Self-Regulated Learning Skills and Online Activities Between Higher and Lower Performers on a Web-Intensive Undergraduate Engineering Course

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Abstract

The objective of this study was to evaluate students' self-regulated learning (SRL) skills used in a Web-intensive learning environment. The research question guiding the study was: How did the use of student SRL skills and student engagement in online activities compare between higher- and lower-performing students participating in a Web-intensive engineering course? Specific focus was given to exploring how higher- and lower-performing students' forethought, performance control, and self-reflection as well as how their online activities differed. In this study, a Web-intensive course was defined as a unique online learning environment where lectures are broadcasted through Web conferencing software while students participate in the lectures from a computer laboratory, facilitated by teaching assistants. Fifty-seven valid data sets were analyzed from questionnaire, data logs provided by a learning management system, ranking questions, and project performance. The findings suggest that higher performers outperformed lower performers significantly on goal setting. On the other hand, lower performers reported a significant higher score on task strategies than their higher-performing peers. Regarding students' online activities, higher performers accessed all course materials significantly more frequently than lower performers. Furthermore, when evaluating the promptness of assignment submission, the results found the higher performers showed that they were significantly more prompt than lower performers in submitting their assignments. This article also outlines suggestions for further research in the Web-intensive course.

Keywords: Web-intensive course, self-regulated learning, forethought, performance control, self-reflection, engineering online education

INTRODUCTION

The advances in computer technologies have made learning possible to anyone, at any time, and in any place. Despite those benefits, there are still challenges to provide a good learning environment which fosters student effective learning experiences. The rapid growth of online distance education worldwide has prompted the need to revise delivery structures and re-think pedagogical practices that were once appropriate. Four major concerns about online learning and its quality relative to face-to-face classroom learning were suggested by Gallagher and McCormick (1999). Those four concerns are (1) student attitude and satisfaction; (2) interactions of students and faculty; (3) student learning outcomes; and (4) faculty satisfaction. Responding to those concerns, Web-based instructional designers and teachers adopt Chickering and Gamson's (1987) seven principles of effective education (e.g., clear guidelines for interaction, provide timeline for each task assigned to students) to promote effective engagements of students in learning. New models of teaching can proactively use the seven principles when addressing the needs of the program to avoid pitfalls.

Numerous studies found that self-regulated learning (SRL) is a significant predictor of academic performance (e.g., Khatib, 2010; Kitsantas, Winsler, & Huie, 2008; Musso, Kyndt, Cascallar, &

Dochy, 2012; Lynch, 2006; Pintrich & de Groot, 1990; Zimmerman & Martinez-Pons, 1986); however, while some studies have comprehensively evaluated SRL in the context of online learning, very few show emphasis in engineering education. SRL can be defined essentially as a form of iterative, goal-directed activity that involves interpreting tasks, setting goals, selecting, adapting or even inventing strategies effective for achieving those goals, monitoring progress, and adjusting approaches as needed (Zimmerman, 2008). Effective SRL is particularly critical in complex or ill-structured tasks, such as engineering design (Lawanto, 2010; Lawanto, Goodridge, & Santoso, 2011; Lawanto & Johnson, 2012). In other contexts such as programming course and computer-based instruction, previous studies revealed that students who highly employed their SRL strategies performed better than the students who did not use their strategies optimally (Bergin, Reilly, Traynor, 2005; Kinnebrew, Loretz, & Biswas, 2013; Young, 1996). Furthermore, other studies suggested that scaffolding features can be used to help students use their SRL strategies in a computer-based learning environment (e.g., Azevedo, Cromley, & Seibert, 2004; Azevedo & Hadwin, 2005).

Zimmerman argued that self-regulated learners are “metacognitively, motivationally, and behaviorally active participants in their own learning process” (Zimmerman, 1986, p. 308). These characteristics represent the core elements for the development of autonomy and responsibility which facilitate students to take charge of their own learning process. Since these traits are for students to take an active role in their learning, the possession of SRL skills becomes crucial in within the online learning environment. Although previous studies (Bergin et al., 2005; Kinnebrew et al., 2013; Young, 1996) showed that students who highly employed their SRL strategies in a computer-based instruction performed better than their peers who did not use their strategies optimally, the authors have not found a study that trace students SRL skills and actual behaviors while engaged in a Web-intensive course based on their design project performance. In this study we focused specifically on higher- and lower-performing students' SRL skills as reflected by their efforts in: accessing online course materials such as quizzes/homework and supplementary (or on demand) information, and submittal of assignments and quizzes through a learning management system.

In the current study, we specifically use the term *web-intensive* course as explained by Southard and Rubens (2001). They established a definition by stating that a web intensive course should "meet in a physical venue at specific intervals during the course." They further stated that, "…additional interactions occur via the web through email, chat, and discussion programs as required. Most courses materials are conveyed electronically (p. 83)." The current study refers to a unique learning environment where the instructor was never physically in front of the class and lectures were broadcasted through web conferencing software. Students participated in the lectures from a geographically isolated computer laboratory where supplemental on site instruction was conducted by teaching assistants when necessary.

LITERATURE REVIEW

Self-regulated learning is characterized by three main features which include awareness of thinking, use of strategies, and motivation (Paris & Winograd, 2003). The first feature, awareness of thinking, is popularly called metacognition. From a cognitive perspective, metacognition has been associated with cognitive processes. The difference between cognition and metacognition is based upon functionality. While cognition concerns one's ability to build knowledge, process information, acquire knowledge, and solve problems, metacognition concerns the ability to control the working of cognition to ensure that the goals have been achieved or the problem has been solved (e.g., Flavell, 1979). Thus, metacognitive activity usually precedes and follows cognitive activity (Johnson, Dixon, Daugherty, & Lawanto, 2011). Researchers have maintained that the important issue in metacognition and SRL is to understand "the correspondence between metacognition and action. To explicitly look into how thoughts and feelings of learners guide their thinking, effort, and behavior?" (Paris & Winograd, 1990, p. 21).

