An Analysis of Online Students' Behaviors on Course Sites and the Effect on Learning Performance: A Case Study of Four LIS Online Classes

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This research investigated the relationship between online students' behaviors in a learning management system and their learning performance, as measured by their final grades. Four online information technology classes in a major U.S. library and information science program were studied. The course sites' log data, as well as the students' final grades were analyzed at both the class level and the general level using the aggregated data from all four classes. The results show that the number of days students delayed in accessing weekly lecture materials had a significantly negative correlation with the final grade, while an increased number of discussion board postings had a positive correlation with the final grade. This correlation was significant on borderline, at $p = 0.05$ level. In one class an increase in the frequency of accessing the syllabus was significantly correlated with the final grade. The implications of the results are discussed. Based on the findings, suggestions on strengthening e-learning are proposed.

Keywords: learning management system, e-learning, interaction behaviors, learning performance, online courses

Introduction

Background

Online education, supported by various forms of technologically rich platforms, mainly learning management systems that integrates student management, learning material delivery, learning assessment, etc., has increased rapidly in recent years. According to the most recent report on online education in the United States by Babson Research Group (Allen, Seaman, Poulin, & Straut, 2016), which uses the U.S. National Center for Education Statistics data, by fall 2014, in the U.S. there was a 3.9% increase in the number of distance education students, up from the 3.7% rate recorded the previous year. More than one in four students (28% of a total of 5,828,826 online students) was taking at least one distance education course. Among the 5.8 million online students, 2.85 million were taking all of their courses at a distance and 2.97 million taking some, but not all, distance courses (Allen *et al.*, 2016).

In the field of library and information science, Islam, Kunifuji, Hayama, and Miura (2011) found that 85 (about 23% of a total of 370 worldwide) LIS programs were using e-learning systems for delivering education, and Blackboard/Blackboard Vista (25.89% was the most frequently used learning management system). The majority (i.e., 73 of 85 LIS programs; 86%) were delivering their course contents asynchronously (Islam *et al.*, 2011). More recently, according to the American Library Association (ALA) (2016), among the 59 ALA accredited schools, over the half (30) now offer 100% online programs. Only eight schools do not have any online offering. The remaining schools offer online educa-

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tion for select courses (ALA, 2016).

Online education in general provides several advantages when compared with traditional face-to-face classroom settings. For example, online students have the flexibility in terms of time and location to access the course material, and to participate in class discussions, as long as they have access to the needed technology (e.g., Barcelona, 2009; Fincham, 2013; Hampel, 2014). This flexibility is particularly important for those who want to continue their education while working part- or full-time. Studies have demonstrated that e-learning is welcomed by students when supported by a learning management system (e.g., Dang & Robertson, 2010; Juhary, 2014; Lonn & Teasley, 2009; Martín-Blas & Serrano-Fernández, 2009). Nguyen (2015) found that online learning is generally at least as effective as the traditional format.

An online course typically delivers course material digitally to the class using a learning management system. Based on the media through which online education is delivered, online education/learning can be synchronous or asynchronous. The former is commonly supported by media such as videoconference and live chat, and the latter is commonly facilitated by media such as email and discussion board (Hrastinski, 2008a). In either setting, the instructor's role has changed from lecturer to facilitator in students' learning.

The current study focuses on asynchronous e-learning. The study examines the relationships between students' online behaviors on a learning management system and their learning performance, to identify the behavior patterns affecting learning performance and to suggest ways to improve student learning in the online environment.

Research Questions

This study focused on online learning using a learning management system: the Blackboard system. Robert Godwin-Jones (2012) described a typical Blackboard model, which consisted of an online gradebook, posted syllabus, assignment tracking, linked and/or uploaded course materials, and threaded discussion boards for interactivity and collaboration. This is a typical asynchronous online learning environment. This study focused on examining students' online learning behaviors in accessing the course syllabus and weekly posted learning materials, and through their posting to the learning management system's discussion board. The interaction activities investigated in this study, (i.e., accessing course syllabus, weekly posted learning materials by the instructor, and communicating with the class via the system's discussion board), are fundamental activities on a learning management system that every student has to perform when taking an online course. How did these fundamental activities impact students' learning was examined here.

The research questions for the study, are therefore:

Q1. Does student access to the course syllabus relate to learning performance?

Q2. Does student access to weekly learning materials posted by the instructor relate to learning performance?

Q3. Does the use of the discussion board on the course site relate to learning performance?

