The Relationship between the Learning Styles of the Students and Their e-Learning Course Adaptability

Kazunori Nishino, Hiroko Toya, Shinji Mizuno, Kumiko Aoki,
and Yoshimi Fukumura

Kyushu Institute of Technology, Faculty of Computer Science and Systems Engineering,
680-4 Kawazu, Iizuka, Fukuoka, 820-8502 Japan
nishino@lai.kyutech.ac.jp, toya@smile.kyutech.ac.jp,
s_mizuno@aitech.ac.jp, kaoki@code.u-air.ac.jp,
fukumura@oberon.nagaokaut.ac.jp

Abstract. This study investigated learning styles of students who had or had not taken e-learning courses, developed a learning style questionnaire for e-learning courses, and examined the relationship between the learning style and the adaptability to e-learning courses. As the result, the student's adaptability of e-learning courses can be suggested before his/her taking an e-learning course. It was found that using the multiple regression model obtained in the study, about 40% of the adaptability to e-learning courses can be explained by the learning style questionnaire developed in the study.

Keywords: learning styles, e-learning, class adaptability, asynchronous learning.

1 Introduction

In recent years, e-learning has become widely used in higher education and company training. E-leaning can be classified into two categories based on the proportion of online components in a class: blended learning where e-learning supplements in-class teaching, and full online learning which is conducted without any face-to-face meeting. In this study, e-learning means the latter; full online learning.

E-learning has an advantage of allowing for learners to study at "any time" and "any place." In addition, it allows diverse learning forms with the use of information and communication technologies (ICT). On the other hand, as e-learning is usually conducted asynchronously, it requires more self-discipline of students in comparison to face-to-face classes. It might be easier for students who like to learn at their own pace to continue and complete e-learning. However, it can be challenging for those who don't like studying on their own and prefer face-to-face classes. It is not unusual that students drop out from e-learning courses and fail to get credits for the course they have registered for [1].

Several measures for preventing students' dropout have been taken with the use of ICT. The use of learning management systems (LMS) can ease the distribution of course materials and communication among students or between students and staff. Some measures have been taken to help students understand the content of e-learning

materials and to motivate students in studying materials through e-mails sent by teachers and tutors of e-learning courses [2]. However, the use of ICT in e-learning tends to become complex as its functionality increases and may discourage those students who are not well equipped with the ICT use.

The use of ICT and asynchronous learning is a typical characteristic of e-learning. However, as it is stated earlier, those who don't like asynchronous learning or the use of ICT may have the tendency to drop out in the middle of e-learning courses. Therefore, it is desirable that students and their teachers know the students' learning styles and their adaptability of e-learning courses in advance [3].

This study aims to investigate the relationship between students' learning styles in e-learning and their adaptability of e-learning courses by surveying learning styles of students and analyze the correlation between the learning styles and the adaptability of e-learning courses.

2 Learning Styles in e-Learning

The research on learning styles has been popular in Western countries, especially in the U.K. and in the U.S. in the past 30 years. There has been a vast amount of literature on learning styles. According to the Learning Skills Research Center (LSRC) in the U.K., the number of journal articles on the subject has reached more than 3,800. In those articles, 71 different theories and models of learning styles have been presented. LSRC has selected 13 most prominent theories and models of learning styles among the 71 theories and models, and further studied the 13 models [4]. LSRC classified the 13 models of learning styles into five categories from the most susceptible to environments to the least susceptible ones based on the Curry's onion model [5].

As discussed above, there have been many theories about learning styles and it has not been agreed upon the flexibility of learning styles in terms of whether individual learning styles are independent of the learning environments or they are adaptable to the environments.

When investigating learning styles in e-learning, how should we consider the "flexibility of learning styles"? E-learning has the potential to provide "student-centered learning" and tends to be designed based on the pedagogy of providing learning environments according to the students' needs, abilities, preferences and styles rather than providing uniform education without any consideration of individual needs and differences. Therefore, it is meaningful to provide students and teachers with information about the students' adaptability of e-learning courses by using a questionnaire for learning styles in e-learning.