According to Zimmerman, SRL refers to students' "self-generated thoughts, feelings, and actions which are systematically oriented toward attainment of their goals" (Zimmerman, 1994, p. ix). His SRL model consists of three phases: forethought, performance control, and self-reflection (Zimmerman, 1998). The first phase, *forethought*, refers to readiness processes and beliefs that occur before students put any effort in their learning activity. This phase consists of two main components: task analysis and self-motivation beliefs. During this phase students set their learning goals and expectations, identify strategic planning, and think about the value of the activity. The second phase, *performance control*, consists of processes during the learning activity including self-control and self-observation. Students execute their plans, focus on their task strategies, and monitor their learning events. In the third phase, students adjust their learning strategies employed in the previous phases: forethought and performance control. The third phase consists of a student's implementation and use of self-judgment and self-reaction.

Research suggests that SRL benefits student learning (Khatib, 2010; Lynch, 2006; Pintrich & de Groot, 1990; Zimmerman & Martinez-Pons, 1986). Since autonomy and responsibility are mandatory for a student to play an active role in their learning, the possession of SRL skills becomes crucial in Web-based instruction or online learning (Barnard, Lan, To, Paton, & Lai, 2009; Lee, 2009). Bourne, Harris, and Mayadas (2005) suggested that online engineering education should provide a high-quality format, reliable in terms of its accessibility, and cover broad topics in engineering disciplines. To effectively provide ‘a high-quality format,’ online engineering education programs should not only be concerned with the technology used in the program, but also with the pedagogical aspect of online learning (Chizmar & Walbert, 1999). With regards to the student, online learning requires effective learning skills. This study will investigate self-regulated learning skills employed by the students in a web intensive solid modeling course.

For traditional higher-education institutions where most students are on campus and physically present with the instructor, the delivery of an online learning experience may not be relevant or justifiable. However, with ever increasing course enrollments becoming a more frequent scenario within more traditional educational settings (Snyder & Dillow, 2011), institutions may look to use different methods in delivering online materials. For example, educational institutions can approach the development of online synchronous courses by implementing a single instructor who broadcasts into a classroom of students with supplemental facilitation by on site by competent teaching assistants. This enhanced online course approach allows a greater number of students to be present during a synchronous broadcast lecture while still allowing on-site interaction with a supplemental teaching assistant to provide immediate feedback and support. In this context the course can be referred to as *a Web-intensive course* thus setting it apart from the typical synchronous course delivery model where there is no on-site expert interaction and students receive the lecture either individually or in isolated groups. Advantages to students seen within this model are found in their self-efficacy, lessened sense of isolation, and immediacy of feedback. The advantages to the university involve the financial savings found by allowing one instructor to direct a course to a larger student population. In addition, this type of augmented model can prove extremely effective for engineering courses requiring laboratory experiences as well as online implementation into a hesitant university system where there is still resistance to embrace an online STEM curriculum (Bourne, Harris & Mayadas, 2005). In fact this type of model may promote a more rapid adoption of online instruction to the STEM fields.

THE STUDY

The purpose of this study was to evaluate students' self-regulated learning (SRL) skills used in a "Web-intensive" learning environment. This study used Zimmerman's (1998) SRL model which evaluates students' *goal setting*, *environment structuring*, *task strategies, time management*, *help seeking*, and *self-evaluation* activities while engaged in a Web-intensive learning environment.

Research Question

The research question constructed for this study was:

> "How did the use of students SRL skills and engagement in online activities compare between higher- and lower-performing students participating in a Web-intensive engineering course?"

Study Participants

Fifty-seven undergraduate engineering students at a large land-grant university in the western United States participated voluntarily in the study. Among those students, three were females (5%) and 54 were males (95%). Most of the student participants were sophomores (91%) while a minor amount were freshmen (9%). A letter of consent was obtained from the participating students at the beginning of semester.

Context of the Web-Intensive Course

The course that participants were enrolled in is an engineering graphic course required in the pre-professional mechanical engineering program for a large land-grant university. The course involved the learning and application of a parametric solid modeling software assessed through a variety of homework, quizzes, and design projects. In this course, the students used solid modeling software to develop and model a variety of objects. Initially students learned the basics of solid creation including extrusions and revolutions and then rapidly progressed into the development of assemblies. Finally students focused on evaluating part to part interaction, clearances, and the creation of animations showing required motions. Emphasis was also given to document generation, dimensioning based on American National Standards Institute (ANSI) and International Organization for Standardization (ISO) standards, and an introduction to geometric dimensioning and tolerance. Dimensioning refers to designating the sizes of associated features on a part while tolerances refer to the allowable range of variation in that size that the part must be accurate to. The class eventually culminated with an introduction to finite element analysis, a software implemented analysis technique allowing students to visualize and quantify stresses and deformation within the part under specific applied loading conditions.

The course required students to complete two projects during the semester that have increasing difficulty. The final project emphasized an open-ended and ill-structured design and was a capstone activity worth 20% of the students' course grade. Students were allotted four weeks to complete the design project (see Figure 1 for examples of students' project outcomes). Students were initially given a theoretical background or setting for the final design project requiring the robotic arm to be implemented in an assembly line application essentially acting as a transporting mechanism to move parts from one location to another. Teaching assistants were present during the lecture to aid students. The same teaching assistants also provide two hours of voluntary open laboratory access outside of class for extra help.

The class uses a learning management system (LMS) providing students with a variety of course materials. This LMS also allows the instructor the ability to track student access to course resources. Within this class those resources fall within three categories including *assigned*, *optional*, and *informative*. The assigned category has materials essential to the student's success in the class. These materials are mandatory and can include information for successful completion of homework, projects, and quizzes. The optional category describes materials that allow the students to practice and reinforce concepts learned in the class but will not be graded and therefore has a secondary impact upon class performance through the added opportunity to master the concepts. The informative category encompasses materials designed to capture student interest, retain their motivation, and let them see the production side of mechanical engineering rather than just the virtual design. The materials include video files offered through the LMS demonstrating how parts will be manufactured after they are designed in the software, handouts on how to use their engineering calculator, and handouts showing engineering paper sizes. Most of this material is reference material and has no direct impact upon the class grade other than possible ties to motivation.

