAD showed me how I did on my quiz. I check the quiz scores and then, looking over time, I can see how I've done with the quizzes." Similarly, another participant mentioned that "I was able to check my progress. Each week, I go in look at my completion and quiz score."

The nine participants (82%) also reported that they benefitted from being able to monitor their video completion rates via the LAD. For example, one participant stated that "I thought the LAD shows like completion on the videos, it actually checks how much of the video I've watched and finished." Another participant stated that "it shows me my completion as to whether I've watched the full video. I think that it helped me by showing that." A majority of the

participants reported that the LAD was primarily used for self-monitoring, which led to the next two important self-regulated learning steps: self-awareness and self-reflection.

Four of the participants (36%) stated that being able to identify discrepancies between their current status and goals as a benefit of using the LAD. For example, one participant commented that "when I saw the number on the LAD, it made me realize that 'oh I should do better in terms of completing the videos next time' because my personal goal was to watch the full video and do well on the quiz."

Five of the participants (45%) stated that the LAD helped them monitor their learning progress. For example, one stated that "I could see how ready I am for the quiz and completion." Another participant expressed her preference for the LAD in terms of monitoring her progress:

> The LAD helped me maintain my order and know where I am at in my study. Because I am the one who wants to know how much I have completed and where I am at, because I am really confused and basically my whole life is like getting out of order. If I don't know where I am at I might easily put something on pause. The LAD leads exactly where I am at in this course.

It is notable that the LAD helped the participants not only check their learning progress, but also identify discrepancies between their current statuses and goals.

Reflection.

Four of the participants (36%) stated that they had opportunities to reflect on their learning while using the LAD. One participant stated that "I did reflection about whether I am doing well, what I could work on to do better." Another participant described how he used the information displayed on the LAD for reflection:

> When I see the LAD, the dashboard helps me be aware of my responsibility and understanding. The first aspect is that it shows my completion rate, so, I think that it's about my responsibility, and the other aspect is about my level of understanding. I mean my scores on my quizzes represent my level of understanding of the content. While using the LAD, I could think about my responsibility and understanding.

The participants' comments revealed that the self-monitoring of their progress represented by simple graphs and numbers made them engage in in-depth self-reflection.

Challenge.

Although most of the students had positive experiences with the LAD, two of the participants (18%) pointed out challenges that they faced. One complaint was that the LADs components were not ideally arranged. "I felt like stuff [was] spread out and like they can just put it all on the one thing. The dashboard was underneath that tab. And I just need to click to a reflection like under the link. It was little confused at the first time. I thought it would be great if you put everything right there." This design issue seemed to affect the usability of the LAD.

Another problem reported by the participants was that the numbers displayed on the LAD caused them to be distressed. For example, one student reported that "I didn't watch the whole video once because I got all my quiz answers, but it [the LAD] showed that I watched 80%. And then I thought 'oh, I should go through and watch the whole video even I finish the quiz.' I feel like kind a burden to watch the whole video." This comment indicated that the pressure caused by the displayed information may have a negative impact on student learning.

Suggestion.

Four of the participants (36%) provided suggestions for improving the LAD. One participant suggested changing the order of the weeks on the LAD in order to improve its usability:

> I think the dashboard goes Week 1, Week 2, Week 3. But usually people want to see the most recent assignment at first. So maybe switch it so then my Week 3 would be on top because it was the most recent one. If we have a lot of assignments, I have to scroll up to go to the bottom.

The comment above showed that simple changes to the design of the LAD could lead to better usability.

Another participant mentioned that she wanted to see what she missed on quizzes on the LAD. "I wish there was an option near your quiz score that could tell you what you missed." One participant expressed that he would like to see more information on the LAD in addition to quiz scores and video completion rates. "I thought it would be great if there were more information. For example, how has my score been changing or an assignment due alert bar, maybe? The dashboard was simple and easy-to-use, but I would like to have more information about me." These comments indicate that more information could not only to attract students' attention to the LAD, but also help them see their learning trajectories.

Future intention to use.

Nine students (82%) reported positive experiences with the LAD and future intentions to use it. For example, one participant expressed her satisfaction with a strong intention to use the LAD in the future as follow:

> I will definitely use it [the LAD] again. I'm just enthusiastic. The LAD is really cool because I was able to see how much I had to go and it made me kind of use time management better. I thought that it was a very cool feature that really helped my learning experience.

Another participant also expressed her enthusiasm for using the LAD. "I really do like it. It was just like an easy thing to use, but I can check my progress. I think I would use it in the future." Another participant pointed out the benefit of having visualized information about their learning progress and exhibited his willingness to use it in his other classes.

> I think this learning analytics dashboard is comparative and effective because the dashboard is more like the animation things, so, basically, it looks fancy. So, this makes me and students to get more interested that another traditional thing. I wish I could use it in my other courses.

These comments showed that the LAD not only helped the students better learn in the flipped classroom, but also has lead to their willingness to use it in the future in other courses.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

The purpose of the two studies were to examine the effects of LADs on students' self-regulated learning, engagement, performance as well as their learning experiences in the flipped learning context. A LAD was designed to facilitate the students' self-monitoring, self-awareness, and self-reflection. Study 1 was conducted in order to compare the students who used the LAD to students who did not use it in terms of their self-regulated learning, engagement, and learning performances. Study 2 was concerned with the students' experiences with and perception of the LAD. The findings are described relative to each of the research questions and hypotheses. A summary of the key findings is presented in Table 15.

