A SEQUENTIAL ANALYSIS OF TEACHING BEHAVIORS TOWARD THE USE OF BLACKBOARD LEARNING MANAGEMENT SYSTEM

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ABSTRACT

In the era of online learning, Learning Management Systems (LMSs) such as Blackboard and Moodle offer a great variety of functions to facilitate teaching and learning and are widely used in the context of higher education. Most previous studies using data mining have focused on exploring student behavior patterns toward using LMSs, but seldom address the behavior patterns of teachers. The main purpose of this study is to utilize frequency and sequential analyses to investigate the behavioral patterns of university teachers toward using Blackboard. The operational behaviors of 268 teachers at Zhejiang University were extracted from the Blackboard platform for the period from August 2018 to January 2019 and further classified into five types: (1) *course and content*; (2) *assignment*; (3) *communication and collaboration*; (4) *assessment*; and (5) *administration*, according to the study from Dabbagh (2005). Frequency analysis results indicated that the most frequently observed teacher operational behavior was *course and content*, followed by *assessment* and then *administration*. In addition, sequential analysis results showed that most teachers are willing to use *communication and collaboration* and *assignment* after using *course and content*. We further compared these two sets of data and found that *communication and collaboration* were the most frequently used functions besides *course and content*. Almost all of the teachers only expressed the individual *assessment* behavior without combining other behaviors despite *assessment* appearing at a higher usage frequency. In contrast, *communication and collaboration* and *assignment* showed a lower frequency of usage, but there was a higher frequency of use either before or after using *course and content*. Results from this study have practical implications for educators and researchers in order to clearly understand university teacher behavior regarding the use of Blackboard.

1. INTRODUCTION

Learning management systems (LMSs) as web-based instructional infrastructures, such as Blackboard or Moodle, have been widely adopted to support teaching and learning via built-in platform tools to carry out the delivery of teaching content, assessing student outcomes, tracking learning processes, and providing interactions with others (Mohd Kasim and Khalid, 2016; Watson et al., 2007). When teachers or students participated in these online teaching and learning activities or tasks through LMSs, such as downloading notes, accessing grades, performing tests or quizzes and participating in online discussions, their operational behaviors were recorded at that time into the specific format set from the database of LMS platforms. A number of prior research studies have examined user behavior regarding the use of LMSs. For instance, Cerezo et al. (2016) used an educational data mining (EDM) approach to explore students' learning patterns through focusing on learning effort, time spent working and procrastination by analyzing Moodle logs. Munoz-Organero et al. (2010) analyzed the behavioral patterns of 180 students from six different universities through the interactions of each particular student with the content and services of a learning management system (LMS). Tempelaar et al. (2017) incorporated dispositional dimensions (such as self-regulation and emotion) into conventional learning analysis models to explore the behavior of students using LMSs. Li and Tsai (2017) used cluster analysis to investigate students' LMS behavioral patterns and found these different behavioral patterns were associated with their motivation and learning performance. De Smet et al. (2012)

attempted to investigate instructional use and the technology acceptance of LMSs by examining the usage behaviors of 505 secondary school teachers regarding the functions of LMSs such as document publishing, announcements, uploading or publishing exercises, among others. Hou (2013) used sequential analysis to explore learner's interactive behaviors and behavioral patterns in using an educational game and explored the behavioral differences between students of different genders, plus those with high/low prior knowledge and high/low learning performance. Most of these studies were conducted to investigate the behavior of students. However, few studies have been done on the teachers, in particular those working at the university level.

The major purpose of this study was to investigate the behaviors of university teachers toward the use of Blackboard by utilizing both frequency and sequential analysis. Frequency analysis is a descriptive statistical analysis that can show frequency and times of access to determine usage patterns (Peled and Rashty, 1999). In addition, sequential analysis can be used to explore behavioral patterns via calculating the frequency of each behavioral category immediately following another behavioral category (Chiang et al., 2014; Hou, 2013; Hou et al., 2010; Sun et al., 2017). To achieve the purpose of this study, the two specific questions to be addressed are as follows:

(1) What are the frequency and distribution of teachers' behaviors using Blackboard?