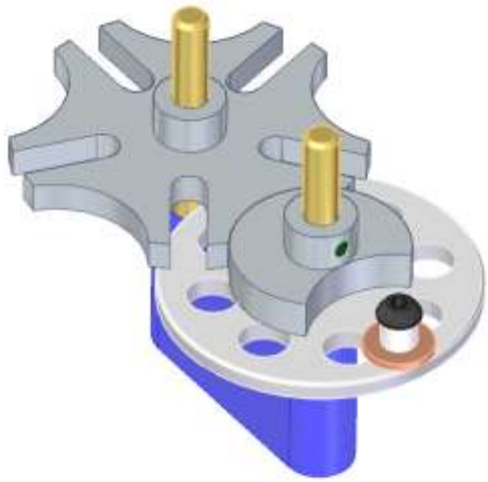
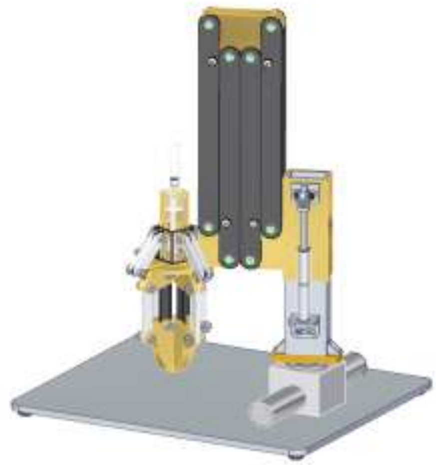
Outcome Example of Project – Sequence #1	Outcome Example of Project – Sequence #2
	

Figure 1. Examples of students' project outcomes

Links in the LMS are also provided to allow students to see scholarship opportunities as well as learning objectives for the course and outcomes. The LMS also provides appropriate upload locations for all homework and quizzes to be submitted to as well as access to any file that is needed for the homework and quiz to be completed. Similar folders are provided for projects and quizzes and in some cases video clips are delivered showing proper mechanism motion if needed. Video records of lectures are also provided.

Instrumentation

This study involved data collected from four sources: (1) Questionnaire; (2) Data logs provided by a learning management system (LMS) used for the course; (3) Ranking questions, and (4) students' project performance. A twenty-four items of Online Self-regulated Learning Questionnaire (OSLQ), with a 5-point Likert-scale ranging from "strongly disagree" (a score of 1) to "strongly disagree" (a score of 5) originally developed by Barnard, Paton, and Lan (2008) was used to evaluate students' self-regulated learning skills in their online learning environment. The OSLQ consists of six subscale constructs, including goal setting, environment structuring, task strategies, time management, help seeking, and self-evaluation. Based upon Zimmerman's

SRL model (1998), the first two subscales (i.e., goal setting and environment structuring) are part of *forethought strategy*, the next three subscales (i.e., task strategies, time management, and help seeking) are part of *performance control* strategies, and the self-evaluation subscale belongs to what is termed *self-reflection*. According to Barnard, Lan, and Paton (2010), the internal reliability score of the OSLQ was sufficient ($\alpha = .90$). Cronbach's Alpha coefficients for its six subscales ranged from .85 to .92 (see Table 2 for examples of the survey items).

Table 1

Examples of OSLQ Items and Cronbach's Alpha Scores of OSLQ Subscales

No.	Items	Subscale	Cronbach's Alpha
1.	I set standards for my assignments in online courses.	Goal setting	.88
2.	I choose the location where I study to avoid too much distraction.	Environment structuring	.92
3.	I prepare my questions before joining in the chat room and discussion.	Task strategies	.85
4.	I allocate extra studying time for my online courses because I know it is time-demanding.	Time management	.91
5.	If needed, I try to meet my classmates face-to-face.	Help seeking	.92
6.	I ask myself a lot of questions about the course material when studying for an online course.	Self-evaluation	.89

Besides data from the OSLQ, we also collected data from the data logs provided by the LMS used, ranking questions, and project performance. Data such as mean scores of the frequency of students accessing various learning materials (e.g., supplementary or on demand information for all students) and number of on-time, late, and early submitted course assignments (e.g., homework, quizzes, projects) were also collected. Ranking questions were also developed and asked to provide better information on how students used the learning management system in terms of assessing learning materials and submitting assignments. Furthermore, data of students' project performance were analyzed to create two groups of participants: higher- and lower-performing students. A hierarchical cluster analysis using Ward's method (Ward, 1963) was used in the cluster analysis to find relatively homogeneous clusters based on measured parameters (i.e., project performance).

Data Collection and Analysis

In the current study, data were collected from questionnaire, data logs provided by the LMS used, ranking questions, and project performance. Data such as mean scores of the frequency of students accessing various learning materials (e.g., supplementary or on demand information for all students) and number of on-time, late, and early submitted course assignments (e.g., homework, quizzes, projects) were also collected. Ranking questions were also developed and asked to provide better information on how students used the learning management system in terms of assessing learning materials and submitting assignments. Furthermore, data of students' project performance were analyzed to create two groups of participants: higher- and lower-performing students. A hierarchical cluster analysis using Ward's method (1963) was used in the cluster analysis to find relatively homogeneous clusters based on measured parameters (i.e., project performance).

As a first step in analyzing 80 data sets from the OSLQ, the survey data were evaluated for irregularities. Specifically we looked for anyone who responded to each survey item with the same answers (e.g., marked "5" for all items or blocks of items). One suspiciously completed survey was identified and one student did not complete the survey. As a result of the finding, we excluded their data sets from our data pool, and ended up with 57 data sets to be analyzed. To analyze data from OSLQ, mean scores were calculated for each SRL features (i.e., goal setting, environment structuring, task strategies, time management, help seeking, and self-evaluation). Then, mean scores for individual items of OSLQ were also calculated. A non-parametric statistical test (i.e., Mann-Whitney test) was used to measure significant differences in OSLQ subscale and item levels between higher and lower performers.