Table 15

Research Questions and Findings

Research questions	Findings
RQ1: What is the effect of the LAD on student self-regulated learning?	The LAD group demonstrated a higher level of self-regulated learning than the non-LAD group. The participants reported that they benefitted from adequate opportunities to monitor their progress.
RQ2.a: What is the effect of the LAD on student engagement?	The LAD group demonstrated greater behavioral engagement with the pre-class sessions. However, no statistically significant difference existed between the LAD and non-LAD groups in their behavioral engagement with the in-class sessions.
RQ2.b: What is the effect of the LAD on student cognitive engagement?	No statistically significant difference existed between the LAD and non-LAD groups in regard to their cognitive engagement with the pre-class sessions. However, the LAD group reported higher levels of cognitive engagement with the in-class sessions.
RQ2.c: What is the effect of the LAD on student emotional engagement?	The LAD group's emotional engagement was improved throughout the pre- and in-class sessions. The LAD group demonstrated statistically significant greater emotional engagement with the pre- and in-class sessions than the participants of the non-LAD group.
RQ3: What is the effect of the LAD on learning performance?	The LAD group demonstrated higher quiz scores than the non-LAD group over time. The video completion rate differed between the two groups, but the difference did not change over time.

RQ4: What are the student experience with and perception of the LAD?	Some students who participated in the interview reported that the LAD was helpful in regard to managing their learning. Some students perceived it as a useful monitoring tool to check their progress.

Research question 1: What is the effect of the LAD on student self-regulated learning?

The survey analysis revealed that the students who used the LAD demonstrated a higher level of self-regulation. These results were aligned with Dabbagh and Kitsantas' (2012) assertion that instructional support for self-regulated learning leads to students' actual use of self-regulated learning strategies. For example, Schmitz and Perels (2011) used standardized diaries as a self-monitoring tool to facilitate students' self-regulatory behaviors in a math learning context and found that the students' overall self-regulated learning skills were improved. The self-regulated learning mechanism described in the prior studies involved three main activities that the LAD in the current study targeted: self-monitoring, self-awareness, and self-reflection (Santos et al., 2012). The students become aware of their progress and performance through self-monitoring, which, in turn, led to meaningful self-reflection (Govaerts et al., 2012).

The findings from the interviews also supported the validity of the LAD. The majority of the participants reported that they benefitted from the opportunity to monitor their progress in regard to completing assignments during the pre-class sessions. For example, one participant stated that "the LAD improved things for me, personally. I liked how it helped me keep goals in mind and it was a good way to keep track of my progress." As such, the LAD served to keep the students consistently aware of their learning goals. The findings also validated the self-regulated learning principle 1 and 2, and the guidelines derived from them; the LAD that incorporated these principles and guidelines were found to facilitate students to set realistic goals based on accurate and constant self-monitoring.

Although most of the students only outright mentioned the advantage of the LAD as a self-monitoring tool, self-monitoring led the students to the subsequent self-regulated learning activities, self-reflection, and strategy use. One participant pointed out that "the LAD makes me to think about what I can do to improve my score or what I am doing right now to keep my score. I've seen it after an assignment and I had a reflection right next to my score. I could reflect on how my progress was and then what I need to improve on for the next assignment." As indicated by the comment above, the participants used the information displayed on the LAD as a source of reflection on their learning strategies.

The role of the LAD as a bridge to the use of self-regulated strategies is in line with recent research that examined the effect of LADs on students' actual self-regulation (e.g., Grann & Bushway, 2014; Pistilli & Arnold, 2010; Scheuer & Zinn, 2007). Student awareness gained by self-monitoring triggered actions, such as planning and goal setting (Zimmerman, 2002). The current study reaffirmed the potential of the LAD to help students execute self-regulation in a real setting.

Research question 2.a: What is the effect of the LAD on student behavioral engagement?

The survey analysis results indicated that the LAD group exhibited greater engagement with the pre-class sessions than the non-LAD group. In other words, the students in the LAD group paid more attention to the videos and made more of an effort to enhance their understanding of the class topics. This finding provided empirical evidence that the LAD contributed to the intensity of the students' learning since the LAD intensified the students' learning-related behaviors, which was also indicated from the self-regulated learning survey analysis. The students' attention and efforts facilitated by the LAD are a key component of recursive self-regulation as illustrated in the conceptual framework for the design of the LAD

(see Figure 1). The students are expected to adapt their learning strategies through their continuous attention and efforts (Verbert et al., 2013).

The interviews with the participants also revealed that the LAD served to intensify the students' learning-related behaviors. Most of the students reported that the LAD helped them pay attention to the videos and quiz assignments. For example, one participant stated that "…because the numbers were laid out for you at the end showing your progress, it could kind of help me improve my own progress. I could see like 'Oh, I only watched 75% of this video.' I need to go back and give it more attention." This comment revealed that the LAD triggered the participants' actions to improve their learning performances.

As indicated by several of the participants, the visualized information on the LAD effectively alerted the participants to what needed to be done to improve their performances. Visualization has been recognized as a key feature of LADs because it is an effective and efficient way to turn learner attention to important information (Duval, 2011; Verbert et al., 2013). Compared to textual information that requires learners to make a substantial cognitive effort in order to interpret it, visual information only displays important elements in order to elicit learner attention (Card, Mackinlay, & Shneiderman, 1999; Corrin & Barba, 2014). The effect of visualized information on the students' immediate actions was mentioned by many of the participants during the interviews. For example, one participant stated that "when I saw the LAD, I just realized the circle is incomplete and thought that 'oh I should do better in terms of completing the videos.' I thought that is pretty efficient." This comment confirmed the impacts of visualization on the LAD as an intuitive way of alerting students.

