Does Time Play a Role? Prediction of Learning Performance with Time-use Habits in Online Assignments

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***Abstract*—For the students, poor time-use habits can easily lead to academic failure. The online learning environment is full of learning resources, and students are not able to get monitor and guide of the teachers face-to-face. Therefore, students are expected to have better time management skills. In this study, 67 middle school students were taken as examples to study their online assignments in LMS in three semesters, and four indicators of time-use habit were constructed: submission, procrastination, speed and regularity. These indicators were used to analyze their prediction effect to students' learning performance. The results show that there is a significant negative correlation between procrastination and learning performance, and the predictive power of procrastination is the best; there is a significant positive correlation between assignments submission times and learning performance and speed is also. While regularity does not show significant correlation with learning performance.**

Keywords—time management, learning analytics, time-use habits, learning performance

I. INTRODUCTION

Nowadays, the time and human cognitive resources that people can use are limited. Therefore, how to manage limited time reasonably to help us accomplish tasks in work and study more efficiently has become an essential skill for a person. Students are no exception. Students often face a heavy burden of academic work. If they cannot effectively manage their time, they will be prone to academic failure. However, academic procrastination seems to become a common problem for students. If they cannot realize and correct their bad time-use habits, it will not be conducive to students' academic improvement.

Time-use habit is an important part of self-regulation ability, and has been analyzed by a large number of researchers on its relationship with learning performance. However, current measurement of time-use habits still relies on student self-reports, such as questionnaires. Due to the social approval, students often do not respond objectively to expressions such as "I am not in a hurry to perform my duties."

At present, most of the research on time-use habits focus on traditional classroom context, but the time-use habits in online learning are more critical. There are two reasons. First, online learning is an asynchronous context and the time and space are more flexible. Students can arrange the time and progress of learning more freely, so there are more requirements for students' time management ability. Second, online learning lacks face-to-face interaction between teachers and students, and students cannot fully receive the attention and encouragement from teachers. In the online learning environment, students generate a large amount of learning behavior data in the learning management system (LMS). With learning analytics, the student behavior data is processed and analyzed, and the analysis results are more objective and scientific than self-report. Therefore, time-use habits in online learning should be an important topic of research.

Based on the above expressions, this study focuses on students' online assignments from the perspective of learning analytics, using the students' procedural behavior data to measure the time-use habits, and analyze the relationship between students' time-use habits and their learning performance.

II. RELATED WORK

The research on time-use habits is mainly divided into two types of learning context: traditional learning context and online learning context. In the traditional learning context, Kelly used Time-use Efficiency Scale to investigate the time-use habits of 141 graduate students. The questionnaire consists of three dimensions: awareness of time, awareness of that which Fills time and positive in-task work habits. The results have shown that the higher the score of the students' questionnaire, the higher the students' GPA [1]. Macan and Shahani used the Time Management Behavior Scale. The questionnaire consists of four dimensions: Setting goals and priorities, Planning and Scheduling, Perceived Control of Time, Preference for Disorganization. By testing 165 students, the study found that the higher the student's questionnaire score, the higher the academic score, and the less academic pressure. And the Perceived Control of Time has the strongest influence on academic performance [2]. Adebayo developed the Time Management and Students Academic Performance (TMSAP) questionnaire. The questionnaire focused on the procrastination, planning and prioritization of 200 college students. The results showed that three dimensions had significant impacts on academic performance. In addition to the relationship between time-use habits and academic achievement, some researchers have studied the mediation of other factors [3]. For example, Osman et al. used self-efficacy as a moderator variable of time-use habits and academic achievement. Using a structural equation model to conduct a questionnaire survey of 226 college students, the results showed that self-efficacy can be used as an effective moderator variable, and there is a significant positive correlation between time-use habits and academic achievement [4]. Won and Yu selected 194 high school students who participated in the STEM course, to understand the impact of their parents' support on their time-use habits. The study defined the time-use habits as three dimensions:

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planning time, monitoring time and procrastination. The results showed that the greater the parents support the students, the stronger the students' ability to plan and monitor the time, and the weaker the procrastination [5]. In addition, a study by Balkis and Duru has shown that girls are less likely to show academic procrastination than boys [6]. This finding is consistent with Pehlivan's research [7].