Similarly with data collected from LMS data logs, means scores of the frequency of students accessing learning materials were calculated. Data logs refer to the number of accesses made on quizzes/homework and other course materials. In addition, each late-, on-time, and early-submitted assignment was given a 1, 2, or 3 point, respectively. For example, if a student submitted one late-, one on-time, and one early- submitted homework, he or she would receive a 6 point (i.e., 1 + 2 + 3) for his or her promptness in submitting homework. A zero was given for any unsubmitted assignments. Descriptive statistics and Chi square tests were conducted to evaluate the amount of efforts made to access all learning materials and promptness in submitting online assignments between higher- and lower-performing students.

From ranking questions, students voiced their thoughts about why they sometimes accessed on a particular online material item more than once (i.e., for an illustration, see Table 2). Table 2 shows the total number of students who rank each individual statement on a scale from 1 to 5 with 1 equating to what students felt as the first relevant reason and 5 equating to what students perceived as the least relevant reason. The final rank column was developed by weighting the responses for each rank and dividing by the total ranks available. To illustrate this step in more detail, the number of highest ranked (i.e., Rank 1) responses was multiplied by 5, the number of next highest ranked responses was multiplied by 4, and this method continued on until the number of lowest ranked (i.e., Rank 5) responses was multiplied by 1. Summing the products of all the rankings within a feature yields the large numerator in the quotient seen in the weighted products column. This summed product was then divided by the total available ranks forming a weighted value. The weighted values for each distinct feature were then comparable and facilitated a final ranking (1 through 5) for each of the features or survey items the students responded to.

Table 2

An Illustration of Ranking Questions Weighting System

#	Statement *Sometimes I access on particular online material item more than once because…*	Rank 1	2	3	4	5	Sum of multiplications divided by 5	Final Rank
1	Statement….	"a"	"b"	"c"	"d"	"e"	"x"	["y"]

Findings

To address the research question, *how did the use of students SRL skills and engagement in online activities compare between higher- and lower-performing students participating in a Web-intensive engineering course?*, we first focused on the creation of two groups. The results revealed that the mean score of project performance for higher-performing students (n = 29) was 94.84 (min. = 91.75; max. = 99.21) and the mean score for lower-performing students (n = 28) was 86.43 (min. = 76.40; max. = 90.93). A Mann-Whitney test found that mean scores between both groups was significantly different ($Z = -6.48$; $p < 0.001$). The authors presented the findings between both groups in two parts: self-regulated learning skills and online activities.

Higher and Lower Performers' Self-Regulated Learning Skills

Descriptive statistics of the OSLQ subscales showed that higher performers reported higher scores on goal setting and environment structuring compared to lower performers. On the other hand, lower performers had higher mean scores on the rest of the subscales (i.e., task strategies, time management, help seeking, and self-evaluation). A series of Mann-Whitney tests on the subscale levels reported that higher performers outperformed lower performers in goal setting (Z =-2.375, p = .009). Lower-performer students outperformed higher-performing students in task strategies (Z = -2.114, p = .017). More specifically, the statistical tests from OSLQ analysis revealed that the higher-performing students outperformed the lower-performing students on three goal setting items: "I set standards for my assignments in online courses" (Z = -2.170, p = .015), "I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester)" (Z = -1.751, p =.040), and "I keep a high standard for my learning in my online courses" (Z = -2.536, p = .006). On the other hand, lower-performing students reported significantly higher scores on three items including task strategies ("I read aloud instructional materials posted online to fight against distractions"; Z = -2.112, p = .018), time management ("I try to schedule the same time every day or every week to study for my online courses, and I observe the schedule"; Z = -1.988, p = .024), and self-evaluation items ("I communicate with my classmates to find out how I am doing in my online classes"; Z = -1.767, p = .038). Table 3 shows the mean scores and standard deviations of online SRL skills between both groups for each item.

Table 3

Mean Scores and Standard Deviations of Online SRL Skills (N = 57) between Higher and Lower Performers

No.	Questionnaire Item	Higher Performer (N = 29)	Lower Performer (N = 28)
		M (SD)	M (SD)
Goal Setting**		**4.06 (0.61)**	**3.62 (0.65)**
1.	I set standards for my assignments in online courses.*	4.21 (0.86)	3.68 (0.86)
2.	I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester).*	3.90 (1.08)	3.43 (0.96)
3.	I keep a high standard for my learning in my online courses.*	4.21 (0.62)	3.64 (0.91)
4.	I set goals to help me manage studying time for my online courses.	3.59 (0.91)	3.29 (1.01)
5.	I don't compromise the quality of my work because it is online.	4.38 (0.98)	4.07 (1.05)
Environment Structuring		**3.85 (0.72)**	**3.72 (0.81)**

No.	Questionnaire Item	Higher Performer (*N* = 29) *M* (SD)	Lower Performer (*N* = 28) *M* (SD)
6.	I choose the location where I study to avoid too much distraction.	3.69 (1.17)	3.61 (1.32)
7.	I find a comfortable place to study.	4.03 (0.78)	3.89 (0.92)
8.	I know where I can study most efficiently for online courses.	3.93 (1.10)	3.68 (0.91)
9.	I choose a time with few distractions for studying for my online courses.	3.76 (0.79)	3.71 (1.05)
Task Strategies*		**2.07 (0.66)**	**2.51 (0.74)**
10.	I try to take more thorough notes for my online courses because notes are even more important for learning online than in a regular classroom.	2.17 (1.07)	2.50 (0.88)
11.	I read aloud instructional materials posted online to fight against distractions.*	1.48 (0.69)	2.07 (1.12)
12.	I prepare my questions before joining in the chat room and discussion.	2.28 (1.22)	2.64 (1.22)
13.	I work extra problems in my online courses in addition to the assigned ones to master the course content.	2.34 (1.17)	2.82 (1.12)
Time Management		**2.80 (0.92)**	**3.11 (0.75)**
14.	I allocate extra studying time for my online courses because I know it is time-demanding.	2.90 (1.05)	2.64 (1.06)
15.	I try to schedule the same time every day or every week to study for my online courses, and I observe the schedule.*	2.62 (1.24)	3.29 (1.12)
16.	Although we don't have to attend daily classes, I still try to distribute my studying time evenly across days.	2.90 (1.15)	3.39 (0.92)
Help Seeking		**3.16 (0.72)**	**3.35 (0.67)**
17.	I find someone who is knowledgeable in course content so that I can consult with him or her when I need help.	3.34 (1.11)	3.79 (1.07)
18.	I share my problems with my classmates online so we know what we are struggling with and how to solve our problems.	2.66 (1.26)	3.07 (1.18)
19.	If needed, I try to meet my classmates face-to-face.	3.79 (0.91)	3.57 (1.10)
20.	I am persistent in getting help from the instructor through e-mail.	2.86 (1.16)	2.96 (1.07)
Self-Evaluation		**2.66 (0.99)**	**3.01 (0.88)**
21.	I summarize my learning in online courses to examine my understanding of what I have learned.	2.62 (1.12)	2.79 (1.17)
22.	I ask myself a lot of questions about the course material when studying for an online course.	2.69 (1.04)	2.86 (1.04)
23.	I communicate with my classmates to find out how I am doing in my online classes.*	2.79 (1.26)	3.36 (1.13)
24.	I communicate with my classmates to find out what I am learning that is different from what they are learning.	2.55 (1.33)	3.04 (0.99)