Literature Review

Research on students' general use (without distinguishing synchronous and asynchronous learning) of IT in learning has produced mixed results. While Dang & Robertson (2010), Juhary (2014), Lonn & Teasley (2009), and Martín-Blas & Serrano-Fernández (2009) showed that students preferred e-learning using learning management systems, Margaryan, Littlejohn, & Vojt (2011) found that students appeared to select traditional pedagogies, with only minor uses of IT tools for delivering content. The latter study therefore

suggests that it would be misleading to claim that students were shifting the patterns of learning and were in favor of technology use.

Several studies have investigated the use of learning management systems and students' learning. Spivey and McMillan (2013) studied the relationship between student effort and performance among students in a finance course, using the Blackboard system's logged data. Student effort was measured by the number of times students accessed learning materials that were placed on the Blackboard system. The study examined if more frequent access of the resources would affect the students' grade performance. The results of the study indicate that performance was positively influenced by the frequency of accessing. A more evenly spaced study schedule was also found to have a positive effect on performance, while cramming (i.e., intense studying in a short period of time immediately preceding an exam) did not. The mode of course delivery for this study, however, appears to be a blended learning context, where course materials were delivered via the Blackboard system, but tests were conducted within a classroom. This context is quite different from a purely online learning setting, where students are located remotely at locations far away from each other and from the instructor.

Liang, Jia, Wu, Miao, and Wang (2014) studied the factors that might influence learners' participation and performance in a MOOC environment. Students' learning records captured in the learning management system and their feedback collected from a survey were explored. Regression analysis was conducted to examine the correlation among perceived learning experience, learning activities and learning outcomes. Their findings suggest that learners' perceived usefulness rather than perceived ease of use of the MOOC positively influenced learners' use of the system, and consequentially, their learning outcome (Liang *et al.*, 2014).

Hung, Chou, Chen, and Own (2010) developed an online learning readiness scale to measure students' readiness for online learning. The scale included five dimensions: self-directed learning, motivation for learning, computer/Internet self-efficacy, learner control, and online communication self-efficacy. Data from 1051 college students in five online courses in Taiwan revealed that students' levels of readiness were high in computer/Internet self-efficacy, motivation for learning, and online communication self-efficacy and were low in learner control and self-directed learning. This study found that students in a higher grade (junior and senior) exhibited significantly greater readiness in the dimensions of self-directed learning, online communication self-efficacy, motivation for learning, and learner control than did students in lower grades (freshman and sophomore) (Huang *et al.*, 2010).

In addition to the effect of student effort of accessing the learning materials posted on the course site, a few studies investigated the use of discussion boards on the Blackboard system and reported varying results. Alghamdi (2013) reported that the frequency of posting to Blackboard discussion board was positively related to improvements seen in the test scores among those in the control group but not among those in the experimental group. Badawy & Hugue (2010) reported a positive attitude from students regarding the use of discussion boards in their online courses. However, most studies which examined the use of discussion boards in the online learning environment focused on students' preference or satisfaction, rather than on the potential impact of students' discussion board behavior on their learning performance.

When comparing synchronous and asynchronous online learning, Coogle and Floyd (2015) found that education graduate students in their study perceived benefits from both synchronous and asynchronous learning environments. Hrastinski (2008b) found different effects of synchronous and asynchronous online dis-

cussions, by examining two online classes that participated in two asynchronous and two synchronous online discussions. Synchronous communication induced personal participation, which could be regarded as a complement to cognitive participation. However, cognitive participation is a more reflective type of participation supported by asynchronous communication. In synchronous discussions, the e-learners felt that they worked together and were not restricted to only discuss course content. This was likely to induce arousal and motivation and increased convergence on meaning, especially in small groups (Coogle & Floyed, 2015). Clouse & Evans (2003) investigated the effects of asynchronous and synchronous lectures and discussions with graduate business program classes both on campus and off campus. Their results indicated that in three scenarios, synchronous face-to-face or videoconference lecture/synchronous face-to-face or videoconference discussion, synchronous face-to-face or videoconference lecture/asynchronous threaded discussion, and asynchronous online recorded PowerPoint lecture/asynchronous threaded discussion, the student performance on a test was similar. Only when an asynchronous online recorded PowerPoint lecture was combined with a synchronous online chat discussion, the student performance was significantly lower than others.

The previous research on the differences between synchronous and asynchronous e-learning indicate that each has its own advantages and limitations. While synchronous e-learning enhances students' feeling of participation, enables them to get immediate feedback, and helps communications, it reduces the flexibility in terms of time the online students would enjoy. Also, as a learning tool, synchronous chatting includes an unorganized manner that everyone could speak at once at a discussion session. Asynchronous learning, on the other hand, can enable more students in discussion and can provide students with time to reflect on content and responses from others prior to posting their own response (Clouse & Evans, 2003). Asynchronous e-learning also fully supports the flexibility the online education offers.

