Making Sense of Online Learning Behavior: A Research on Learning Styles and Collaborative Learning Data

Meng SUN[a], Jiu-Tong LUO[a], Dong-Ming QIAN[b] & Xiao-Qing GU[a*]

[a] *Department of Educational Information Technology, East China Normal University, China*

[b] *e-Educational System Engineering Research Center & Shanghai Engineering Research Center of Digital Education Equipment, East China Normal University, China*

*xqgu@ses.ecnu.edu.cn

Abstract: This study focused on the relationship between learning styles, online behaviors and group collaborations. Sixty junior students from a university in China were taken as research object. Index of Learning Styles was used as a measuring tool to test participants' learning styles. Relationships between variables were measured by using bi-variate correlations analysis and one-way analysis of variance respectively. The results revealed a meaningful relationship between learning styles and online collaborative behavior. In addition, groups' online collaborative performances could be significantly different. However, grouping by learning styles might not be the factor that make effects on group collaborations.

Keywords: Learning styles, online learning, online behaviors, group collaborations

1. Introduction

The emergence of "big data" in education holds promise for improving learning processes in formal education, and beyond as well (Siemens & Baker, 2012). Currently, the learning management system (LMS) has been widely used, and has stored a lot of data, which notably supporting researchers' studies. The analysis of learners' online behaviors is a research focus in educational technology area. In the field of cooperative learning, what factors can affect groups' performances is also a topic worthy to explore.

It has been proven that learners' personality can affect learner behaviors in online learning environment. Many educators consider learning styles as an important factor to influence students' learning process. Furthermore, education research has emphasized that collaborative learning could improve project quality and performance (Soliman & Okba, 2006). The way in which students are grouped may affect the group performance. One of the features that can be taken into consideration when grouping is students' learning styles.

The aim of this study was to examine the relationship between learning styles, online behaviors and group collaborations. For this purpose, the following research questions will be answered:

- Which dimensions of learning style have effect on learners' online behaviors?
- Which kinds of online behaviors could be affected by learning style?
- Is there a significant difference among groups' online performances?
- Is there a significant relationship between group members' learning styles and groups' online collaborative performances?

2. Theoretical framework

LMS such as Blackboard, Moodle, Sakai et al., and many other learning systems have been widely used in e-learning around the world, providing teachers and students with a great variety of features which can be included in the course such as learning material, quizzes, discussion forums, assignments, and so on (Graf & Liu, 2008). With a lot of e-learning behavioral data produced, learning analytics (LA) has

emerged as a new technology aimed to make sense of these data. Learning analytics is a technology focused on measurement, collection, analysis and reporting data about learners and contexts，for purposes of understanding and optimizing learning and the environments in which it occurs (Siemens et al., 2011; Siemens, 2012). Research on learning analytics has found that learning behavior data can predict students' learning to some extent.

Learning style is a unique combination of primary forms of processing information as well as the way in which various techniques and personal idiosyncrasies are used, and it has been though as one of the factors which can affect person's behavior. Research on learning style started from 20th century, and many teachers used this theory while they were teaching. There are various definitions and classifications of learning style.

Learning style is the way in which each person absorbs and retains information and/or skills, regardless of how that process is described, it is dramatically different from each person (Dunn, 1984). Pask (1988) defined learning style as a kind of strategy that learners like to use when they were processing a specific information. And Kolb (1999), Lotas (1977) and Oxofrd (1993) et al. also put forward their own classifications of learning style from difference aspects. Soloman & Felder (1997) developed an index of learning styles and was widely used today. In this instrument, learning styles were divided into four dimension, such as sensing or intuitive, visual or verbal, active or reflective and sequential or global.

3. Methods

3.1 The Participants and Context

72 (14male, 58 female) junior students majoring in educational technology from a university in China took part in the research. They were all in the course on Instructional System Design which lasted for 20 weeks began in March and ended in June. The course task for the students was to work in groups of six on a project assignment. Students could choose their partners freely. During the course, they should do theme discussion at the course platform (Sakai) and upload their homework to the platform. In addition, every group member should discuss about their group projects after class via the instant communication tool (QQ).