Note. *) significant at .05 level (1-tailed) and **) significant at .01 level (1-tailed)

Higher and Lower Performers' Online Activities

In this study, students' online activities in a Web-intensive course were represented by the number of access times of online documents and promptness of assignment submission. Chi-square tests were conducted to investigate whether significant differences on online activities between higher- and lower-performing students existed. The findings showed that higher-performing students accessed all course materials significantly more frequently than lower-performing students ($\chi^2 = 3.347$, $df = 1$, $p = .030$; see Table 4). The information provides additional insights into students' task strategies while learning in a web-intensive course. Although results from OSLQ analysis showed that lower performers reported a higher score on task strategies, the actual behavior showed that higher performers did better on accessing course materials than their lower-performer peers. This information may reflect the higher performers' recorded self reporting on the OSLQ that they set a high standard for their learning in their learning courses.

Table 4

Access Times of Online Documents

Type of online materials/resources	Higher Performers ($N = 29$)	Lower Performers ($N = 28$)
	M (*SD*)	*M* (*SD*)
Informative course materials/resources	51.07 (21.73)	39.96 (17.80)
Assignments materials	161.34 (36.91)	136.89 (31.95)
Optional resources	46.17 (16.62)	42.25 (14.46)
All course materials/resources*	258.59 (59.93)	219.11 (48.27)

Note. *Informative course materials/resources:* learning objectives and outcomes, scholarship opportunities; *Assignment materials*: quizzes, projects, homework, journal; *Optional resources*: archived video lectures, links to external sources; *) Chi-square: 3.347, $df = 1$, $p = .03$

Furthermore, the score that indicates the promptness of assignment submission was calculated based on the following categories of submissions: late-, on-time, and early-submitted assignment. Each late-, on-time, and early-submitted assignment was given a 1, 2, or 3 point, respectively. In other words, frequency of submissions for each category was multiplied by 1, 2, or 3 points. For any unsubmitted assignment a score of zero was given. This interprets that the group of students who had higher score was better than another group in terms of promptness of assignment submission. The results found that there was a significant difference between both groups (see Table 5). Again, the findings reported that higher-performing students outperformed the lower-performing students on their actual behavior while working on their assignments. This information may reflect higher performers' recorded self reporting the OSLQ that they set high standards for their assignments in online courses.

Table 5

Promptness of Assignment Submission

Assignment submission	Higher Performers (n = 29)	Lower Performers (n = 28)
Total score of assignment submission*	2070	1913

*) Chi-square: 6.189, $df = 1$, $p = .01$

Higher Performers: Assessing Online Documents and Promptness of Assignment Submission. Based upon collected data it is observable that higher-performing students marked the first relevant reason of assessing particular online material items more than once because the students "find that the online materials are quite better than other instructional sources (e.g., more organized)." They felt that it was also because they "practice a procedure and need to refer to it multiple times to master it." It is also interesting to note that they ranked the two least relevant reasons as "searching key facts about a particular concept" and "memorizing key information" (see Table 6). These findings indicated that they focused more on conceptual knowledge than factual knowledge.

Table 6

Ranking of "Accessing Online Learning Materials" of Higher Performers (N = 29)

#	Statement Sometimes I access on particular online material item more than once because…	Rank 1	2	3	4	5	Sum of multiplications divided by 5	Final Rank
1	I find that the online materials are quite better (e.g., more organized) than other instructional sources.	9	8	3	3	6	19.6	[1]
2	I need to search key facts about a	7	3	4	8	7	16.4	[4]

	particular concept.							
3	I need to summarize important information.	3	5	12	5	4	17.0	[3]
4	I want to memorize key information.	3	8	5	7	6	16.4	[4]
5	I practice a procedure and need to refer to it multiple times to master it.	7	5	5	6	6	17.6	[2]

The findings also revealed that higher-performing students marked the first relevant reason for redoing and resubmitting an online quiz was because "there are some missing portions to the solutions." They felt that it was also because they found "error(s) in submitted work and therefore needed to make correction(s)" and they want to "make sure they will get a maximum score." It is also interesting to note that they ranked the two least relevant reasons as "having technical trouble with the system" and "finding a better solution than the one previously submitted" (see Table 7). These findings informed us that higher performers tend to make sure they answered all questions and found no error on their solutions when resubmitting the quiz.

Table 7

Ranking of "Redo and Resubmit an Online Quiz/Homework" of Higher Performers (N = 29)

#	Statement	Rank					Sum of multiplications divided by 5	Final Rank
	Sometimes I redo and resubmit an online quiz/homework because…	1	2	3	4	5		
1	I find error(s) in my submitted work and therefore need to make correction(s).	6	6	6	1	10	16.8	[2]
2	I realize there are some missing portions to my solution.	7	7	5	9	1	19.4	[1]
3	I have technical trouble with the system.	6	6	6	5	6	16.6	[3]
4	I want to make sure I will get a maximum score.	6	3	8	6	6	16.8	[2]
5	I find a better solution than the one previously submitted.	4	7	4	9	5	16.6	[3]

Lower Performers: Assessing Online Documents and Promptness of Assignment Submission.