Given the mixed results regarding the general use of technology in learning, and the lack of detailed analysis on the effect of behaviors on learning performance in online learning settings, the current research sought to use students' access data on the Blackboard system that was used mainly as an asynchronous e-learning platform, to explore whether students' interaction behaviors are associated with learning performance. Different from the study conducted by Spivey and McMillan (2013), the current research focused on online students living in geographically dispersed locations, where the course site served as the primary place they would meet asynchronously. The study used observable behavioral measures instead of proxy measures such as satisfaction or preference that are discussed in Naveh, Tubin and Pliskin (2010).

Methodology

This research employed the learning analytics approach introduced by Jones (2012). The students' course access data was analyzed to reveal their interaction behaviors on the learning management system course sites. The data was preprocessed, and then analyzed on identified important measures, to answer the research questions established for this study.

Course Settings in the Study

Two information technology (IT) courses in a master of library and information science program in the U.S. were involved in this study. Of these two courses, one was a mandatory introductory course. The other course was an advanced, elective course, taken by the students mainly based on their interests. These two courses are regularly offered every semester. The

classes in fall 2014 (F2014) (September–early December 2014) and winter 2015 (W2015) (early January–end of April, 2015) semesters were examined, leading to a total of four separate classes (each of the two courses had one class in each of the semesters).

The two IT courses involved in the current study were organized following the model described by Robert Godwin-Jones (2012). The major course components on the course site included course announcement, course syllabus, contents, discussion board, and assignments. Each of the components could be accessed from the navigation pane on the course site. The course announcement area was set as the default display when the course was accessed.

Course syllabi were posted at the beginning of the semester a few days before the classes officially started. Opening the syllabus link would lead directly to the display of the PDF version of the course syllabus on the screen.

Weekly learning materials such as lecture notes, tutorials, videos, readings, etc. were located in a "Contents" folder, and these were further organized into folders by weeks. Class materials were posted by the instructor week by week, on a specific day (such as Monday) of the week as the semester progressed.

For all classes, assignments were posted in an "Assignments" folder with a link to it from the course home page. All assignment description files, except the final exam for the introduction class which was hosted on the course site and could be done only on the course site, could be downloaded by students and submitted to the course site after an assignment was completed, before or on the due date. Similar to the weekly class learning materials, assignments were also posted progressively along the class schedule, usually a few weeks before the due date.

Discussion forums on the discussion board were created by the instructor, with a few types: the regular ones included weekly discussions for each week's content related topics and question and answers for each major assignment. Additional forums were created in response to special class needs, such as calling for students' willingness to have a synchronous online meeting, or forming small study groups, etc. When discussing on content related topics, students were required to post meaningful comments. Postings like "I agree," "me, too," or "absolutely," etc., were not considered quality postings, and were explicitly prohibited in the course syllabus. Therefore, student postings did not have such short one or two words postings. For each week two students were assigned to facilitate discussion. Their responsibilities included posting discussion topics, normally two or three, that are related to the content and to follow up with the rest of the class' responses, if needed. The instructor monitored the discussions, and would join discussions from time to time. Forums were created as the semester went by. For each of the four classes, participation in class discussion accounted for 10% of the total grade for the course.

The discussion board allows for student-to-student; student-to-instructor and instructor-to-students asynchronous communications. Previous studies on the use of discussion board mainly focused on students' preference or satisfaction (Servonsky, Daniels, & Davis, 2005). In this study, we wanted to find out if discussion board activity would directly relate to the students' learning performance.

While blended learning is adopted widely in higher education, which mixes elements of face-to-face and online educational delivery (Agosto, Copeland, & Zach, 2013), the courses involved in the current research were completely online. Occasionally Adobe Connect, a synchronous teleconference tool would be used to have an online discussion session or a guest lecture, but such use was rare and was skipped in this research. The classes were chosen in the study for the convenience reason because the author was the instructor, who was a faculty member with

more than 10 years' experience teaching online. The instructor was fully engaged in the classes, monitoring the course sites daily, often several times a day, to follow the progress of the classes.

Students

The four classes included a total of 88 students who completed the course. The general statistics about the students are presented in Table 1. Since no students' demographic data was available in the learning management system, students' gender was identified based on their names.

The numbers in Table 1 do not include those who withdrew from the class during the semester, but they do include a few who failed the class at the end, i.e., it includes all students who completed the course, whether successful or not.