Though some studies were conducted on the Kolb's learning style [6] in developing computer-based training (CBT) [7], few studies on learning styles in e-learning have been done in the past. In this study, we developed a questionnaire to measure learning styles in e-learning, investigated the relationship between learning styles in e-learning and the adaptability to e-learning courses, and tested the validity of the questionnaire.

3 Development of the Questionnaire for Learning Styles in e-Learning

3.1 The Learning Style Questionnaire

To investigate the learning styles in e-learning, we developed a learning style questionnaire. The questionnaire consists of 36 items asking preferences in studying, understanding, questioning, and doing homework in terms of asynchronous learning and the use of ICT. In addition, the questionnaire included the four reverse coded items to test the validity of the data. The questionnaire was made available online as the target sample was the students who were taking e-learning courses and it was natural for them to access the questionnaire online.

The survey on learning styles was administered to those students who enrolled in the eHELP (e-Learning for Higher Education Linkage Project) which is a credit transfer system for e-learning courses offered by multiple universities in Japan. All the items in the questionnaire were asked with the 7-point Likert scale; from 1 being "don't agree at all" to 7 "agree strongly." The survey was conducted from the early December, 2008 to the early January, 2009, and obtained valid responses from 53 students. Those responses in which answers to the items were all the same including the reverse coded items were considered invalid.

3.2 Factor Analyses of the Questionnaire Results

A factor analysis of the data was conducted with SPSS using the Maximum Likelihood Estimation with Varimax rotation. The result is shown in the Table 1 below.

As the majority of the items which belong to the factor 1 concern the place, time, and content of asynchronous learning, the factor 1 is named as "preference for asynchronous learning." As for the factor 2, the majority of its items are about the use of computers in terms of studying and understanding, and this factor is named as "preference for the use of computers in learning." As the 9 items which belong to the factor 3 are mostly related to communication matters, the factor 3 is named as "preference for asynchronous digital communication." The items for the factor 4 concern the autonomy of deciding study sequence, and it is named as "study sequence autonomy."

The results of the factor analysis described above were analyzed in terms of the reliability of the factors. The four items which did not belong to any of the four factors mentioned above were excluded from the analysis. In addition, the factor 4 was also excluded from the analysis as the factor had only two items and did not contribute much to the overall explanation.

To test the reliability of each factor in the questionnaire, Cronbach α was analyzed for each factor. The Cronbach α for the factor 1, 2, and 3 resulted in 0.862, 0.805, and 0.664 respectively. As for the factor 3, if the item q34 was deleted the overall reliability would increase to 0.759. Therefore, the item q34 in the factor 3 was deleted in the further analysis.

As a result, the 33 items in the questionnaire comprise the three factors: the factor 1 "preference asynchronous learning," the factor 2 "preference for the use of computers in learning" and the factor 3 "preference for asynchronous digital communication," and those were analyzed further.

Table 1. The Result of Factor Analysis of e-Learning Learning Style Questionnaire Data (After Rotation)