(2) Behind the behavioral distributions, what are the displayed patterns of teacher sequential behaviors toward the use of Blackboard?

2. METHODOLOGY

2.1 Data Acquisition and Extraction

This study extracted teacher usage logs from the Blackboard platform operating at Zhejiang University during the period from August 2018 to January 2019. The preliminary examination found that 689 teachers used BB; after deducting the less-used sample of teachers, there remained 268 teachers who more actively used Blackboard to serve as an analysis sample in our study. Through data cleaning and pre-processing, a total of 34561 behaviors were marked.

2.2 Data Coding and Analysis

In this study, 34561 teacher operational records of using Blackboard were identified; in turn, these were divided into five different usage types according to the LMS tool categories identified by Dabbagh and Kitsantas (2005): *Course and Content* (T1); *Assignment* (T2); *Communication and Collaboration* (T3); *Assessment* (T4); and *Administration* (T5) (see Table 1). To test the reliability of the data coding, all coded records were double checked by two graduate students of educational technology who received the same coding training. The Cohan's Kappa reliability was 0.989 ($p < .001$), demonstrating the scheme coding to be reasonable and credible.

Table 1. The coding scheme of teacher LMS behaviors

Code	Tool category of Blackboard	Example
T1	Course and Content	Creating course content, announcements, syllabus, introductions, videos, etc.
T2	Assignment	Creating tests, quizzes, surveys, questions, assignments, tasks, homework, etc.
T3	Communication and Collaboration	Using Ding talk, email, logs, discussion forums, blogs, Wikis, groups, etc.
T4	Assessment	Using grades, grade indicator boards, grade centers, self-evaluations, mutual-evaluations, etc.
T5	Administration	Using class management, data management, contacts, teaching calendars, course reports, etc.

In order to gain a richer insight into the way teachers behave toward the use of Blackboard, we first conducted frequency analysis to estimate the frequency (monthly) and distribution of five different usage behavioral types regarding Blackboard. Afterward, a lag-two sequential analysis approach was used to explore the overall sequential behavioral patterns displayed by teachers. The behavioral codes are used to simplify the sequential characterizations according to chronological order, and formed a series of sequential analysis matrix calculations to discover the behavioral transitions among two different behavioral types (for example, T1→T2 means using *assignment* after using *course and content*) (Bakeman and Gottman, 1997; Hou, 2012). It should be noted that continuous or repeated operational behaviors for each behavioral type were ignored (such as T1→T1 signifying the repetitive use of *course and content*).

3. RESULTS

3.1 Frequency Analysis

To answer the first research question, 34561 LMS records involving 268 teachers were coded into five different behavioral types; as such, the overall distribution of the behavioral frequencies is presented in Table 2.

Table 2. Distribution of the quantitative frequency analysis of codes within the five behavioral types

Code	Tool category of Blackboard	Frequency	%
T1	Course and Content	15200	43.98
T2	Assignment	2811	8.13
T3	Communication and Collaboration	3873	11.21
T4	Assessment	7821	22.63
T5	Administration	4856	14.05
	Total	**34561**	**100.00**