The introduction course was a required course for all students. A student could be waived out of the course if the student had prior computing course work or experience, and was familiar with the applications and concepts covered in the course, as evidenced by passing a quick test. The advanced course was an elective course for those who wanted to enhance their IT skills. The majority of the students were female students, as can be seen in Table 1. Only seven were male students. All students taking these classes were required to have access to high speed internet and appropriate computers, as a condition to be accepted into the online program.

Table 1. General Statistics on the Student Samples.

Semester	Male	Female	Total
F2014-Intro	1	22	23
W2015-Intro	2	20	22
F2014-Advanced	1	21	22
W2015-Advanced	3	18	21
Total	**7**	**81**	**88**

Data Set

The data for this research was collected from three sources:

1. The students' final grade data was accessed directly from each of the four class course sites.
2. The discussion board data was also from each class site, but this data was included in a report for the instructor created by the Blackboard system to examine the number of postings on the discussion board. The report included the number of postings distributing month by month over the semester, forum by forum; and the total number of postings by each student;
3. The students' course material access data was extracted from the Blackboard system's log files, provided by the Blackboard system's campus support team. The Blackboard system's log data contained student IDs, the Blackboard content accessed, and the timestamps of access.

Students' Interaction Behavior Measures

Human-computer interaction behaviors may be measured from different dimensions, depending on the purpose of the research and the granularity of the available data. After a careful examination of the data used for this study, the following measures were identified for the learning interaction behaviors investigated in this study:

- For course *syllabus* access, the frequency of accessing was used in the study, (i.e., the number of times a student accessed the course syllabus during the semester). Given the role of the courses' syllabus in a class, it would be expected that access frequency is linked to the familiarity about the course organization and schedule, and thus is linked to learning activity management,

and ultimately learning performance. Increased access to the course's syllabus would lead to more organized learning which would ultimately help a student achieve a better final grade. However, it was also possible that the syllabus file was downloaded onto the student's computer for access. In these instances when access to the syllabus occurred on a local computer, the figure could not be counted.

- For accessing *weekly posted learning materials*, two measures were used:

  a. The *number of weeks* that the student failed to access posted weekly learning materials. This measure is similar to the number of classes a student would miss/skip in a traditional face-to-face classroom setting. Students were supposed to go over the posted learning materials each week as part of the learning process. This measure was intended to find out whether the students on a learning management system would also stick to the course schedule and follow course learning materials week by week.

  b. The timeliness of accessing weekly learning materials, or the *number of days* between the day when the learning materials posted and the day the student actually accessed the posted materials, if that week was not completely skipped by the student. For example, "0" means the student accessed the materials the same day when the materials were posted by the instructor, and "35" would mean that the student accessed the materials 35 days after the materials were posted.

One important requirement for online students is to be self-disciplined. This includes following the class schedule and studying the learning materials along the timeline of the course. The class learning materials were distributed every week on the scheduled day specified in the course syllabus, similar to the class meeting in a face-to-face situation. The above two measures were intended to determine whether students would access the learning materials on the course site, and whether their access was on schedule. The idea was that the sooner the student accessed a week's materials, the closer the student followed the schedule and that these behaviors would help improve student learning.

- For using the discussion board, the *total number of postings* (all were qualified ones) by each student on the discussion board was used as the measure for participation or communication in class. This measure reflects how involved a student was in his or her learning.

Enabling students to communicate online on the course site is one of the basic requirements of a learning management system. While the use of a discussion board has been shown to have a positive impact on student satisfaction with e-learning (Badawy & Hugue, 2010), the current study was particularly interested in finding out whether the use could be directly related to students' learning performance.

Amount of time spent on a task in an online context has been a frequently used measure in studying human behaviors. For example, the amount of time spent reading a document may be used as an important indicator of how much the reader understood the document. This measure, however, is only partially reliable in settings where online behavior cannot be directly observed. In log data this is an unreliable measure because what a user was actually doing during that period of time is unclear. For example, a document could be opened for hours or even days but this does not necessarily mean the user actually read the accessed document for that long. Therefore, the amount of time on task was not used as a measure in this study.

For accessing the weekly posted learning materials, the frequency of access,

which had been used in Spivey and McMillan (2013), was not used in this study because some materials were in compressed format, and the students needed to download such files to their local computer. Unlike the situation with accessing to the course syllabus, where there was just a possibility that the file could be downloaded, in this case, it was certain that part of weekly learning materials had to be downloaded to the local computer. In such situations, the access would be to their local disk, which are unknown to the study.

Learning Performance

The student's final grade was used as the measure of learning performance. The final grade received by each student was an accumulated score for his or her performance in the entire course. The score ranged from 0 to 100.