Based upon collected data it is observable that lower-performer students marked the first relevant reason of assessing particular online material items more than once because the students "need to summarize important information." They felt that it was also because they "want to memorize key information." It is also interesting to note that they ranked the least and second least relevant reason as "practicing a procedure and need to refer to it multiple times to master it" and "searching key facts about a particular concept," respectively (see Table 8). In contrast to higher performers, lower performing students focused more on factual knowledge by summarizing important information and memorizing key information rather than discovering and refining conceptual knowledge.

Table 8

Ranking of "Accessing Online Learning Materials" of Lower Performers (N = 28)

#	Statement	Rank					Sum of multiplications divided by 5	Final Rank
	Sometimes I access on particular online material item more than once because…	1	2	3	4	5		
1	I find that the online materials are quite better (e.g., more organized) than other instructional sources.	7	4	6	5	6	16.6	[3]
2	I need to search key facts about a particular concept.	5	5	6	4	8	15.8	[4]
3	I need to summarize important information.	4	13	4	5	2	19.2	[1]
4	I want to memorize key information.	7	6	6	3	6	17.8	[2]
5	I practice a procedure and need to refer to it multiple times to master it.	5	0	6	11	6	14.2	[5]

The findings revealed that lower-performer students marked the first relevant reason of redoing and resubmitting an online quiz because they "have technical trouble with the system." They felt that it was also because "there are some missing portions to my solution." It is also interesting to note that they ranked the least and second least relevant reason as "making sure they will get a maximum score" and "finding error(s) in their submitted work and therefore need to make correction(s)," respectively (see Table 9). These findings suggest that lower performers tend to be more concerned on the problem with the online system than the errors on their solutions when resubmitting the quiz. It is also interesting to note that they did not perceive the quality of their answers as a priority, instead they focused more on whether their solutions were complete or not.

Table 9

Ranking of "Redo and Resubmit an Online Quiz/Homework" of Lower Performers (N = 28)

#	Statement Sometimes I redo and resubmit an online quiz/homework because…	Rank 1	2	3	4	5	Sum of multiplications divided by 5	Final Rank
1	I find error(s) in my submitted work and therefore need to make correction(s).	8	4	3	4	9	16.4	[4]
2	I realize there are some missing portions to my solution.	4	9	4	8	3	17.4	[2]
3	I have technical trouble with the system.	9	6	5	1	7	18.6	[1]
4	I want to make sure I will get a maximum score.	1	7	6	8	6	14.6	[5]
5	I find a better solution than the one previously submitted.	6	2	10	7	3	17.0	[3]

DISCUSSION AND CONCLUSIONS

Distance education emerged in response to the need of providing access to those who would otherwise not be able to participate in face-to-face courses. It encompasses those programs that allow the learner and instructor to be physically apart during the learning process and maintain communication in a variety of ways (Keegan, 1986). The rapid growth of online distance education worldwide has prompted the need to revise delivery structures and re-think pedagogical practices that were once appropriate.

Previous research suggested that self-regulated learning skills were essential for students who are taking online course (McMahon & Oliver, 2001; Young, 1996). The frame of this study was designed to provide information on how higher-performing students use their self-regulated learning skills and engage in online activities within a Web-intensive engineering course. The findings of the current study also suggests how online educators should provide instructional design or treatment that help low performers to exercise their SRL skills and activities.

Self-Regulated Learning Skills between Higher and Lower Performers

Findings revealed that the higher-performing students outperformed the lower-performing students on three goal setting items regarding setting standards for the assignments, setting short- and long-term goals, and keeping high standard for learning in online courses. On the other hand, lower-performing students reported significantly higher scores on three items including read aloud materials to avoid distraction (task strategies), schedule the same time to study (time management), and communicate with classmates to find out how the student was doing in online classes (self-evaluation). The findings confirmed previous studies related to the essential role of goal setting in learning activities (Butler, 1997; Lawanto, Santoso, & Yang, 2012; Schunk, 1990, 2001; Yeo, Loft, Xiao, & Kiewitz, 2009) but place the results within a new environment of web-intensive learning. Schunk (1990) emphasized that goal setting is related to strategies to accomplish the tasks, as he stated, "Specific goals boost performance by creating greater specification of the amount of effort required for success and the self-satisfaction anticipated" (p. 74).

It is also interesting to note that on average lower performers had relatively better scores on four OSLQ subscales including task strategies, time management, help-seeking, and self-evaluation. These findings may suggest that lower performers were overrated or misjudged their self-regulated learning skills. The readers are cautioned and should interpret the findings carefully as a question is brought forth concerning lower performers' frequency of access to all online learning materials. The access was significantly lower than that seen for the higher performers.

Specifically, the authors assumed that students who rated themselves high on task strategies should have the findings reflect their engagement in online activities. Moreover, the lower performer rated high on time management, but findings on promptness of assignment submission showed that they had relatively lower mean scores compared to their higher performer peers. Hadwin & Webster (2012) suggested that there are correlations between overconfidence in judgment and learning performance (i.e., GPA) which may certainly be in play in the current study. Our findings revealed inconsistencies between lower performers' perception reflected on questionnaire scores and their actual behaviors related to task strategies and time management.

Online Activities between Higher and Lower Performers

Online activities in this study were represented by accessing online learning materials and submitting assignment through a learning management system used in the class. The findings showed that higher-performing students access all course materials significantly more frequently than lower-performing students. Furthermore, when evaluating the promptness of assignment submission, the results found that there was a significant difference between both groups. The higher-performing students show that they were significantly more prompt than lower-performing students in submitting their assignments.