	factor			
	1	2	3	4
q1) I understand better when I study at my convenient time rather than learning in class with other people. (async)	**0.891**	0.084	0.115	−0.099
q2) I can familiarize myself better when I study independently at my convenience than studying with others at one place. (async)	**0.729**	0.163	−0.202	−0.117
q3) I would rather study alone at the place and time convenient to me than learn in class with other people. (async)	**0.721**	−0.045	0.233	−0.041
q4) I can be more creative when I study alone than studying with others at one place. (async)	**0.694**	0.196	0.137	−0.085
q5) I feel more motivated when I study at my convenience than learning in class with other people. (async)	**0.681**	0.271	−0.009	0.132
q6) I can learn better when I study at the time I decide than when I study at the time decided by others. (async)	**0.681**	0.104	0.214	−0.086
q7) I tend to learn more actively when I study alone than studying with others at one place. (async)	**0.635**	0.028	0.008	0.052
q8) I study at my own pace and do not care how others study. (async)	**0.596**	−0.117	0.417	−0.142
q9) I can concentrate better when I study independently at my convenience than studying with others at one place. (async)	**0.594**	0.238	0.046	−0.11
q10) I feel less tired when I study independently at my convenience than studying with others at one place. (async)	**0.593**	−0.043	0.348	−0.078
q11) I wan to study at the same pace with other sudents. (sync)	**−0.587**	−0.031	0.032	0.153
q12) When I study through computers, I tend not to care how others study. (with ICT)	**0.564**	0	0.476	−0.075
q13) I wan to study at my own pace. (async)	**0.538**	0.285	0.106	0.262
q14) I tend to learn more actively using computers than studying in class. (with ICT)	0.358	**0.642**	0.075	−0.025
q15) It is easier for me to memorize what is on a computer rather than to review printed materials. (with ICT)	0.119	**0.635**	0.04	−0.247
q16) I can be more creative when I think on paper than using computers. (without ICT)	0.082	**−0.618**	−0.165	0.083
q17) I would rather do group learning through computers than face-to-face. (with ICT)	−0.012	**0.617**	−0.092	0.288
q18) I can concentrate better looking at a computer screen than looking at a blackboard or a large screen in a classroom. (with ICT)	0.452	**0.571**	0.069	0.113
q19) I feel more motivated when I study using computers than learning from teachers in person. (with ICT)	0.206	**0.563**	−0.157	0.15
q20) I understand better when I learn through computers than when I learn by reading books. (with ICT)	0.17	**0.562**	0.511	0.077
q21) I can be more creative when I think using computers than thinking on paper. (with ICT)	−0.018	**0.56**	0.277	0.01
q22) It is easier for me to communicate through computers or cell phones than to communicate face-to-face. (with ICT)	−0.087	**0.52**	0.39	−0.03
q23) I would rather follow the computer instruction rather than study reading textbooks. (with ICT)	0.208	**0.491**	0.458	−0.023
q24) I prefer learning through computers to learning by reading books. (with ICT)	0.221	**0.474**	0.447	0.102
q25) I feel less tired looking at a computer screen than looking at a blackboard or a large screen in a classroom. (with ICT)	0.076	**0.437**	0.245	0.034
q26) It is easier for me to take test on a computer than on paper. (with ICT)	−0.01	0.296	**0.599**	0.146
q27) I would rather submit my report in an electronic format than in a paper and pencil format. (with ICT)	0.083	−0.012	**0.588**	0.21
q28) It is easier for me to take test individually than to take one in a place with others. (async)	0.269	−0.006	**0.535**	−0.173
q29) I would rather receive answers later from teachers via mail than asking questions in person or through chat. (async)	0.001	0.161	**0.526**	−0.011
q30) I prefer communicating via email to communicating through telephones. (async)	−0.099	0.068	**0.468**	−0.086
q31) I am familiar with computers. (with ICT)	0.145	0.001	**0.461**	0.029
q32) I prefer taking notes using a computer than writing on paper. (with ICT)	0.204	0.336	**0.445**	−0.08
q33) I would rather ask questions using email or bulletin boards than asking teachers in person. (with ICT)	0.096	0.295	**0.445**	0.077
q34) I would rather study reading textbooks rather than follow the computer instruction. (without ICT)	−0.048	−0.67	**−0.422**	0.163
q35) I want to decide the study sequence on my own. (async)	0.27	−0.124	0.161	**−0.941**
q36) I want to follow the study sequence which my teacher decides. (sync)	−0.125	0.053	0.032	**0.583**
q37) I prefer being assessed individually upon completion of the assignment to being assessed at the same time with others. (async)	0.114	−0.22	0.091	0.238
q38) I want to drill what I have learnt repeatedly. (async)	0.259	−0.096	0.062	0.184
q39) It is easier for me to tackle with the project I decide than the one assigned to me. (async)	0.188	0.105	0.309	−0.194
q40) I prefer looking my grade online to being given it on paper. (with ICT)	0.212	0.343	0.372	−0.204

4   The Survey on the Adaptability to e-Learning Courses

When the learning style questionnaire was administered, the questionnaire on the adaptability to e-learning courses was also administered to the students who enrolled in eHELP courses. The items in the questionnaire are shown in the Table 2. The questionnaire consists of 10 items asking psychological aspects of learning such as the level of students' understanding and the level of satisfaction.