In online learning context, researchers focus more on how to improve students' time-use habits and verify the effectiveness of interventions. For example, Tabuneca used an Android app to help students monitor their online learning time and use the Validity and Reliability of Time Management Questionnaire (VRTMQ) to investigate students' time planning, time attitudes and time wasters. The study found that monitoring learning time can help students improve their time management skills, and push reminders to students through the app at regular intervals can effectively correct their bad time habits [8]. Kim et al. used the Learning Analytics Dashboard (LAD) to help students manage their time. A survey of 151 college students found that students using the LAD had significantly higher scores than those who did not use the LAD [9].

It can be found that even in the online learning context, most of the relevant research still use the traditional questionnaire survey method to measure the students' time-use habits, and the use of online behavioral data indicators to quantify the time-use habits is still a minority. However, some results have a good inspiration for this study. For example, Jo et al. constructed three variables related to time management, namely Total login time, Login frequency, Regularity of login interval. The first two variables can be directly summed from the original data, and the third variable is the result of calculating standard deviation. The results showed that the three variables can reflect the students' time management ability. The longer the login time, the higher the frequency, and the more regular login, the better the time management ability of the students [10].

Through the above analysis, it can be found that the factors that can represent the time-use habits can be summarized as procrastination, time planning and monitoring, which can be defined as four factors of submission, procrastination, speed and regularity in online learning environment. Therefore, the research questions of this study are as follows:

(1) How to use online learning behavior data to characterize the submission, procrastination, speed and regularity in online assignments?

(2) Are there differences among different types of students in regard to submission, procrastination, speed, and regularity in online assignments?

(3) Can the submission, procrastination, speed and regularity in online assignments predict students' learning performance effectively?

III. Methodology

A. Participants and Context

The learning management system (LMS) used in this study is the Cloudbag platform, developed by the Intelligent Learning System Lab of Beijing Normal University. The platform can support students to view videos, take online assignments, interact in the forum and other learning activities. This study selected the online assignments to analyze the students' time-use habits.

A total of 67 students from a middle school in Guizhou Province of China participated in the study, and the participants enrolled in nine courses in LMS. The study lasted for three semesters. The first semester was from March 2016 to June 2016, during which all students generated a total of 1,743 assignments; the second semester was from September 2016 to December 2016, during which all students generated a total of 591 assignments; the third semester was from March 2017 to June 2017, during which time all students generated a total of 728 assignments.

B. Measures

1) Classfication of Learning Outcome

Krumm et al. believed that the level of online learning outcomes can be analyzed by a combination of exam scores and the number of LMS visits [11]. All students in this study were divided into three categories, A to C. From Class A to Class C, students' learning outcomes are high to low. This study calculated the average score of each student in the final exam of the three semester, and counted the ranking of the total number of LMS visits of each student, and comprehensively obtained the classification of the learning outcome. There are 16 students in Class A, 39 students in Class B, and 12 students in Class C. TABLE I shows the learning outcome classification scheme.

TABLE I. Learning Outcome Classification Scheme

Student Percentage Points Earned	LMS Visits Percentile Rank	Classification
>=85%		A
80%<=X<85%	<75th percentile	B
80%<=X<85%	>=75th percentile	A
75%<=X<80%		B
70%<=X<75%	<25th percentile	C
70%<=X<75%	>=25th percentile	B
<70%		C

2) Time-use Habits

Submission: the total number of times students submit assignments.

Procrastination: the extent to which the student postpones the assignment until the deadline. i is the number of submitted assignments, where $time_{submit_n}$ is the submission time of the n^{th} assignment, $time_{begin_n}$ is the release time of the assignment, and $time_{end_n}$ is the deadline . Procrastination equals to the average ratio of the interval between the submission time and the release time of each assignment and the interval between the deadline and the release time. The value of the procrastination is between 0-1. The closer the value is to 1, the more serious the procrastination is. The specific calculation is as (1).

$$procrastination = \frac{\sum_{n=1}^{i} \frac{time_{submit_n} - time_{begin_n}}{time_{end_n} - time_{begin_n}}}{i} \quad (1)$$

Speed: how quickly students complete homework. i is the number of submitted assignments, where $time_{start_n}$ is the time for the n^{th} assignment to start answering, and $time_{submit_n}$ is the submission time of this assignment. Speed equals to the average value of time used in completion of each

assignment. The smaller the value, the faster the student completes the assignment. The calculation is as (2).