Data Processing and Analysis

Data collected from the different sources noted above were first cleaned, by removing the data that was linked to the students who withdrew from the class. Pearson correlation analysis was the main statistical procedure to analyze the relationships between different measures of learning interaction behaviors and the final grade. The data analysis was first performed on each class's data, hoping to find the effects of the behavior measures in each class. The data from the four classes were then integrated into one aggregated data set. The analysis on this data set was undertaken at a general level rather than focusing on an individual class.

Results

The descriptive statistics on students' final grades are presented first. The results from the analysis for each of the four classes are presented the next, and this is followed by the results from the analysis on the aggregated data set.

Table 2. Summary of Student Grades for the Involved Classes.

Class–Semester	Average	Std. Dev.	N
Intro-F2014	89.7	9.4	23
Intro-W2015	89	9.6	22
Advanced-F2014	94.7	3.1	22
Advanced-W2015	95	3.8	21

Students' Final Grades for Different Classes

The data in Table 2 shows that for the introductory classes the students performed well overall, but that their grades varied dramatically, with an average difference around 9.5 points. However, for the advanced classes, the students' grades averaged about 95 points, with differences being the grades less than 4 points. This grade improvement may be explained by the fact that the students who took the advanced class had been trained in the introduction class, and thus had certain familiarity with the content of the advanced class. More importantly, since the advanced course was an elective course, not a required one , the students were more interested and were more motivated in the advanced class, and thus did better than in the introductory class.

Class Level Analyses

To find out whether there would be significant correlations in a class, data analysis was first performed separately for each of the four classes. Different measures from each class were examined first. The descriptive statistics of the four classes are presented in Table 3. The numbers in the table are averages and standard deviations in parenthesis.

As Table 3 shows, in terms of the number of times the course syllabus was accessed, the introductory classes were slightly more than the advanced classes.

Table 3. Descriptive Statistics on the Behavior Variables of the Four Classes.

Class	# of Syllabus Access	# of Skipped Weeks	# of Delayed Days	# of Postings
Intro-F2014	14.2* (11.1)**	2.8 (2.5)	4.3 (2.5)	56 (30)
Intro-W2015	11.8 (8.4)	1.3 (1.1)	5.6 (4.2)	34.2 (11.6)
Advanced-F2014	9.5 (4)	2.6 (2.7)	5.5 (3.7)	43 (30.4)
Advanced-W2015	10.2 (6.6)	6.2 (2.5)	5.3 (3.6)	60.5 (60.3)

Notes: *Averages; **Standard deviations

Different classes have different dynamics. Student behaviors can be dramatically different from class to class, even for the same course. This is reflected in the number of weekly lectures skipped by students. While the students in the winter 2015 Introductory class skipped only one and about one third weeks on average, the students in the winter 2015 advanced class skipped 6.2 weeks on average, as Table 3 shows. Even comparing between the two classes of the same course, the winter 2015 advanced class skipped more weeks than the fall 2014 class did.

Different from the variations in the number of skipped weeks, the number of days delayed to access weekly posted learning materials seemed to be in the same range across the four classes. Averagely the students would delay about 4 or 5 days to check the posted materials.

There are also variations in the number of postings among the different classes. The winter 2015 introductory class posted only 34 times on average per student, the advanced class, also in the winter semester, posted over 60 times per student, nearly doubled the number of postings the introductory class did.

The results of Pearson correlation analysis are presented in Tables 4, for each class respectively.

In Table 4, the numbers listed under each behavior measure are Pearson correlation coefficients with the final grade for each class. In each cell that contains numbers, the first number is correlation coefficient and the number following in the parenthesis is the significance p value. Among the four classes, only in the winter 2015 Introduction class the correlation between the number of times the syllabus accessed and the final grade is significant, at $p = 0.049$. The correlation is positive: the more access to the syllabus the higher the final grade.

In other classes, there are no significant correlations between the two measures. Some low-grade students had high number of accesses and some high-grade students had very low number of accesses.

Did skipped and delayed access to the weekly posted learning materials relate to a student's final grade? Correlation analyses

Table 4. Correlations between Behavior Measures and Final Grade for Four Classes.

Class		# of Syllabus Access	# of Skipped Weeks	# of Delayed Days	# of Postings
Intro-F2014	Correlation:	0.069 (0.377*)	–0.152 (0.244)	–0.229 (0147)	0.326 (0.065)
Intro-W2015	Correlation:	0.361 (**0.049**)	0.085 (0.354)	–0.318 (0.074)	0.283 (0.101)
Advanced-F2014	Correlation:	–0.043 (0.424)	–0.198 (0.188)	–0.073 (0.374)	–0.255 (0.126)
Advanced-W2015	Correlation:	0.069 (0.384)	–0.211 (0.180)	–0.325 (0.075)	0.246 (0.141)

Notes: *Significance (p), one-tailed

found no significant correlations between the two measures and the final grade. It did not seem to matter whether or not an online student's skipping or delayed access to some weekly lectures would affect the student's grade, in any of the four classes. However, the correlation coefficients are indeed negative (except the winter introductory class, which is just less than 0.1), indicating a reverse relationship between the two measures and the final grade: the more skipped weeks or longer delays the lower the final grade. This relationship makes sense because without accessing (in a timely fashion) to learning materials the learning performance would not be good.