3.2 Measuring Tools

This study used the Chinese version of Index of Learning Styles (ILS) developed by Soloman & Felder (1997), and it had been tested in many researches in China. This questionnaire contains 44 items divided into four dimensions: active-reflective, sensing-intuitive, visual-verbal and sequential-global. Each dimension has associated with 11 forced-choice items with each option (a or b). Taking active or reflective as an example, for statistical analysis, it used 'b' responses minus 'a' responses, and then the ranging of number will between -11 to +11 (Felder et al., 2005). In this study, +11, +9, +7, +5, +3, +1 represented the learning style were active, and -11, -9, -7, -5, -3, -1 represented the learning style were active on the active-reflective dimension. The higher the value, the stronger is the preference. And the rest three dimensions were following the same distinguishing method mentioned above.

4. Data sources and analysis

In the study, results of students' learning styles inventory and online behavior, including clickstreams of students' participating in platform activities and groups' chat logs after class were all expected to be recorded and analyzed. However, one of the 72 student did not finish the questions of the ILS, and one group did not submit their group chat logs. Finally, data from 10 groups (60 students) were evaluated in total. The population was composed of 83.3% female (N = 50) and 16.7% male (N = 10).

Adopting a quantitative method, SPSS 19.0 was used to analyze the data. In order to answers the research questions, bi-variate correlations analysis and one-way analysis of variance (ANOVA) test

were used; other basically and descriptively statistical analysis techniques such as frequency, percentage and standard deviation of the distribution were also employed.

5. Results

5.1 Students' learning styles

The average scores of the four dimensions, as shown in Table 1, revealed that the leaning style of all the 60 students were a little more active, sensing, and sequential, but much more visual.

Table 1: The results of students' learning styles

Learning Styles	N	Mean	SD	Min	Max
active-reflective	60	0.33	3.77	-9	9
sensing-intuitive	60	1.10	4.11	-9	7
visual-verbal	60	5.67	3.73	-5	11
sequential-global	60	0.17	4.27	-7	11

5.2 The relationship between learning styles and online behaviors

To investigate the relationship between learning styles and online behavior, correlation analysis was performed. One kind of the online behavior was frequencies of participating in platform activities (FA) which mainly consisted of uploading, downloading and posting. The other was average frequencies of speech (FS) in all the six times of after-class group discussion via QQ.

The Table 2 showed that there was significant positive correlation between active-reflective dimension and TS ($r = 0.27$, $p < 0.05$). But the other dimensions of learning styles showed no significant correlations.

Table 2: Correlations analysis results of relationship between learning styles and online behaviors

variables	1	2	3	4	5
1.active-reflective					
2.sensing-intuitive	-0.14				
3.visual-verbal	-0.02	0.00			
4.sequential-global	-0.20	0.33**	-0.41		
5.FA	0.43	0.15	-0.13	-0.04	
6.FS	0.27*	-0.01	-1.00	-0.07	0.45**

** Correlation is significant at the 0.01 level;
* Correlation is significant at the 0.05 level.

5.3 Differences among groups' online performances

The online behavior differences among groups were analyzed in one-way ANOVA (see Table 3). It showed that among different groups, students' collaborative behaviors were significantly different ($F=3.260$, $p<0.01$). Students in Group2, 8 and 9 talked much, but students in Group 1, 11 and 12 talked little. However, significant differences were not found among groups at the level of platform activities ($F=0.694$, $P>0.05$), which was relatively independent.

Table 3: ANOVA results of groups' online performances

		Sum of Squares	df	Mean Square	F	Post Hoc Tests LSD
FS	Between Groups	9.010	9	1.001	3.260**	G2>G1 G8>G1 G8>G11 G8>G12

	Within Groups	15.355	50	0.307		G9>G12
	Total	24.365	59			G9>G1
FA	Between Groups	3.563	9	0.396	0.694	.711
	Within Groups	28.521	50	0.570		
	Total	32.083	59			

** Mean difference is significant at the 0.01 level.

5.4 Difference of group members' learning styles

It was clear that active-reflective learning style could make a significant influence on one's speech times, which were significantly different among groups. Thus, it should be analyzed that if it was the group formations that resulted in the difference, and whether the groups with more speech times had more active members or their group members got much higher cores at active-reflective dimension. Under the condition that each group contained both active and reflective members (see Table4), one-way ANOVA was used to investigate if there was a significant difference of group formation at active-reflective dimension. It could be seen from Table 5 that there was no significant group formation difference ($F=1.436$, $p>0.05$). All groups were heterogeneous and group formation were alike, but interaction within groups were significantly different (see Table 3).