$$speed = \frac{\sum_{n=1}^{i}(time_{submit_n} - time_{start_n})}{i} \quad (2)$$

Regularity: the tendency of students to start working at a specific time. $time_{start}$ is the time each student starts answering assignments (only extract the hour part). Regularity equals to the standard deviation of the starting time of each assignment. The smaller the value, the more students tend to complete homework at a fixed moment. The calculation method is as follows.

$$regularity = \sqrt{variance(time_{start})} \quad (3)$$

C. Process

After quantifying the time-use habits in the online assignment, this study used SPSS 20.0 to conduct a descriptive statistics of the four indicators of student time-use habits. Then, using one-way analysis of variance, we investigated whether there was a significant difference in the time-use habits among the three types of students. Finally, multiple linear regression methods were used to test the predictive effect of online assignments time-use habits on learning performance.

IV. Results

A. Descriptive Statistics of Time-use Habits in Online Assignments

TABLE II shows the overall performance of students in terms of time-use habits. The average number of assignments submission per student is 53.15, but the number varies from student to student. The number of the most assignments submission by one person is 110, while the least is only 23. In terms of procrastination, the average is 0.4 (<0.5), reflecting that students generally can complete homework in the first half of the specified period, and the overall procrastination is mild. In terms of speed, the average is 170.89, and the standard deviation is 2.24, indicating that the difference in speed between different students is not large. In terms of regularity, the class average is 4.27, which indicates that the moment for students to complete the assignment is not very fixed.

TABLE II. Descriptive Statistics of Time-use Habits

	N	Mean	St. Dev.	Min	Max
submission	67	53.15	25.04	23	110
procrastination	67	0.40	0.13	0.06	0.80
speed	67	170.89	2.24	165.27	174.65
regularity	67	4.27	0.94	1.73	6.67

B. Differences among Different Classifications of Students in Regard to Their Online Assignments Time-use Habits

This study separately analyzed the differences among students of different categories, in regard to their time-use habits of each semester. TABLE III shows that, in terms of the number of assignments submission, Class B students was the highest (56.333) while Class C students was the least (41.667), but the three types of students did not show significant differences. In terms of procrastination, there is a significant difference between the three categories of students (F=12.679, Sig.=.000<.001). Class A students have the lowest value (.329), indicating the least degree of procrastination; while Class C students have the biggest number (.536), indicating the most procrastination. By different semester, the three types of students showed significant differences (F = 5.053, Sig. = .006 <.01) only in the first semester. In addition, from the first semester to the third semester, the three types of students gradually increased their scores, indicating that the procrastination of students has become more and more serious with the passage of time. In terms of speed, in general, Class C students have the lowest value (168.979), indicating that they have the fastest speed; while Class A students have the highest value (171.900), indicating that it is the slowest. By different semester, the three types of students showed significant differences (F = 6.418, Sig. = .003 <.01) only in the second semester. At the same time, as the study progresses, the three classes of students complete the practice faster and faster. In terms of regularity, the overall three categories of students did not show significant differences. However, in the third semester, the three types of students showed significant differences (F=4.081, Sig.=.035<.05). Class A students have the lowest number (2.188), indicating that students are more likely to complete assignments at regular intervals per day; while Class C students have the highest number (3.030), indicating that there is no obvious tendency for such students to practice during the time period.

TABLE III. Difference Analysis of Time-use Habits

		Sum Mean±SD	**Semester 1** Mean±SD	**Semester 2** Mean±SD	**Semester 3** Mean±SD
submission	A	54.000±30.932	28.938±22.939	6.938±6.475	18.125±3.052
	B	56.333±24.678	32.103±17.255	8.487±6.444	15.744±8.512
	C	41.667±13.179	22.333±9.604	6.000±3.438	13.333±6.972
	F-value	1.615	1.400	.933	1.486
procrastination	A	.329±.105	.306±.115	.402±.127	.666±.137
	B	.391±.120	.354±.123	.516±.203	.672±.190
	C	.536±.070	.450±.116	.522±.324	.702±.097
	F-value	**12.679*****	**5.053****	1.771	.188
speed	A	171.900±1.257	173.683±.217	169.616±.710	163.956±.149
	B	171.071±1.807	173.605±.232	169.245±.567	163.895±.257
	C	168.979±3.335	173.726±.331	168.810±.473	163.878±.241
	F-value	**7.276*****	1.323	**6.418****	.497
regularity	A	4.347±1.136	4.449±1.314	4.129±1.757	2.188±.356
	B	4.218±.866	4.209±.885	4.112±1.850	2.215±.885
	C	4.343±.991	4.113±.588	3.784±1.833	3.030±1.370
	F-value	.142	.498	.164	**4.081***