Prior studies that have used LADs have employed visualization techniques to organize key information for learners (e.g., Chen & Huang, 2014; Fidalgo-Blanco, Sein-Echaluce, García-

Peñalvo, & Conde, 2015; Kim et al., 2016). For example, Fidalgo-Blanco et al. (2015) provided students with visual information about their teams' learning during a field trip. Without having the teacher near them, the students used collaboration strategies in a timely manner to coordinate teamwork based on visual information regarding their teams' progress as provided by a LAD. Chen and Huang (2014) presented students with visual information about their self-regulation during web-based reading. They found that the visual information successfully triggered subsequent self-regulatory behaviors from the students.

However, in the current study, the two groups did not differ in their behavioral engagement with the in-class sessions. This finding may be attributed to the fact that the information on the LAD was related to the pre-class sessions. The participants were presented with information only about their quiz scores and video completion rates. Therefore, the behavioral engagement triggered by the LAD pertained more to the pre-class sessions than the in-class sessions. Behavioral engagement is manifested as observable behaviors (Linnenbrink & Pintrich, 2003) as phrased in the questionnaire (i.e., paying attention, working hard), while cognitive and emotional engagement are close to student internal states (Finn & Zimmer, 2012). Therefore, it may be reasonable to expect that the use of LAD triggers students' immediate reactions associated with the pre-class sessions; it is important to investigate how students' behavioral engagement with the pre-class sessions affect other types of engagement with the in-class sessions.

Research question 2.b: What is the effect of the LAD on student cognitive engagement?

The two groups did not differ in their cognitive engagement with the pre-class sessions. No difference existed in cognitive engagement with the pre-class sessions between the two groups. This lack of difference may be attributable to the low complexity of the pre-class

sessions in flipped classrooms as they do not require much cognitive effort (Pierce & Fox, 2012). Cognitive engagement is highly dependent on the degree of mental efforts that the students invest in the learning tasks (Chapman, 2003; Pintrich & Schrauben, 1992). The pre-class sessions that the participants had to complete for this study consisted of watching videos, taking follow-up quizzes, and writing short reflections. The quizzes were intended to check whether the participants paid attention to the video content and, therefore, only consisted of multiple-choice items.

The low-level difficulties of the pre-class sessions are among the important characteristics of a flipped classroom; learners understand the basic concepts of the course topic during the pre-class sessions and have opportunities to elaborate on them through inquiries (Margulieux et al., 2016; Tucker, 2012). In this regard, the students may not have invested a great deal of cognitive resources during the pre-class sessions. In fact, two of the students mentioned that the video and quiz assignments were not challenging. One participant said that "the assignments were very easy to do. I should go through and watch the whole video and do the quizzes. That was all I needed to do." This comment revealed that the assignments did not cause the students invest the extra time and effort necessary to manifest cognitive engagement. However, considering the fact that the LAD group weekly quiz scores went up, this measure of cognitive engagement may not be sensitive enough to capture participant cognitive engagement.

In contrast, the LAD group reported higher levels of cognitive engagement with the in-class sessions. In the current study, the in-class sessions forced the participants to apply what they learned from the pre-class sessions through an authentic project; the students had to interview real teachers about technology integrations as well as suggest plans for addressing the issues mentioned by the teachers. In sum, the findings from the survey analysis revealed that the

effect of the LAD on student cognitive engagement became prominent during the in-class sessions. It is conceivable that the students' behavioral engagement with the pre-class sessions may have led to their cognitive engagement with the in-class sessions.

Indeed, during the interviews, the participants described the transition from behavioral engagement to cognitive engagement in the two modes of flipped learning. One participant said that "so I have an experience with BYOD through the videos and, when my professor explained about what the BYOD is and its objectives and stuff in class, I was like 'Oh, I know this stuff' and it caught my attention." Another participant reported a similar experience: "I just watched the videos and completed the quizzes as assignments. And it comes very interesting when I met teacher to hear about how they thought about BYOD. I already watched the video in which the teachers discussed their feelings about BYOD, so the interview went pretty well. The videos really help me to the BYOD project." Different types of engagements become prominent and this transition constitutes a complete cycle of self-regulated learning (Butler & Winne, 1995). The findings indicated that the LAD played a role in helping the students sustain their engagement throughout the pre- and in-class sessions.

Research question 2.c: What is the effect of the LAD on student emotional engagement?

The LAD group demonstrated higher levels of emotional engagement with both the pre- and in-class sessions. Given the survey item that measured student enjoyment, the LAD group seemed to have enjoyed the entire flipped learning concept more than the non-LAD. As opposed to behavioral and cognitive engagement, emotional engagement was aroused throughout the pre- and in-class sessions. This finding is consistent with Reschly and Christenson's (2012) claim that behavioral and cognitive engagement are transformed into emotional engagement. According to Wanner and Palmer (2015), students do not make a sufficient effort during pre-class sessions in

flipped learning, and the lack of interest and motivation is ascribed to the absence of clear guidance for self-regulated learning (Strayer, 2012). In the current study, the students' self-regulated learning skills were improved by the use of the LAD, which helped the participants engage with flipped learning with excitement.

The interview analysis also yielded a consistent finding that the participants felt excited throughout the three-week project. One participant said that "the BYOD project is my only experience with the LAD in the course and it was very positive one. I really enjoyed the LAD. It was very interactive and engaged and easy-to-access. I hope I could use it for another course, so I could keep track of my progress." The participants' pleasant experiences in using the LAD could be associated with the influence of self-regulated learning on their self-efficacy. The students felt increasing confidence as they made progress based on successful self-regulation (Stajkovic, Lee, Greenwald, & Raffiee, 2015). In the current study, the LAD played a role in regard to enabling the participants to feel confident about what they should do, which may have led to positive emotions toward flipped classrooms. Another participant's statement implied the psychological process:

> The LAD is so cool. I am just enthusiastic. It definitely contributed to completing my project because I was able to see what I missed and how much more. I thought it was very cool feature that really helped my learning experience.