Table 4: Group formation on active-reflective learning style

		G1	G2	G3	G4	G5	G7	G8	G9	G11	G12
active	N	4	4	1	3	4	5	5	5	5	2
reflective	N	2	2	5	3	2	1	1	1	1	4
Total	N	6	6	6	6	6	6	6	6	6	6

Table 5: ANOVA results of group members' learning styles

		Sum of Squares	df	Mean Square	F
active-reflective	Between Groups	172.000	9	19.111	1.436
	Within Groups	665.333	50	13.307	
	Total	837.333	59		

6. Discussion

This study explored a new and important issue on the relationship between learning styles, online behaviors, and group collaborations. It implemented a quantitative research methodology to analyze:

- Which dimensions of learning style that has effect on learners' online behaviors.
- Which kinds of online behaviors that could be affected by learning styles.
- Whether there is a significant difference among groups' online performances.
- Whether there is a significant relationship between groups' formation and groups' online collaborative performances.

This study highlighted the emergent themes such as learning analytics (LA), group collaborative in online environment. And this innovative research also got some meaningful findings from the perspective of LA. The main conclusions were listed as following. Firstly, learning styles could influence individuals' online collaborative learning behaviors rather than the non-collaborative learning behaviors. Among the four dimensions of learning styles, active-reflective dimension played a key role. This study showed that active learners talked much more than reflective learners in a group, and the more active they were, the more frequently the talked. The findings were found to be theoretically consistent with the predictions of the Felder-Silverman learning style model (Felder & Silverman, 1988). Active learners prefer to process information actively by doing something with the learned material, for example discussing, explaining, or testing it. On the other hand, reflective learners prefer to think about the material and work alone. Regarding group discussing, active learners are expected to post more often in order to ask, discuss, and explain something, while reflective learners are supposed to prefer to participate passively by rarely expressing themselves. As a result, active learners

are fit for group work, and could be advised to play the leading role in the group discussion to create positive and active environment.

Secondly, some kinds of online behavior such as uploading and downloading activities were not influenced by learning styles. Students with different learning styles showed no significant difference in terms of participating frequencies. Such behaviors possibly affected by other learner characteristics like gender or motivation types (Lim & Kim, 2003).

Thirdly, group formations of heterogeneous leaning styles might not the main factor that affect online group collaborative performances. All groups contained both active and reflective learner, but their averages speech times were significantly different. In other words, active learners in some groups spoke more than which in other groups. It is similar with the reflective learners. Some researches maintain that people in heterogeneous groups have the opportunity to learn from each other and will have better outcomes. Students believe that heterogeneity has potential benefits for their group performance (Herrmann, 1987; Kyprianidou et al., 2012). It was interesting in this study that heterogeneous groups could also perform differently. Other factors rather than learning styles might play a key role, like "group members' reliability, good mood, mutual respect and empathy, clearly agreed goals, willingness to help, flexibility and adaptability" (Kyprianidou et al., 2012).

7. Conclusions and future work

In this paper, the relationship between learning styles, online behaviors, and group collaborations are addressed. Students with different learning style preferences showed significantly different online behaviors in some patterns. These results seem to be important when instructors design course contents and set course tasks. However, not all group collaboration performances could be affected by learning styles. For example, group discussion could be rather different while the group formation were alike in terms of learning styles. As a result, instructors should consider more factors when grouping the students.

Future work will deal with correlations of learning styles and other online behaviors such as time spent on examples, exercises, self-assessment tests, content objects and so on. The Sakai platform should be re-developed to do the analytic work and give the students more suggestion on their study. Moreover, qualitative analysis methods should be used for group discussion contents in order to explore what are the main factors that affect non-collaborative behaviors on the platform and group performance.

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