*Note: *p<0.05, **p<0.01, ***p<0.001. The same as below.*

C. Predicting Learning Performance Based on Students' Online Assignments Time-use Habits

Calculate the average score of students' final exam in the three semester, and analyze the relationship between students' time-use habits and exam scores. Through correlation analysis (see TABLE IV), it is found that there is a significant negative correlation between procrastination and exam scores, that is, the more serious the student procrastinate, the worse the learning performance; the speed and learning performance have a significant positive correlation, that is, the longer the student completes the assignment, the better the learning performance. The number of assignments submission and regularity do not show a significant correlation with learning performance.

TABLE IV. CORRELATION ANALYSIS BETWEEN TIME-USE HABITS AND LEARNING PERFORMANCE

	SUB	PRO	SPE	REG	GRA
SUB	1				
PRO	.256*	1			
SPE	-.450***	-.527***	1		
REG	-.211	-.008	.200	1	
GRA	.209	-.488***	.466***	.035	1

Note: SUB means submission, PRO means procrastination, SPE means speed, REG means regularity and GRA means grade. The same as below.

In order to understand the predictive effect of time-use habits on learning performance further, this study used the number of submissions, procrastination, speed and regularity as predictors, and used students' exam scores as the outcome variable. Stepwise method for multiple regression analysis was used to investigate learning performance can be explained by time-use habits to what extent. Four variables were entered in sequence to form four regression equations (see TABLE V).

It was found that the four predictors have a high degree of explanatory power for learning performance, with R^2 as high as 0.527, indicating that the predictor can explain the 52.7% change in learning performance. Since the number of samples is small, the adjusted R^2 should be used, and the interpretation ratio of 49.6% is also satisfactory. Among them, the negative prediction effect of procrastination is significant, while the speed and the number of assignments submission show a significant positive prediction effect. Specific to the predictive contribution of each predictor to learning performance, it can be seen that the contribution of procrastination is the highest, which can explain 22.6% of the exam scores; the second is the number of assignments submission, which can explain 21.9% (49.6% minus 27.7%) of the exam scores. The last is speed, which can explain 6.1% of the scores (29.9% minus 23.8%). The regularity does not produce a predictive contribution to the score because it does not reach a significant level.

TABLE V. DETERMINANTS OF LEARNING PERFORMANCE

	Dependent variable: exam scores			
	(1)	(2)	(3)	(4)
PRO	-21.201***	-14.570**	-14.411**	-15.426***
SPE		12.582*	12.902*	22.297***
REG			-1.182	1.884
SUB				23.436***
Intercept	632.821***	632.821***	632.821***	632.821***
Observations	67	67	67	67
R^2	.238	.299	.299	.527
Adjusted R^2	.226	.277	.277	.496

V. DISCUSSION AND CONCLUSION

From the above analysis, procrastination has the most obvious impact on learning performance. The more serious the academic procrastination, the more likely students are fail academically. Therefore, in online learning environment, teachers should focus on students who often start assignments only when they are close to the deadline. At the same time, as time progresses, students' procrastination is generally more and more serious, reflecting the phenomenon that students are prone to fatigue and slackness during the learning process. Therefore, teachers should take measures to help students maintain their motivation to learn, such as adjusting the difficulty of assignments, or setting the reward system.

The number of submissions has a good predictive effect on learning performance. Through assignments, students can check and reflect on their own learning. The more the number of assignments, the more familiar the students are to their overall level of knowledge. Teachers can also intervene and guide students more specifically through the results of the assignments.

In terms of the speed of completing the assignment, due to the lack of face-to-face pressure on the teacher in the online learning environment, students tend to lack in-depth thinking when they practice, and rush to submit assignments. Therefore, the more time invested in the assignment, the more attentive the student answers. Teachers can emphasize the importance of online assignment during the course assessment and attract students' attention.

Regularity does not show a predictive effect on learning performance. The reason is that the time at which students start their homework is largely influenced by the time the teacher releases it, and is less affected by the student's own plan for time. However, with the passage of time, Class A students formed a more fixed assignment time in the third semester. So, when teachers arrange the assignment, it can be fixed at certain time periods to help students develop stable time-use habits.

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