As indicated in the comment above, the use of the LAD led to a successful learning experience, which, in turn, led to positive emotions. The findings also confirmed that the Principle 3 and guideline were successfully implemented to make the students value what they learned during pre-class sessions; evidence presented above indicated that the students acknowledged the role of the LAD as motivating them to complete their project.

Research question 3: What is the effect of the LAD on student learning performance?

The students' learning performances were measured using weekly quiz scores and video assignment completion rates. With the scores from the first week used as the baselines, trends for scores in the 2nd and 3rd weeks were analyzed. The findings can be summarized as follows.

First, a significant difference existed in the quiz scores over time between the two groups. According to the preliminary analysis, the first week's quiz scores did not differ between the two groups; the means of LAD group's quiz score was 46.09, while that of non-LAD group's mean was 46.82. The score difference became greater as the project progressed from the 2nd to the 3rd week. In Figure 5, the LAD group's quiz score shows a decreasing trend, while that of the LAD group increases over time.

It can be inferred that enhanced student self-regulated learning strategies and engagement positively affected student performance. This finding is aligned with Loyens, Magda, and Rikers' (2008) assertion that student self-regulated learning implies active engagement, which leads to improved academic performance. In the current study, the students' self-regulated learning and behavioral engagement with the pre-class sessions and the students' cognitive engagement with the in-class sessions led to increased learning performances. It is notable that the non-LAD group showed a decreasing learning performance over time, which was consistent with the findings reported in Kim et al. (2014). In the current study, the use of the LAD helped to address the salient weaknesses of the flipped learning model: lack of self-regulation, low engagement, and poor performance. This study presented empirical evidence that LADs have the potential to help students maintain the level of performance toward their learning goals.

Second, according to another repeated ANOVA result on the students' video completion rates, the group effect was significant; overall, the LAD group showed a significantly higher

video completion rate than the non-LAD group. However, there was no time effect. This result can be attributed to a decreasing completion rate found in both groups. For the same reason, there was no time × group effect.

Nevertheless, the use of the LAD may have helped the LAD group maintain a superior video completion rate to the non-LAD group throughout the project considering that, in the first week, the completion rate did not differ between the two groups (F=1.091, p=.302). In the second week, however, the LAD group showed a drastic increase in its completion rate, while this rate dropped in the non-LAD group. Although both groups showed decreases between the 2nd and 3rd weeks, the LAD group maintained a much higher completion rate of 64.89% compared to non-LAD group's rate of 27.27%. Although not significant, the difference between the two groups became greater over time.

The higher completion rates demonstrated by the LAD group are aligned with the findings described above that the LAD group showed greater behavioral engagement with the pre-class sessions than the non-LAD group. The interviews also revealed that the LAD helped the students keep up with the assignments, as indicated by one participant, who stated that "the LAD helped me complete the video better. I was very engaged in the assignment because the feature on it keeps me thinking about the task." The effect of the LAD on the students' completion rates was consistent with Arnold and Pistilli's (2012) finding that a self-monitoring tool prevented students from dropping out of online courses. The authors found that students who used Course Signal, a visualized intervention tool employing learning analytics, demonstrated higher course completion rates than those students who did not use it. The current study provided empirical evidence that the use of LADs positively impacts students' actual behaviors.

Implications for Research

The findings obtained from the two empirical studies contribute to the knowledge base in the areas of self-regulated learning and instructional design. Although self-regulated learning theory has been studied in an extensive body of research, little is known about how LADs promote students learning in terms of their self-monitoring, awareness, and reflections are promoted by LADs. This study presented insights into what students learned and what they achieved during flipped learning when they were able to monitor their own behaviors with an LAD. While more research is needed, the students' learning experiences illustrated in this study may help researchers understand students' self-regulated learning processes through the lens of engagement.

The results of this study also provide insights for future research seeking ways to use data analytics to optimize online learning environments. Students' self-regulated learning has been recognized as being critical to student success in online learning (Zimmerman & Schunk, 2011). However, the successful use of self-regulated learning strategies is largely dependent on the students' willingness and abilities. The LAD proposed in this study presented a potential way for a self-monitoring tool to facilitate students' use of self-regulated learning strategies. Future research would benefit from implementing self-regulated learning tools that leverage data generated in online learning environments. Student learning traces, such as log data, may serve as an important source for designing instructional support, not only in the flipped classroom, but also in various online learning environments.

Implications for Practice

The results of this study have several implications for practice. First, the results provide some evidence that the challenges of a flipped classroom (e.g., students having to complete tasks

and/or readings ahead of time) could be managed by a well-structured intervention. Previous research has consistently argued that self-regulated learning could be improved using instructional support (e.g. Azevedo & Cromley, 2004; de Bruin & van Gog, 2012). In this study, the LAD was designed based on a self-regulated learning framework (see Chapter 2); the data provides some evidence that the LAD may be effective in regard to improving students' self-regulated learning, which has been identified as one of the most important challenges in the flipped classroom. Implementing a tool or other strategies initiated with the LAD should be considered for improving self-regulated learning in a flipped classroom.

The results of this study also provide guidelines for the design and development of self-regulated learning support. Self-regulated learning involves context-specific skills. The results of this study give indication that it can be properly supported when an instructional intervention is based on contextual knowledge about student learning processes. Through the development and testing of the LAD proposed for this study, the results shed light on how students' self-regulated learning support could be provided through an LAD.

Furthermore, the principles and guidelines proposed in this study may benefit practitioners who seek to design and develop LADs in similar contexts. Considering that blended learning involves both face-to-face and online components, this study's approach to using student log traces to visualize students' learning progress can be applied to similar contexts. Given the growing use of blended learning models in higher education, the learning analytics approach tested in this study provides timely insights into how students' self-regulated learning could be supported in flipped learning environments.