The questionnaire (see Table 2 below) was administered online to the students enrolled in each of the eHELP courses upon their completion of the course (i.e., between December, 2008 and January, 2009) and 69 responses completed the questionnaire. All the items in the questionnaire were asked with the 7-point Likert scale; from 1 being "don't agree at all" to 7 "agree strongly." The scores for the item (g) and (h) were reverse-coded. The mean score was 4.7.

To test the reliability of the 10 items in the questionnaire, Cronbach α was analyzed. As a result, Cronbach $α = 0.783$ was obtained and we determined to use all the 10 items as one factor of adaptability to e-learning courses.

Table 2. The Question Items in the Adaptability to e-Learning Course Questionnaire and Mean Scores

Item	Mean
(a) The content of this e-learning course is more understandable than regular class contents.	4.51
(b) The style of learning of this e-learning course is easier to learn than regular class.	4.90
(c) The pace of this e-learning course is more suitable than regular class.	4.91
(d) This e-learning course is more satisfying than regular class.	4.36
(e) This e-learning course is more effective than regular class.	4.35
(f) This e-learning course is more interesting than regular class.	4.91
(g) This e-learning course makes me more tired than regular class.	4.84
(h) This e-learning course makes me more nervous than regular class.	5.59
(i) This e-learning course brings me more endeavor than regular class.	4.07
(j) This e-learning course brings me more motivation than regular class.	4.41

5   Results and Discussions

5.1   Results of the Learning Style Questionnaire

Based on the learning style questionnaire analysis discussed in the section 3, the mean score for each factor was calculated. In addition, for the comparison purpose, the same questionnaire was administered in the early February, 2009, to those students who had not enrolled in eHELP courses. The mean scores of 53 eHELP students and 39 non-eHELP students for each of the three factors: the preference for asynchronous

Table 3. Factor Scores for eHELP Students and non-eHELP Students

	eHELP Students (n=53)	Non-eHELP Students (n=39)
Factor 1: preference for asynchronous learning	4.59	4.09
Factor 2: preference for the use of computers in learning	3.93	3.23
Factor 3: preference for asynchronous digital communication	4.35	3.55

learning, the preference for the use of computers in learning, and the preference for asynchronous digital communication, are shown in the Table 3.

In comparing the two means of eHELP students and non-eHELP students in terms of their scores of their learning styles, one-way ANOVA was analyzed for each of the three factors. The result showed that the learning styles were significantly different between the two groups ($p<0.01$) and the scores of all the factors are significantly higher among eHELP students than among non-eHELP students.

5.2 Correlations

Correlations between the scores of the three learning style factors and the score for the adaptability of e-learning courses were analyzed among the 69 respondents who completed both of the two questionnaires. The correlation r were shown in the Table 4 below.

Table 4. Correlations between the Adaptability to e-Leaning Courses and the Leaning Style Factors

	r	P	n
Adaptability - Factor 1	0.53	< 0.01	69
Adaptability - Factor 2	0.60	< 0.01	69
Adaptability - Factor 3	0.29	0.015	69

A statistically significant ($p <0.01$) correlation was seen between the learning style factor 1 (the preference for asynchronous learning) and the adaptability of e-learning courses and between the factor 2 (the preference for the use of computers in learning) and the adaptability. The correlation between the learning style factor 3 (the preference for asynchronous digital communication) and the adaptability to e-learning courses is not as high; however, the correlation is statistically significant at the level of $p=.05$.

5.3 Multiple Regression Analysis

In order to further investigate the relationships between the adaptability to e-learning courses and each of the three factors of learning styles, multiple regression analysis was conducted. The results are shown in the Table 5.