Table 2 indicates that the highest frequency of teacher behavior is focused on *course and content* (T1, 43.98%) and is followed by *assessment* (T4, 22.63%). The frequency of the other three behaviors (*administration*, *communication and collaboration*, *assignment*) is less than 15%, with the difference in frequency among each of these only 3%. The distribution trend diagram of the frequency regarding teachers' LMS usage behaviors is shown in Figure 1. Four types of frequency trend change (T1, T2, T3, and T5) decremented over time, yet the frequency of T4 increased with time.
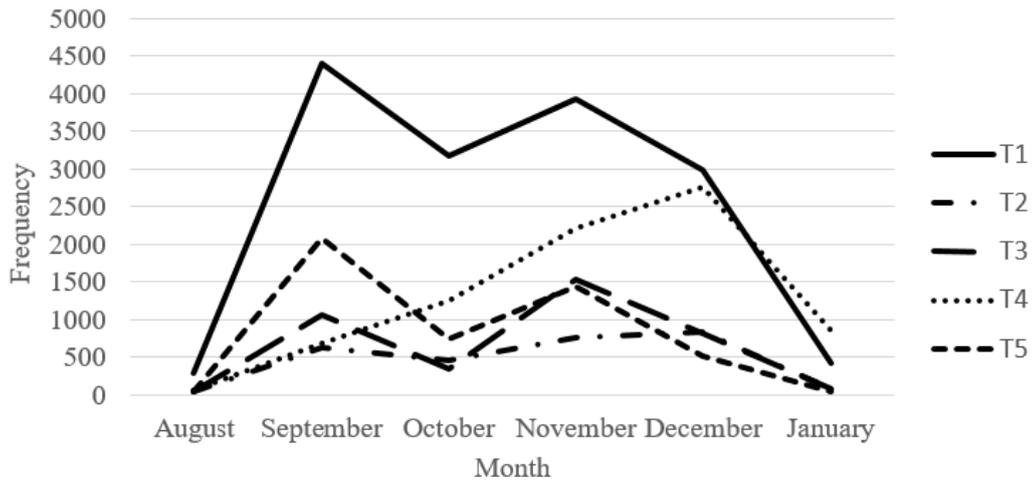
Figure 1. The frequency diagram of teachers' LMS behaviors

3.2 Sequential Analysis

To answer the second research question, the result of lag-two sequential analyses is shown in Table 3, where the rows represent the former teacher behaviors and the columns represent the latter ones. The values of the adjusted residuals (Z-score) between the two behavioral types are estimated, and the z-score higher than 1.96 indicates the behavioral transition (such as T1→T2, 12.49 in Table 3) is reaching significance (Bakeman and Gottman, 1997).

Table 3. The adjusted residual table for all teacher behaviors toward the use of Blackboard

Z	T1	T2	T3	T4	T5
T1	-11.71	**12.49***	**16.41***	1.01	**11.33***
T2	**21.65***	-11.71	-5.04	-7.26	-6.28
T3	**23.88***	-5.39	-11.71	-5.84	-3.97
T4	**4.57***	-5.21	-4.06	-11.71	-8.77
T5	**20.32***	-5.39	**3.06***	1.01	-11.71

* $p < 0.05$

In order to clearly demonstrate the sequential transition of teacher behavioral types. Figure 2 showed the entire range of teachers' sequential behaviors regarding the use Blackboard; the node size represents the frequency strength of the teacher behavioral types, arrows represent the order of the operation, while line thickness represents the amount of the operation frequency of occurrence from one behavioral type to another.
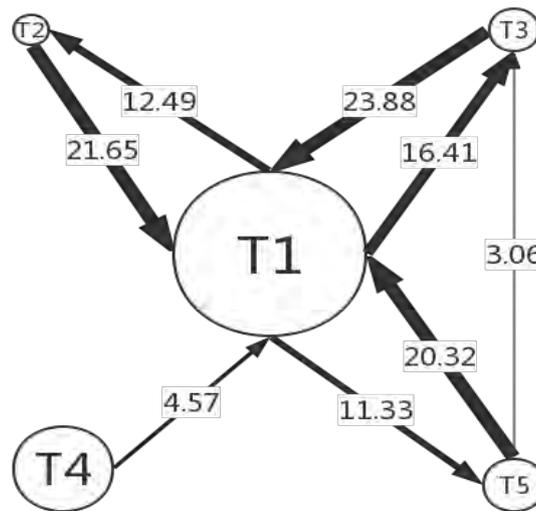
Figure 2. The behavioral pattern diagram of all teachers