Plans for Refining the Learning Analytics Dashboard

The LAD developed for this study was an initial effort at helping guide students' self-regulated learning. The results of the study help to inform suggestions for revisions and continued development.

First, automating the data synchronization between the learning management systems and the proposed LAD will enable the students to monitor their learning progress in real time. The current system requires the instructor's manual work to update the data to be displayed for each assignment. Manual updating could easily be done by instructors for a small- or mid-size class, but it may take substantial time for a large-size class. A SQL code for automating synchronization specific to different types of learning management systems would help with this effort. I am seeking an interdisciplinary collaboration in order to improve the technical aspects of the LAD used for this study.

Second, adding an alert feature to the proposed LAD to remind the students of important upcoming tasks and assignments will further support self-regulated learning in a flipped classroom environment. The current system relies on the students' willingness to open the LAD, which leads to irregular or infrequent monitoring. Alert messages containing a summary of the students' learning progress may facilitate the students' self-reflection and consistent commitment to the tasks and/or readings needed for the flipped classroom.

Third, equipping the LAD with features to highlight the perceived value of learning tasks may assist with completion of tasks. Although the LAD was found to foster student emotional engagement, it is possible that some contextual factors accidently influenced students' emotional reactions to the LAD. As emphasized in Principle 3, student perception of learning tasks is

influenced by instructional strategies. Future revisions of the LAD used in this study may benefit from having explicit features designed to enhance learners' perception of task value.

Fourth, refining the LAD to provide a more comprehensive view of student learning may assist instructors with tracking and analyzing the learning process. The current LAD only displays student video completion rates and quiz scores. Although the data indicate that this simple information had some positive impacts on student learning, more information regarding the students' understanding of the content may lead to more in-depth self-reflection. Recent data analytics techniques, such as social network analysis and text mining, can be employed to capture students' social interactions and understanding of the course topics.

Limitations

There are several limitations in this study. First, this study adopted a quasi-experimental design because random assignment was practically implausible. The experiments were conducted with students who were already enrolled in particular sections of a course and reassigning students to different sections would cause considerable disruption. The students were expecting the course structure and policy as described in the syllabus, so reassigning some of the students who agreed to participant in this study would be unfair to them. Despite an incomplete random assignment and limited generalizability, the best effort was made to collect data from multiple sources, including student responses to a survey, interviews, log traces, and quiz scores. By combining the findings from the multiple data sources, this study obtained as comprehensive view of the impact of the LAD as possible on the students' self-regulated learning, engagement, and performance.

Second, some important factors in an experimental setting, such as having the same instructor, was not possible between the experimental and control group in Study 1 for this

research. In Study 1, the instructor of the experimental group was the researcher of this present study. This fact may have influenced the participants' learning performance (i.e., Hawthorne effect); the participants in the experimental group may have behaved differently than usual being aware that they were observed in an experimental setting.

Third, since the students who took the course came from diverse majors, their backgrounds, interests, and prior knowledge might have influenced their learning and performance. Although the course was primarily offered to prepare pre-service teachers for teaching, it was open to non-education majors. It is conceivable that the students who majored in education may have had better prior knowledge and experience than the non-education major students. The diversity in the course may limit the generalizability of this study.

Fourth, inferential statistical analyses could not be performed in Study 2 due to the small sample size. The small sample size issue made it impossible to conduct an experiment involving both experimental and control groups as was done in Study 1. Although Study 2 replicated Study 1 in terms of the intervention and instruments, the findings from the two studies should carefully be interpreted in consideration of those differences in research design. Nevertheless, Study 2's findings from the interviews provided more in-depth information about the students' experiences with the LAD. Descriptive statistics also helped understand the changes that occurred in the students as a result of using the LAD.

Fifth, the types of information displayed to the students were limited to student video completion rates and quiz scores because these two indicators were the two main tasks that the participants were required to complete prior to the in-class sessions. More proxies that represent student interactions with resources could aid students in monitoring various aspects of their learning. For example, information about how frequently students rewound videos and how long

they paused them at a particular time points could help the students gain a better understanding of their learning processes. Future research should consider using advanced video hosting systems in order to capture student fine-grained behaviors.

Sixth, the characteristic of the course as an elective course could influence the student learning performance. During the interview, one student mentioned that the course was not her top priority as it was an elective course. A weekly assignment in an elective course may be neglected, especially toward the end of the semester when students have multiple final exams and assignments from other courses. As such, the LAD and flipped classroom model might have not fully functioned as intended. Future research that considers those factors would provide more reliable findings.

Last, a majority of the students who participated in this study were female. This skew may have resulted in some degree of bias. Although prior studies have reported no or marginal gender effects on students' self-regulated learning (Hong, Peng, & Rowell, 2009; Yukselturk & Bulut, 2009), future research with a balanced sample would provide more reliable findings.

Conclusion

This study sought to address the current gap resulting from the self-regulated nature of flipped classrooms. In designing, developing, and implementing a LAD, this study provided comprehensive insights into how students' learning can be enhanced using the learning analytics approach. The main intervention used in this study was a LAD. The LAD was proposed based on the concept of the quantified self, which enables students to monitor their own learning progress (Verbert et al., 2013). Specifically, this approach was intended to promote students' self-awareness, self-monitoring, and self-reflection (Duval, 2011). The design and development of

the LAD involved the review of extensive literature on self-regulated learning theories, followed by two empirical studies conducted to examine the impact of the developed LAD.