Information gathered from ranking questions provided insights into the way both groups access online materials and submit their assignment. Higher performers reported the reasons of assessing a particular online material item more than once was due to a perception that the online material was of higher quality than other instructional sources. They also reported a need to practice a procedure and master the contents as another reason to access online material more than once. While they ranked searching key facts and memorizing key information as some of the least relevant reasons, the lower performers reported summarizing important information and memorizing key information as the two most relevant reasons of accessing online learning materials. According to the lower performers, practicing a procedure and refer to materials multiple times to master learning concepts, and searching key facts, are the least relevant reasons. These findings suggested that higher performers tend to focus more on deep learning (e.g., practicing a procedure and mastery of the learning content). They specifically put any efforts related to factual knowledge (i.e., searching key facts and memorizing information) as least relevant reasons. On the other hand, lower performers focus more on factual knowledge such as memorizing facts (Millis, 2010; Steadman & Svinicki, 1998).

Moreover, there were noted similarities and differences in terms of the reasons of redoing and resubmitting an online quiz between higher- and lower-performing students. The findings showed that higher performers reported the most relevant reasons of redoing and resubmitting an online quiz because they found some missing portions to the solutions, found error(s) in submitted work and therefore needed to make correction(s), and wanted to make sure they will get a maximum score. They ranked the two least relevant reasons as having technical trouble with the system and finding a better solution than the one previously submitted. On the other hand, lower performers marked the first relevant reason of redoing and resubmitting an online quiz as they experienced technical trouble with the system and there were some missing portions to their solution(s). According to lower performers, the two least relevant reasons were: making sure they will get a maximum score and finding error(s) in their submitted work and therefore need to make correction(s). From the findings we found there were similarities between both groups, such as, finding some missing portions to the solutions as the most relevant reason. But both groups were different in their objective of getting a maximum score.

Suggestions for Further Research

The current study was conducted to provide insights into the learning strategies used by higher- and lower-performing students in a Web-intensive undergraduate engineering course. To build further on these efforts, we offer four recommendations. *First*, a rigorous mixed-method approach needs to be used to evaluate students' self-regulated learning skills because this effort is a complex endeavor dealing with thoughts and actions intertwining over time. MacLeod, Butler, and Syer (1996) suggested that the combination of methodological tools will allow for examining cognitive and metacognitive strategies. The method of study can be extended by also interviewing the participants of the class. A retrospective interview can be used to assess what students understand about their self-regulated learning strategies to better clarify 'what students say and what students do' within the context of the activity. Data from the interviews are used to "confirm, cross-validate, or corroborate findings within a single study" (Creswell, 2003, p. 215). In addition, data logs can be extended by also investigating the time stamp associated with the moment of access to the learning materials. *Second*, an increase in sample size is essential to improve the generalizability of the findings. Also, please keep in mind that the students participating in this study were from engineering. Therefore, it may be inappropriate to apply our findings related to all Web-intensive courses. *Third*, a longitudinal study is needed to investigate whether the participants of a Web-intensive course can apply the knowledge and skills gathered in their next class. *Fourth*, as we discussed before, the lower-performer students seemed overconfident with their self-regulated learning. Efforts still need to be conducted to train the students to be aware of their SRL skills and use them while learning in a Web-intensive course.

The self-regulation of learning by students in a web-intensive engineering course warrants deeper investigation due to modern trends in the engineering education fields. This study directly targets the deficiency in literature in this area, and enlightens the reader to a greater understanding of the differences between higher and lower performers in a gateway engineering course with extensive online interaction. Findings revealed a difference between higher- and lower-performing students with regards to goal setting and that lower-performing students might overrate their learning skills. Both groups reported different reasons for assessing online materials. The information illuminates import considerations instructors should know when designing their own web-intensive learning courses.

REFERENCES

Azevedo, R., Cromley, J. G., & Seibert, D. (2004). Does adaptive scaffolding facilitate students' ability to regulate their learning with hypermedia. *Contemporary Educational Psychology, 29,* 344-370. doi: 10.1016/j.cedpsych.2003.09.002

Azevedo, R., & Hadwin, A. F. (2005). Scaffolding self-regulated learning and metacognition – implications for the design of computer-based scaffolds. *Instructional Science*, *33,* 367-379. doi: 10.1007/s11251-005-1272-9

Barnard, L., Lan, W. Y., & Paton, V. O. (2010). Profiles in self-regulated learning in the online learning environment. *International Review of Research in Open and Distance Learning, 11*(1), 61-80. Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/769/1503

Barnard, L., Lan, W. Y., To, Y. M., Paton, V. O., & Lai, S. L. (2009). Measuring self-regulation in online and blended learning environments. *The Internet and Higher Education, 12,* 1-6. doi: 10.1016/j.iheduc.2008.10.005

Barnard, L., Paton, V. O., & Lan, W. Y. (2008). Online self-regulatory learning behaviors as a mediator in the relationship between online course perceptions with achievement. *International Review of Research in Open and Distance Learning, 9*(2), 1-11. Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/516/1075

Bergin, S., Reilly, R., & Traynor, D. (2005). *Examining the role of self-regulated learning on introductory programming performance*. Paper presented at the ICER 2005, Seattle, WA, USA. Retrieved from http://dl.acm.org/citation.cfm?id=1089794

Bourne, J., Harris, D., & Mayadas F. (2005). Online engineering education: Learning anywhere, anytime. *Journal of Engineering Education, 94*(1), 131-146. Retrieved from http://sloanconsortium.org/sites/default/files/v9n1_bourne_1.pdf

Butler, D. L. (1997). *The roles of goal setting and self-monitoring in students' self-regulated engagement in tasks*. Paper presented at the 1997 meeting of American Educational Research Association in Chicago, Illinois. Retrieved from http://ecps.educ.ubc.ca/sites/ecps.educ.ubc.ca/files/uploads/zzz/SPED/Butler_ConfPapers/AERA%201997%20Paper.pdf

Chickering, A. W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *American Association of Higher Education Bulletin, 39*(7), 3-7.

Chang, M. M. (2005). Applying self-regulated learning strategies in a web-based instruction-an investigation of motivation perception. *Computer Assisted Language Learning*, *18*(3), 217-230.

Chizmar, J. F., & Walbert, M. S. (1999). Web-based learning environments guided by principles of good teaching practice. *The Journal of Economic Education*, *30*(3), 248-259.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34*, 906-911.