Table 5. The Result of Multiple Regression Analysis

Variable Name	Regression Coefficient	P
intercept	1.82	**< 0.001
Factor1 (preference for asynchronous learning)	0.23	**0.0054
Factor2 (preference for the use of computers in learning)	0.45	**0.0003
Factor3 (preference for asynchronous digital communication)	0.01	0.9383
Multiple R-square	0.43	** < 0.001
n	69	—

**significant at $p=0.01$. *significant at $p=0.05$.

As shown in the Table 5, the regression coefficients of the Factor 1 and Factor 2 are relatively high and the p values are less than 0.01. However, as for the Factor 3, the regression coefficient is low and its p value is also low. It can be suspected that the multicollinearity is high between the Factor 2 and Factor 3. Therefore, another multiple regression was conducted excluding the Factor 3. The analysis resulted in

Adaptability to e-learning courses = $1.835 + 0.231 \times$ Factor 1 + $0.450 \times$ Factor 2

However, in order to apply this multiple regression model to the non-eHELP student group, we have to first examine if the eHELP student group is not different from the non-eHELP student group. In other words, we have to examine if the learning styles have changed in the course of taking the e-learning courses. If so, we cannot use the learning style factors as the inherent preferences of students and determining factors for e-learning adaptability for students who have never taken e-learning courses. Therefore, we compared the learning styles of two eHELP groups: one being a group of students who have been taking e-learning courses since Spring 2008 and the other being a group of students who have just started taking e-learning courses in Fall 2008.

The result of one-way ANOVA of variance shows that the difference between the two student groups is not statistically significant; therefore, we can conclude that the taking e-learning courses is not likely to affect students' learning styles. It has been considered that students who prefer asynchronous learning and the use of computers in learning opt to take e-learning courses. The student's adaptability of e-learning courses can be forecasted before his/her taking an e-learning course, using the multiple regression model obtained in the study.

6   Conclusion

This study investigated learning styles of students who had or had not taken e-learning courses, developed a learning style questionnaire for e-learning courses, and examined the relationship between the learning style and the adaptability to e-learning courses. As at present only about 40% of the adaptability to e-learning courses can be explained by the learning style questionnaire, the questionnaire needs to be refined further in the future. In addition, in order to further understand the relationship between learning style factors and the adaptability of e-learning courses, a future study

may want to include those who have dropped out from the course as respondents. Furthermore, it would be insightful to see the relationship between the adaptability to e-learning courses and the actual student performances as well as the relationship between the adaptability to e-learning courses and the students' experiences of e-learning courses in the past.

References

1. Kogo, C., Nakai, A., Nojima, E.: Relationship between Procrastination Tendency and Student Dropouts in e-Learning Courses. In: Research report of JSET Conferences, vol. 2004(5), pp. 39–44 (2004)
2. Fuwa, Y., Ushiro, M., Kunimune, H., Niimura, M.: Efforts toward the Establishment of Quality Assurances for Adults Students of Distance Learning on e-Learning System - Practice and Evaluations of Support and Advice Activities-. Journal of Multimedia Aided Education Research 3(2), 13–23 (2007)
3. Nishino, K., Ohno, T., Mizuno, S., Aoki, K., Fukumura, Y.: A Study on learning Styles of Japanese e-learning learners. In: 11th International Conference on Humans and Computers, pp. 299–302 (2008)
4. Coffield, F., Moseley, D., Hall, E., Ecclestone, K.: Learning Styles and Pedagogy in Post-16 Learning. In: A Systematic and Critical Review, Learning and Skills Research Center, London (2004)
5. Curry, L.: An Organization of Learning Styles Theory and Constructs. In: ERIC Document 235185 (1983)
6. Kolb, D.A.: LSI Learning-Style Inventory. McBer & Company. Training Resources Group, Boston (1985)
7. Henke, H.: Learning Theory: Applying Kolb's Learning Style Inventory with Computer Based Training. In: A Project paper for A Course on Learning Theory (1996)