The findings from the two empirical studies can be summarized as follows. The results from Study 1 indicated that the students who used the LAD demonstrated better self-regulated learning skills, engagement, and performance than the students who did not use it. It is important to note that the use of the LAD contributed to different types of student engagement. Specifically, the use of the LAD positively affected the students' behavioral engagement with the pre-class sessions and cognitive engagement with the in-class sessions. In essence, the LAD appears to have helped the students sustain different types of engagement throughout the pre- and in-class sessions without a gap where the students are disengaged from the learning tasks. Furthermore, the students who used the LAD indicated that they maintained their emotional engagement throughout the project. This finding indicates that the use of the LAD helped the students deal with their negative emotions in flipped classrooms reported in prior studies (Wanner & Palmer, 2015).

The results from Study 2 provided further indication that the students who used the LAD had positive experiences with the flipped classroom. The descriptive statistical analysis indicated similar trends in the affect of the LAD on the students' self-regulated learning, engagement, and performance. The findings from the interviews were aligned with Study 1's findings and helped to reinforce the finding that the LAD was effective in regard to facilitating the students' self-monitoring, self-awareness, and self-reflection, which was reflected in the students' engagement and performance.

In short, this study presented the potential of LADs to support students' self-regulated learning, engagement, and performance in flipped learning contexts. Importantly, the results of

this study indicated that various issues, such as students' poor engagement and performances, pointed out in prior studies could be addressed with a well-structured instructional intervention through an LAD. Despite the presented limitations, this study provides principles and design guidelines for LADs. Additionally, the learning analytics approach used in this study has the potential to optimize students' experiences with flipped classrooms. Continued research and implementation of LADs in flipped classroom environments will enable further refinement of the LADs as well as the learning analytics approaches.

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APPENDICES

Appendix A

Consent Form

Self-regulated learning in flipped classroom

Researcher's Statement

We are asking you to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. This form is designed to give you the information about the study, so you can decide whether to be in the study or not. Please take the time to read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information. When all your questions have been answered, you can decide if you want to be in the study or not. This process is called "informed consent." A copy of this form will be given to you. You must be 18 years of age or older to participate.

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Purpose of the Study

The purpose of this study is to investigate the effect of self-regulation support on undergraduate students' flipped learning performance and engagement. The EDIT2000 course is designed for undergraduate students who are interested in technology integration and involves a series of projects that requires the students to study course. Materials at home in advance of in-class sessions. As university instructors are increasingly using flipped learning methods for their courses, the findings of this study will inform practice for flipped learning at UGA.

Study Procedures

The design activity is one of the course projects that are already included in the course syllabus. If you agree to participate, you will be asked to take the following steps

- You will be asked to complete pre-survey before the design activity, the estimate time to complete them is about 7-10 minutes.
- After the activity, you will be asked to respond to a post survey.
- Your project product and related materials will be collected for further analysis.
- (Optional) After completing the post-survey, only those who want to have an interview will invited to an individual interview (20-30 minutes, face-to-face or phone) regarding your experience with the flipped learning. Your interview will be audio recorded.

Risks and discomforts
It may be possible that you feel pressure when you are asked to share your experience with the design activity. We would like you to note that any of comments, responses, and decisions regarding participation in this research study does not affect your grades at all. Your instructors will not see what you said in surveys and interviews. We will also try our best to avoid being intrusive during this study as well as data collection.

Benefits
There may not be visible or direct benefits in a short term from participating in this study. Collected data will also help improve teacher education courses at UGA.

Alternatives
While students who consent to participate in this study fill out surveys, those who did not agree to participate will read a short journal article that is related to self-regulated learning.

Incentives for participation
Those who participate in a study will receive extra 2% points of total score. And those who participate in an interview will receive a ten-dollar check.

Audio/Video Recording
In order to ensure this research findings, reflect what participants said without missing part, interviews will be transcribed verbatim and analyzed word by word. After 3 years from the completion of the data analysis, the recordings of interviews will be destroyed.

Privacy/Confidentiality
Participants' personal information will not be released to anyone outside of the research team. Even the instructor will not see your surveys and interview. Your identifiable information will not be revealed in any publication. Once you consent to participate in this study, you will be asked to write your name and email address, along with some other information. Please note that this is just for researchers to link your survey responses with your interview and artifacts. Your survey responses and interview transcripts will be coded electronically and locked with a passcode. The files will be stored in password-protected devices to prevent anyone without permission from accessing the data. After 3 years from the completion of the data analysis, the recordings of interviews will be destroyed.

Taking part is voluntary
Participation in this study is 100% voluntary, and you can decide not to participate and even stop participating at any time you want. Your decision and withdrawal will never affect your grade. Even if you decided to withdraw from this study, your information and data may be analyzed as part of this study.

If you have questions
The main researcher conducting this study is Janette R. Hill, a professor at the University of Georgia. Please ask any questions you have now. If you have questions later, you may contact Janette R. Hill at janette@uga.edu. If you have any questions or concerns regarding your rights

as a research participant in this study, you may contact the Institutional Review Board (IRB) Chairperson at 706.542.3199 or irb@uga.edu.

Research Subject's Consent to Participate in Research:
To voluntarily agree to take part in this study, you must sign on the line below. Your signature below indicates that you have read or had read to you this entire consent form and have had all of your questions answered.

_____	_____	_____
Name of Researcher	Signature	Date
_____	_____	_____
Name of Participant	Signature	Date

Please sign both copies, keep one and return one to the researcher.