When observing the results of Table 2 and Figure 2, there is obvious behavioral transition between T1 and T3 (T1→T3, 16.41; T3→T1, 23.88), followed by behavioral transition between T1 and T2 (T1→T2, 12.49; T2→T1, 21.65), meaning that teachers are more likely to use *communication and collaboration* and *assignment* after using *course and content*, and vice versa. Most of the operational behavior revolves around *course and content* (T1). No matter what kind of behavior changes, the behavior is transformed into other behavior types through *course and content*. To analyze the line direction and line thickness in Figure 2, we observed that the last behavior of most teachers on the platform was *course and content*. Unexpectedly, there is no obvious behavioral transition from *course and content* (T1) to *assessment* (T4), although *assessment* showed a high frequency of usage. Another interesting finding is the transition from *administration* to *communication and collaboration*—there are fewer connections between these two functions according to our coding scheme.

4. DISCUSSION

According to the results of frequency analysis exploring teachers' usage of the Blackboard platform, it found that the frequency of using courses and content is the highest, while using *assignment* is the lowest. The above results reveal that the LMS usage behavior of teachers was primarily confined to creating or uploading instructional materials or course content for students to download or access. This is consistent with other LMS utilization studies reporting that tools for content distribution are used more often than other tools (Garrote Jurado et al., 2014; Phillips, 2006). Macfadyen and Dawson (2012) also pointed out that teachers usually have relatively higher usage of LMS tools such as content and announcements because they require less effort, time and technical skill to implement. Moreover, according to the time chart of frequency analysis, the *assessment* behavior has a tendency to increase in frequency with time. The cause may be due to its proximity to the semester's final exam, which increases the number of times teachers use *assessment*.

On the other hand, some interesting analysis results regarding teacher behaviors are presented via lag sequential analysis. For example, to compare teacher behavioral transitions in multiple directions, two significant behavioral transitions appeared between both *course and content* and *communication and collaboration* (T1↔T3) and between *course and content* and *assignment* (T1↔T2). The high rate of behavioral transitions between *course and content* and *administration* (T1↔T5) indicated that teachers were more likely to deal with online content of teaching materials and teaching management when they used the Blackboard platform. There is also a significant behavioral transition phenomenon from *administration* to *communication and collaboration* (T5→T3). It is considered that teachers often manage class data and contacts, and then use group or communication functions to interact/communicate with their students.

Moreover, the frequency of teacher *assessment* (T4) behavior appeared to be quite high, but only showed significant one-way behavioral transition (*assessment* to *course and content* (T4→T1)). In addition, we found a behavioral phenomenon in which some teachers repeatedly undertook the same action behavior in some insignificant function modules. This may imply that teachers may not have been quite familiar with how to use Blackboard when they performed some teaching tasks. This result is consistent with Chow et al. (2018), which indicated that trained teachers presented more behaviors in operating various LMS functions than did untrained teachers.

5. CONCLUSION

This study explored teacher behavioral patterns toward the use of Blackboard by using frequency and sequential analysis. The results showed that a majority of teacher behaviors focused on *course and content*, as well as there being a higher behavioral transition that occurs between *course and content* and *assignment* or *course and content* and *communication and collaboration*. In addition, teachers typically use only the *assessment* functions to conduct *assessment* tasks and seldom carry out other teaching tasks when they use LMSs. One limitation of this study is not taking continuous operating behaviors into account when conducting the sequential analysis. Future research might add other analytical methods, such as cluster analysis, to explore other different teacher groups according to behavioral characteristics. Furthermore, some individual characteristics of teachers could be considered to explore their impact on teacher behavior toward the use of Blackboard, such as gender, age, beliefs, and ICT competency. In summary, this study presents a behavioral frequency distribution and sequential behavioral patterns for university teachers toward the use of Blackboard, delivering a deeper and broader understanding of the LMS usage behavior of university teachers in a higher education context.