No significant correlation was found either between the number of postings and the final grade, in any of the four classes. A student who posted minimum number of postings could still get a high grade, and a student who posted many times could still get a low grade. The correlations mostly are positive, meaning the more postings the higher the grade. In one class, however, the correlation is a negative one. This was probably due to the small data set.

Analysis at the General Level on the Aggregated Data Set

In this analysis, the data for the four classes was treated as one data set. By putting all data together, it was hoped that the data size would be large enough to make predictions. Pearson correlation analysis was conducted to examine the correlations between various measures and the final grade, without considering the differences between classes. The descriptive statistics on various measures are displayed in Table 5, and the results of the correlation analysis are presented in Table 6.

Table 5. Descriptive Statistics on Different Measures.

	Average	Std. Dev.
Grade	92.1080	7.62763
Syllabus (times accessed)	11.5000	8.15370
Posting (number posted)	48.5000	37.79892
Skipped_weeks	3.2386	2.92038
Delayed_days	5.2092	3.54226

As Table 6 shows, the number of times the course syllabus was accessed is not significantly correlated with the final grade, although at the class level analysis, there was one class, i.e., the winter 2015 Introductory class, in which correlation between the two was significant. That significance may be a special case for that particular class, in which it happened that those who checked the course syllabus more often got a higher grade finally.

The number of days delayed to access the weekly materials has a negative correlation with the final grade, and the correlation is significant at $p = 0.036$ level. This result indicates that in general, more promptly accessing the weekly posted learning materials (less delaying) would lead to a higher final grade. However, the number of weeks that were skipped did not have a significant correlation with the final grade.

The number of postings also has a strong, positive correlation with the final grade: the more postings, the higher the final grade. This correlation is significant only on borderline of 0.05 level, at $p = 0.056$.

Table 6. The Results of Correlation Analysis between Various Measures and Final Grade.

		Syllabus	Posting	Skipped_wks	Delayed_days
Grade	Pearson Correlation	0.080 (0.229*)	0.171 (0.056)	0.086 (0.213)	–0.193 (0.036)

Notes: *Significance (p), one-tailed

Discussion

Access to Course Syllabus—Does Students' Access to the Course Syllabus Relate to Their Learning Performance?

As the guideline for the course, the syllabus is an important tool for students to get organized for the course, which in turn should be helpful for learning. Therefore, it was reasonable to assume that the frequency of accessing the course syllabus during the semester would be significantly associated with the final grade: the more accesses, the higher the grade. This was the case with only one class, however. At the general level, no significant correlations was found between access to syllabus and grade.

The difference between the results from the class level analysis and that from the general level analysis, may be due to different data size, and different class dynamics. In general the frequency of accessing syllabus on the course site did not seem to be associated with the final grade. However, this does not exclude special cases/classes that there could be significant correlation between this measure and learning performance, as it was in one of the classes in this study.

Therefore, the answer to the first research question tends to be negative. In general, there is no significant association. However, there might be special cases or classes in which there would be a significant association: the more access the higher the final grade. One possibility that there is no significant association is because the syllabus file is downloadable. Some students might have downloaded the file to their local computer, and when consulting the syllabus, they accessed the local file, without going online. The statistics, however, does not include local accesses. The result therefore suggests that using the number of access to a file that is downloadable may not be an accurate measure to use. Since no previous research was done using this measure, future studies are needed to further investigate the effect of this interaction behavior. When conducting such studies, access to the downloaded local syllabus file should be included.

Access to Weekly Posted Learning Materials—Does the Access to Weekly Learning Materials Relate to Learning Performance?

Two measures were used for this interaction behavior: the number of skipped weeks and the number of days delayed to access for the weeks not skipped. The two scenarios are discussed separately below.

The number of skipped weeks. Based on the experience from the traditional face-to-face learning settings, the assumption for this measure was that there would be a significantly negative association between the number of skipped weeks and the final grade: the more weeks when the posted learning materials would be skipped, the lower the final grade. This assumption did not hold true. The results show that the students' final grade did not relate to the number of skipped weeks, from both the class level and the general level analyses. The data shows that the students' behaviors varied dramatically in each class. Many of them skipped many weekly class materials without an impact on their final good grade.