Appendix B

Demographic Survey

1. First name: _____

   Last name: _____

2. What is your age? _____

3. What is your gender?

   A. Male

   B. Female

4. What is your major or intended major? _____

5. What year are you in?

   A. First year

   B. Second year

   C. Third year

   D. Fourth year

6. What is your ethnicity?

   A. White

   B. Black/African American

   C. Asian/Asian American

   D. Hispanic/Latino

   E. Multiracial

Appendix C

Student Learning Strategies Questionnaire

The following items will measure your general self-regulated learning strategies. Continue to respond to each item

	Strongly Disagree <----------> Strongly Agree				
I set my own learning goals (I decide what I need to learn)	①	②	③	④	⑤
I set my own process goals (I list what I need to do to achieve my learning goals).	①	②	③	④	⑤
I identify strategies for achieving my goals.	①	②	③	④	⑤
I revise my goals when necessary.	①	②	③	④	⑤
I am motivated to learn.	①	②	③	④	⑤
I explain (to myself) what I need for an assignment.	①	②	③	④	⑤
I list the strategies (in mind or on something) I'm using when I work on assignments.	①	②	③	④	⑤
I check my progress towards achieving my goals.	①	②	③	④	⑤
I modify (correct) my actions on my own to achieve my goals.	①	②	③	④	⑤
I modify (correct) strategies that are not helping me achieve my goals.	①	②	③	④	⑤
I give helpful advice to my classmates on their work.	①	②	③	④	⑤
I use comments from my teacher to improve on my work.	①	②	③	④	⑤
I use comments from my classmates to improve on my work.	①	②	③	④	⑤
I use comments from my family to improve on my work.	①	②	③	④	⑤
I revise versions of my work to improve them.	①	②	③	④	⑤
I reflect on the strategies I used to achieve my goals.	①	②	③	④	⑤
I evaluate my own work (I look at my work to see if it is good or needs improvement)	①	②	③	④	⑤
I know how I am being evaluated.	①	②	③	④	⑤
I make connections between the amount of time I spend on my work, and my achievement.	①	②	③	④	⑤
I work well with other students.	①	②	③	④	⑤

Appendix D

Student Engagement Survey

The following items to measure your engagement with assigned videos and quiz (pre-class sessions) and class activities (in-class sessions). Continue to respond to each item. This survey is just to see how engaging the pre- and in-class sessions were to you. I would appreciate your honest response. Your response will never affect your grade.

Reading and video assignment

	Strongly Disagree <----------> Strongly Agree						
I paid attention to the pre-class sessions of this course (behavioral)	①	②	③	④	⑤	⑥	⑦
I worked very hard to understand the pre-class sessions for of course (behavioral)	①	②	③	④	⑤	⑥	⑦
I tried to learn as much as I could from the pre-class sessions of this course (cognitive)	①	②	③	④	⑤	⑥	⑦
I enjoyed the pre-class sessions of this course (emotional)	①	②	③	④	⑤	⑥	⑦

Class Activity

	Strongly Disagree <----------> Strongly Agree						
I paid attention to in-class sessions of this course	①	②	③	④	⑤	⑥	⑦
I worked very hard for in-class activity of this course	①	②	③	④	⑤	⑥	⑦
I tried to learn as much as I could from in-class sessions of this course	①	②	③	④	⑤	⑥	⑦
I enjoyed in-class sessions of this course	①	②	③	④	⑤	⑥	⑦

Appendix E

Quiz Assignment

BYOD Quiz #1

Quiz items #1 to #5 are related to the video "BYOD Introduction", and #6 to #10 are related to the video "BYOD in schools: Challenge".

1. **First name, Last name**

2. **1. At the beginning of the video 1 (BYOD Introduction), the person in the blue shirt said they don't need a recorder because...**
   Mark only one oval.
   - ◯ they don't need to scan life forms anymor
   - ◯ the recorder does not work well on the planet without air
   - ◯ everything is on his phone

3. **2. In the video1, the narrator explains that schools do not offer one computer per pupil because...**
   Mark only one oval.
   - ◯ the price of computer is expensive
   - ◯ school board technicians cannot maintain all computers
   - ◯ there are some legal issues related to computer software
   - ◯ School curricular do not require that many computers.

4. **3. Which of the following statements about BYOD is correct?**
   Mark only one oval.
   - ◯ Students can only use a device that meets the standard established by their school.
   - ◯ With BYOD, schools have responsibility to ensure students' devices are working.
   - ◯ If necessary, schools can afford some devices for students who cannot afford their own devices
   - ◯ BYOD makes technology mandatory

5. **4. Which of the following statements about BYOD is NOT correct?**
   Mark only one oval.
   - ◯ From the BYOD perspective, school is no longer the repository of knowledge.
   - ◯ It is up to students to make sure their devices are working.
   - ◯ To be fair, students have to use the same kind of devices for class activities.

6. **5. Which of the following can you infer from this video?**
Mark only one oval.

- Teachers' role should be reconsidered with BYOD.
- BYOD helps students take care of the computable as well as meaningful.
- The narrator suggests that students' use of social media in class be banned during BYOD.
- Our brain can do multitasking.

7. **6. Which of the following is true according to video #2 (BYOD in schools: challenges by fox news)?**
Mark only one oval.

- Most parents are concerned about BYOD hurting the way their kids are learning in school.
- The reporter said we seem to rely more and more on electronic devices.
- The school teaches their students cyber safety.

8. **7. What was the name of the county being reported in this video?**
Mark only one oval.

- Collin county
- Cole county
- Collier county

9. **8. How does the school prevent students from being connected to social media?**
Mark only one oval.

- By asking students to use old devices that cannot access social media
- By offering school district Wi-Fi
- By asking students not to use social media
- By using an application designed to restrict students' access to social media.

10. **9. Which of the following is true in this video?**
Mark only one oval.

- The president of parents rock insists that students are spending too much time on basics with BYOD.
- The son of the president of parents rock is not asking her to be on Facebook.
- The president of parents acknowledges that BYOD made students good at math and reading.
- The president of parents is convinced that the school's effort to teach cyber safety is effective.

11. **10. How can the students be connected to social media?**
Mark only one oval.