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REFERENCES

Bakeman, R. and Gottman, J., 1997. *Observing interaction: An introduction to sequential analysis*. 2nd ed. Cambridge University Press, Cambridge, UK.

Cerezo, R. et al, 2016. Students' LMS interaction patterns and their relationship with achievement: A case study in higher education, *Computers & Education*, 96, pp. 42–54.

Chiang, T. H. C. et al, 2014. Students' online interactive patterns in augmented reality-based inquiry activities, *Computers & Education*, 78, pp. 97–108.

Chow, J. et al, 2018. Comparing trained and untrained teachers on their use of LMS tools using the Rasch analysis, *Computers & Education*, 123, pp. 124–137.

Dabbagh, N. and Kitsantas, A, 2005. Using Web-based Pedagogical Tools as Scaffolds for Self-regulated Learning, *Instructional Science*, 33(5–6), pp. 513–540.

De Smet, C. et al, 2012. Researching instructional use and the technology acceptation of learning management systems by secondary school teachers, *Computers & Education*, 58(2), pp. 688–696.

Garrote Jurado, R. et al, 2014. Classification of the features in learning management systems, *Proceedings of XVII Scientific Convention on Engineering and Architecture*, Havana, Cuba, pp.1-12.

Hou, H.-T., 2012. Exploring the behavioral patterns of learners in an educational massively multiple online role-playing game (MMORPG), *Computers & Education*, 58(4), pp. 1225–1233.

Hou, H.-T., 2013. Analyzing the behavioral differences between students of different genders, prior knowledge and learning performance with an educational MMORPG: A longitudinal case study in an elementary school, *British Journal of Educational Technology*, 44(3), pp. E85–E89.

Hou, H.-T. et al, 2010. Applying lag sequential analysis to detect visual behavioural patterns of online learning activities, *British Journal of Educational Technology*, 41(2), pp. E25–E27.

Li, L.-Y. and Tsai, C.-C., 2017. Accessing online learning material: Quantitative behavior patterns and their effects on motivation and learning performance, *Computers & Education*, 114(300), pp. 286–297.

Macfadyen, L. P. and Dawson, S., 2012. Numbers are not enough. Why e-learning analytics failed to inform an institutional strategic plan, *Journal of Educational Technology & Society*, 15(3), pp. 149–163.

Mohd Kasim, N. N. and Khalid, F., 2016. Choosing the Right Learning Management System (LMS) for the Higher Education Institution Context: A Systematic Review, *International Journal of Emerging Technologies in Learning*, 11(6), p. 55.

Munoz-Organero, M. et al, 2010. Student Behavior and Interaction Patterns With an LMS as Motivation Predictors in E-Learning Settings, *IEEE Transactions on Education*, 53(3), pp. 463–470.

Peled, A. and Rashty, D., 1999. Logging for success: Advancing the use of WWW logs to improve computer mediated distance learning, *Journal of Educational Computing Research*, 21(4), pp. 413–431.

Phillips, R., 2006. Tools used in Learning Management Systems: analysis of WebCT usage logs, *Proceedings of the 23rd annual ascilite conference: Who's learning? Whose technology?*, Sydney, Australia, pp. 663–673.

Sun, J. C. Y. et al, 2017. Exploring learners' sequential behavioral patterns, flow experience, and learning performance in an anti-phishing educational game, *Educational Technology and Society*, 20(1), pp. 45–60.

Tempelaar, D. T. et al, 2017. Towards Actionable Learning Analytics Using Dispositions, *IEEE Transactions on Learning Technologies*, 10(1), pp. 6–16.

Watson, W. R. et al, 2007. An Argument for Clarity: What are Learning Management Systems, What are They Not, and What Should They Become?, *TechTrends*, 51(2), pp. 28–34.