There may be two explanations for this result. First, the student who skipped weekly learning materials might be familiar with the content knowledge of that week, and therefore felt confident to skip that week's posted learning materials.

Second, not accessing the weekly posted learning materials does not mean the student did not learn: it might be the case that although the posted learning materials were skipped, the student still did required readings and used the textbook, without needing to go over the learning materials provided by the instructor.

While this finding does not confirm the assumption that the more skipped weeks the lower the final grade, it does provide a

perspective to confirm the benefit of flexibility that is offered by online learning. Different students can tailor their learning based on their personal needs.

The number of days delayed to access the learning materials. The results for this measure are mixed: while there was no significant correlation between the number of days delayed and the final grade at the class level, the aggregated data did show a significant correlation between this measure and the final grade, at 0.05 level ($p = 0.039$). This result indicates that the more days are delayed, the lower the final grade would be. The reason that there was no significant correlation at the class level perhaps was due to the smaller data size.

Significant or not, in both cases, similar to the skipped weeks measure, the correlations are negative, which reflects the nature of the relationship in the assumption that the more days delayed, the lower the final grade.

The significantly negative correlation is understandable: not accessing in a timely fashion the weekly posted learning materials exhibits that the learning activities are not well organized, and thus not well disciplined. Dror (2008) discussed the importance of properly acquiring information for learning, from the cognition's point of view, and using technology to enhance learners' proper access to information (learning materials).

In fact, an examination of the delays found a pattern among those who delayed access to weekly learning materials: delays most of time were "crammed access," as described in Spivey and McMillan (2013): the student would wait for a few weeks to access the accumulated, more than one week's learning materials at one time. From the student's point of view, this may seem to save time and efforts: learning would occur just once for more than one week, perhaps a few weeks, instead of spending time and efforts on learning every week. However, the result shows that this is not a healthy approach to learning, and would lead to decreased learning performance. This result extends the finding from Spivey and McMillan (2013) to online students, that "cramming" not only "did not have positive impact," but actually having a significantly negative impact on learning performance.

In summary, regarding research question 2, "Does student access to weekly learning materials posted by the instructor relate to learning performance," the answer is yes, if using the measure of the days delayed, and no, if using the measure of skipped weeks.

The Number of Postings on Discussion Board—Does the Use of the Discussion Board on the Course Site Relate to Learning Performance?

The feeling of isolation has long been recognized as a drawback for online learning. Discussion boards are designed to help students communicate with the class, to overcome the feeling of isolation, and to help learning. Presumably, more frequent use of the discussion board, demonstrated through more postings, would lead to a better learning experience, and thus better performance (a higher final grade). Testing on 155 first-year female students, Alghamdi (2013) found that posting to a Blackboard discussion board was positively related to improvement to the test scores among students. In this study, there were positive correlations between the number of postings and learning performance, but the correlation was not significant at the class level: none of the four classes had a significant correlation between the number of postings and the final grade.

However, with the increased data size at the general level, the correlation was significant on borderline, at $p = 0.056$, and the correlation was positive. Therefore, the answer to research question 3 tends to be positive: The more postings, the higher the final grade. It is reasonable to expect a more significant correlation if an even larger data set would be available. This will need to be tested in future studies.

Implications of the Research

While the significant correlation between the access to syllabus and the final grade was just a special case in one class, the significant correlations between the delayed access to weekly learning materials and the final grade, and between the number of postings on the discussion board and the final grade, have implications from two perspectives: one is the students' interaction behaviors on the course sites and the other is the technology support provided by the learning management system. The two perspectives call for different solutions to address the related issues in online education.

From the perspective of student behaviors, the findings provide empirical evidence to the "self-discipline" issue in e-learning, and call for interventions to help online students.

Delayed access to weekly learning materials is similar to physically attending classes once every few weeks in the face-to-face environment. This is rare in face-to-face classrooms with a class size similar to the ones investigated in this study, because such behavior is observable and will be under pressure from peer students and the instructor. The online learning environment seems to make it easier for students to have this behavior. Consequently, this behavior could negatively affect a student's learning performance.

Measures have to be taken to help online students avoid such behavior. One way that is easier to implement in the online environment is to add weekly small quizzes into the curriculum, so that the students will have to go over each week's learning materials in order to pass the week's quiz to get credit. Quizzes can be set up on the learning management system to be graded automatically, so that there will be no extra burden on the instructor's part. A considerable initial effort to set up the quiz is needed, though.