- By unlocking the password for Wi-Fi
- Switching over from Wi-Fi to 3G
- By using Wi-Fi outside of classroom
- The president of parents is convinced that the school's effort to teach cyber safety is effective.

BYOD Quiz #2

Quiz items #1 to #5 are related to the video #3_Teacher Perspective, and #6 to #10 are related to the video #4_BYOD and Education.

1. **Your Name (First name, Last name)**

_____

2. **1. The following are the "benefits of BYOD" the first teacher mentioned in EXCEPT:**
   Mark only one oval.

   - ◯ Students feel comfortable with their own devices.
   - ◯ There are no difficulties student have in suing their devices
   - ◯ Students can collaborate using technology
   - ◯ Students can do research projects using their devices

3. **2. Why was the first teacher concerned about BYOD?**
   Mark only one oval.

   - ◯ Because students can use devices for things they shouldn't do.
   - ◯ Because some students don't have devices.
   - ◯ Because students could be easily distracted by devices.
   - ◯ Because students could look at different things using 2-3 devices.

4. **3. Which of the following is NOT true in the interview with the first teachers about BYOD?**
   Mark only one oval.

   - ◯ Students feel comfortable because they use their devices the same way they used them before.
   - ◯ Students can enhance their learning opportunities through BYOD.
   - ◯ Students can use their devices for research projects
   - ◯ Fortunately, teachers did not have any students who used their devices for things they shouldn't do.

5. **4. Which of the following is NOT true regarding the interviews with the first two teachers?**
   Mark only one oval.

   - ◯ Both teachers were teaching science
   - ◯ Both teachers were concerned about BYOD at first.
   - ◯ The second teacher (Russel)'s students were shocked at first with the way the BYOD program went.
   - ◯ Russel was nervous about device errors during BYOD

6. **5. Which of the following can NOT be inferred from the interview with Russel?**
Mark only one oval.

- ◯ Through BYOD, students learn how to use technology responsibility.
- ◯ BYOD helps students engage in project-based learning compared to conventional form of class.
- ◯ BYOD influences our thought of how to teach students use device responsibly.
- ◯ BYOD helps students answer questions themselves rather than seeking help from teachers.

7. **6. Which of the following is not true?**
Mark only one oval.

- ◯ Some teachers were concerned about themselves not being a techy person.
- ◯ One teacher said they should not have to keep up with the way the world is going.
- ◯ One teacher said she wanted to try something new through BYOD.
- ◯ One teacher said BYOD even influenced student's personality.
- ◯ One teacher said BYOD is empowering their students to be a world leader.

8. **7. Which of the following tools the first student use to make her website?**
Mark only one oval.

- ◯ Wix
- ◯ Google
- ◯ Wordpress
- ◯ Dreamweaver

9. **8. For what did the second student with curly hair do stop motion videos?**
Mark only one oval.

- ◯ Geography project
- ◯ Math project
- ◯ Science fair
- ◯ Chemistry experiment
- ◯ Environment project

10. **9. Which of the following is NOT true?**
Mark only one oval.

- ◯ Some students said they did newscast
- ◯ One student became confident because of BYOD.
- ◯ One student feels power over her learning
- ◯ One girl is interested in working with boys
- ◯ One student got interested in algebra after BYOD

BYOD Quiz #3

Quiz items #1 to #5 are related to the video #5_Meaningful learning activity, and #6 to #10 are related to the video #6_Learning activity example.

1. **First Name, Last Name**

2. **1. The following are not mentioned for learning activity definition in video?**
   Mark only one oval.
   - ◯ Learning activities are for students to acquire new skills and concepts
   - ◯ Learning activities are to practice applying new skills and concepts
   - ◯ In learning activities, practice is more important as it deals with authentic problem
   - ◯ Learning activities allows to student to learning and practice new knowledge and skills

3. **2. Which of following was not mentioned as an example of learning activities?**
   Mark only one oval.
   - ◯ Hand-on task
   - ◯ Small group/whole class discussions
   - ◯ lab experiments
   - ◯ Research paper
   - ◯ Simulations

4. **3. Which of the following is NOT true regarding the description of learning activities?**
   Mark only one oval.
   - ◯ Learning activities centered on student
   - ◯ Requires students to account on learning
   - ◯ Student centered learning should require active student participation
   - ◯ In student centered learning, the role of instructor is guiding student's learning.

5. **4. According to the video, which following is NOT true regarding attributes of meaningful learning activities?**
   Mark only one oval.
   - ◯ 1) For meaningful learning, learning activity should be challenging
   - ◯ 2) To be coherent, all part of learning activities should have logical consistency
   - ◯ 3) Learning activities should be picked based on student's interest.
   - ◯ 4) Learning activity should tailored to the whole class

6. **5. List at least three attributes of meaningful learning activity when you designing your learning activity for our projects.**

7. **6. The teacher, in BYOD#6_Learning Activity Example, teach…**
Mark only one oval.

- Second grade in Sand Pine Elementary school
- Third grade in Sand Pine Elementary school
- First grade in Sand Pine Elementary school

8. **7. For the teacher in BYOD#6 mentioned, in her perspective it is very important …**
Mark only one oval.

- that students have identical device to manage class better
- that students bring their own device
- that students develop the technological literacy skills
- that monitor students by distracting from device

9. **8. Which of following is NOT true?**
Mark only one oval.

- Students already know more than teacher
- The teacher seeks for help to student sometime for using technology
- students should put some time at the beginning to get familiar with device
- Most of students in her class has their device

10. **9. What is NOT the way how teacher provide for the kids who don't have their device?**
Mark only one oval.

- ask student to share with friends
- using teacher's iPad or laptop
- using the classroom laptop

11. **10. How would you prevent students by distracting from device? Provide one or more strategy.**