Gallagher, P., & McCormick, K. (1999). Student satisfaction with two-way interactive distance education for delivery of early childhood special education coursework. *Journal of Special Education Technology*, *14*(1) 32 – 47.

Hadwin, A. F., & Webster, E. A. (2013). Calibration in goal setting: Examining the nature of judgments of confidence. *Learning and Instruction, 24*, 37-47. doi: 10.1016/j.learninstruc.2012.10.001

Johnson, S. D., Dixon, R., Daugherty, J., & Lawanto, O. (2011). General versus specific intellectual competencies: The question of learning transfer. In M. Barak & M. Hacker (Eds.), *Fostering human development through engineering and technology education* (pp. 55-74). Netherlands: Sense Publishers.

Keegan, D. (1986). Interaction and communication, (Chapter 6, pp.89-107). In D. Keegan, *The foundations of distance education*. Kent, UK: Croom Helm.

Khatib, S. A. (2010). Meta-cognitive self-regulated learning and motivational beliefs as predictors of college students' performance. *International Journal for Research in Education, 27,* 57-72.

Kinnebrew, J. S., Loretz, K. M., Biswas, G. (2013). A contextualized, differential sequence mining method to derive students' learning behavior patterns. *Journal of Educational Data Mining, 5*(1), 190-219.

Kitsantas, A., Winsler, A., & Huie, F. (2008). Self-regulation and ability predictors of academic success during college: A predictive validity study. *Journal of Advanced Academics, 20*(1), 42-68.

Lawanto, O. (2010). Students' metacognition during an engineering design project. *Performance Improvement Quarterly, 23*(2), 115-134. doi: 10.1002/piq.20084

Lawanto, O., Goodridge, W., & Santoso, H. B. (2011). *Task interpretation and self-regulating strategies in engineering design project: An exploratory study*. Paper presented at the 118th ASEE Conference, 2011, Vancouver, Canada.

Lawanto, O., & Johnson, S. D. (2012). Metacognition in an engineering design project. *International Journal of Engineering Education, 28*(1), 92-102. Retrieved from http://www.ijee.ie/latestissues/Vol28-1/10_ijee2523ns.pdf

Lawanto, O., Santoso, H. B., & Liu, Y. (2012). Understanding of the relationship between interest and expectancy for success in engineering design activity in grades 9-12. *Educational Technology & Society*, *15*(1), 152–161.

Lee, J-K. (2009). The effects of self-regulated learning strategies and system satisfaction regarding learner's performance in e-learning environment. *Journal of Instructional Pedagogies*, *1*, 30-45.

Lynch, D. J. (2006). Motivational factors, learning strategies and resource management as predictors of course grades. *College Student Journal, 40*(2), 423-428.

McMahon, M. & Oliver, R. (2001). *Promoting self-regulated learning in an on-line environment*. In C. Montgomerie & J. Viteli (Eds.), Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2001 (pp. 1299-1305). Chesapeake, VA: AACE. Retrieved from:

Millis, B. J. (2010). *Promoting deep learning*. The IDEA Center – IDEA Paper #47. Retrieved from http://sph.bu.edu/otlt/teachingLibrary/Learning%20Theory/Deep-learning.pdf

Musso, M., Kyndt, E., Cascallar, E., & Dochy, F. (2012). Predicting mathematical performance: The effect of cognitive processes and self-regulation factors. *Education Research International*, Article ID 250719, 1-13. doi:10.1155/2012/250719

Pintrich, P. R., & de Groot, E. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*(1), 33-50.

Paris, S. G., & Winograd, P. (1990). Metacognition in academic learning and instruction. In B. F. Jones (Ed.), *Dimension of thinking and cognitive instruction* (pp. 15-44), Hillsdale, NJ: Erlbaum.

Paris, S. G., & Winograd, P. (2003). The role of self-regulated learning in contextual teaching: Principles and practices for teacher preparation. A Commissioned Paper for the U.S. Department of Education Project *Preparing Teachers to Use Contextual Teaching and Learning Strategies To Improve Student Success In and Beyond School*. Retrieved from http://www.ciera.org/library/archive/2001-04/0104parwin.htm#_ftn1

Schunk, D. H. (1990). Goal setting and self-efficacy during self-regulated learning. *Educational Psychologist, 25*, 71-86.

Schunk, D. H. (2001). *Self-regulation through goal setting*. ERIC/CASS Digest, 1-6. Retrieved from http://www.eric.ed.gov/PDFS/ED462671.pdf

Southard, S., & Rubens, P. (2001). *Students' technological difficulties in using web-based learning environments*. Proceedings of STC's (Society for Technical Communication's) 48th annual conference (p. 82-86). Arlington, VA: Society for Technical Communication.

Steadman, M., & Svinicki, M. (1998). CATs: A student's gateway to better learning. *New Directions for Teaching and Learning, 75*, 13-20.

Ward, J. H., Jr. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association*, *58*, 236–244.

Yeo, G., Loft, S., Xiao, T., Kiewitz, C. (2009). Goal orientations and performance: Differential relationships across levels of analysis and as a function of task demands. *Journal of Applie Psychol*ogy, *94*(3), 710-726. doi: 10.1037/a0015044

Young, J. D. (1996). The effect of self-regulated learning strategies on performance in learner controlled computer-based instruction. *Educational Technology, Research and Development*, *44*(2), 17-27.

Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary Educational Psychology, 11*, 307-313.

Zimmerman, B. J. (1994). Dimensions of academic self-regulation: A conceptual framework for education. In D. H. Schunk & B. J. Zimmerman (Eds.) *Self regulation of learning and performance: Issues and educational applications* (pp. 3-21). Mahwah, NJ: Lawrence Erlbaum Associates.

Zimmerman, B. J. (1998). Academic studying and the development of personal skill: A self-regulatory perspective. *Educational Psychologist, 33*, 73-86.

Zimmerman, B. J. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal, 45*(1), 166-183.

Zimmerman, B. J., & Martinez-Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal, 45*(1), 166-183.