The finding that the number of postings is positively correlated with learning performance indicates that active participation is very important for an online student to get a higher grade. This finding is not surprising. However, it is common in reality that despite the encouragement from the instructor, many students would still treat the participation in class discussions as "optional," not realizing that it is one requirement for a higher grade. For the classes investigated in this study, students were required to participate in discussions, and a small portion of the total credit was used as reward. Still, some students did not care much to participate.

One possible way to improve the situation is to let the students be aware of the direct link between the participation and their final grade for the course. Hopefully, if a student wants a better grade, this will motivate the student to participate more in class discussions. Periodically providing feedback to students about their participation, based on the numbers recorded by the learning management system, may also be helpful.

From the technological perspective, although the study did not have the data regarding the ease of use of the technology (students investigated in the study were assumed to have the required high speed internet connection and necessary computing equipment, as the condition for being admitted into the online program), it is reasonable to suspect that the access and participation problems found in the study be partially attributed to technological issues, based on an examination of the Blackboard system. First, the system is designed mainly for desktop computers. A mobile version is available. Its functionality, however, is very limited: many parts of a course site are still the desktop version when accessed in the mobile version. For example, the assignment submission page is still the desktop version, making it difficult to read on a mobile device. This potentially hinders students' access to the course material or tools when a student would be in mobile status, such as when traveling or being away from desktop

computers, which is not uncommon in an online environment. In fact, along with the popularity of smart mobile devices these years, many students are used to m-learning, or using mobile devices to access learning resources (Veley, 2014).

Second, the discussion board on the Blackboard system did not really support synchronous discussion sessions, lacking features that can be found in today's social media or collaboration tools, such as instant chatting and voice messaging. Employing synchronous online discussion might help engage students. Voice messaging or chatting is particularly convenient for mobile devices where typing is difficult. In the Blackboard system, the user can only post and respond to messages asynchronously. Many of today's students are social media users and used to using different tools to communicate in their own communities. It is not difficult to imagine that given the available learning management system functions, students might be reluctant to access course sites because of the backward system functions.

Therefore, the findings of the study also indicate that there is large room for improving technology support for online education. Advanced technologies that people are used to should be incorporated into learning management systems to better support students' online learning needs. Mobile versions of learning management systems should be enhanced to support m-learning.

Conclusion

Online education is developing rapidly worldwide. This study investigated the relationships between students' behaviors on online course sites and their learning performance, by analyzing the log data from four IT classes that were hosted on the Blackboard system. The study provides the empirical evidence that in general, the number of days delayed to access the weekly posted learning materials has a significantly negative impact on learning performance, and the number of postings has a positive association on learning performance, significant on borderline. In a specific case, the frequency of accessing the course syllabus was significantly correlated, positively, with learning performance.

The findings confirmed the challenge in online education: how to engage online students in class participation? The implications of the findings are discussed. On one hand, the data revealed the problematic students' behaviors on course sites, and suggestions are made to address the issue of delayed access to learning material and the issue of participation in class discussions: Weekly quizzes for the former and motivating the students with a potentially higher grade, plus providing periodic feedback to students, for the latter. These suggestions, however, are based purely on students' behavior. On the other hand, from the technological point of view, the functions of the Blackboard system were examined, and the potential problems of the learning management system that might contribute to the identified behavior issues in the study are discussed. The current version of Blackboard system is lagging behind today's social medial and communication software in terms of some advanced features. This lack of technological support to students is suspected of hindering students' participation in online classes. The study suggests enhancing mobile versions of learning management systems to support m-learning, and developing and adopting advanced functions such as instant chatting and voice messaging in learning management systems to support synchronous learning.

It should be noted that the issues investigated in the study are just a small aspect of online education. Online education is a complex process, involving many factors that could affect students' learning performance. There are also multiple technologies and modes that can be applied in online education. Different solutions may be helpful in addressing the problems identi-

fied. For example, the affordability of the needed technology may be a problem for some underprivileged students. Different delivery methods for course materials may be used, such as surface mail. But this is another model of education and it warrants an investigation of its own. For those who can afford the needed technology, more advanced technologies are needed to enable students a more convenient access to learning resources. M-learning should be convenient for those who use mobile devices frequently, and thus should be enhanced in online education. This study is limited to just the case using the Blackboard learning system, and with its basic features. All other scenarios mentioned above deserve future studies.

Future research also needs to consider other human factors that are important to learning, such as learner's intelligence, prior knowledge, level of motivation, and learner's cognitive and learning style, etc., as Poulova and Simonova (2012) pointed out. Attention should also be paid to understanding of the nature of the technology use, so that students' behaviors could be better understood (Bennett & Maton, 2010). Only through continuous research and practice, can online education in general and students' learning experience in particular, be improved.

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