Impact of the Interactive e-Learning Instructions on Effectiveness of a Programming Course

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Abstract. The COVID-19 pandemic is forcing schools, universities and learning and development professionals to shift rapidly from in-person to online learning. It made providing of an effective e-learning contents more important. Consequently, the development of e-learning products and provision of e-learning opportunities is one of the most rapidly expanding areas of education and training. The growth of e-learning application is accelerating through both offline and online system. These innovative systems are changing the face of learning as we know it. However, what is known about these innovative approaches for learning and training has been limited by the shortage of scientifically evaluation. This study aims to assess the impact of using interactive instructions on e-learning to improve effectiveness of a programming course. This study develops a questionnaire based on usability evaluation method for an e-learning system. The method extends the current practice by focusing not only on cognitive but also affective considerations that may influence e-learning usability. This paper presents findings from a study of the impact of the learning systems. The study also describes designing evaluation sheet, data collection and analysis strategies of a case study on the evaluation of the e-learning system implemented for Programming Course in Ritsumeikan Asia Pacific University (APU), Japan.

1 Introduction

The growth of the Internet technology was influencing the development of teaching and learning tools. With the existence of the information and communication technology, e-learning had emerged in which it allows learners to learn and explore the contents of courses on anytime and from anywhere. Currently, many products supporting e-learning can be found on the market, and the growth of e-learning application is accelerating through both offline and online system. Some of them allow for compilation of complete e-learning courses which might be placed directly on educational platforms. Moreover, these tools give an opportunity to create modern tests, various quizzes and interactive tasks for checking students' knowledge [1].

Blended Learning is an approach in teaching and learning that combined the e-learning and traditional method. Classes conducted in traditional educational facilities are supplemented with virtual lessons. It is the most efficient educational process involves

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traditional teaching supported by e-learning methods. This method is perfect for students who find it problematic to deal with a particular part of material [2].

The blended learning is implemented at Ritsumeikan Asia Pacific University for Programming classes. The practice in the class use Microsoft Visual Studio 2017. The Classes conducted in a computer room with the Visual Studio installed in all Personal computers for each of students. The course is conventional model with face-to face class meeting twice a week. The course is supplemented with e-learning contents integrated in a Learning Management System (LMS) officially is known as Manaba [3].

When designing a blended learning course or a pure e-learning course, instructors are faced with many considerations and decisions that consequently affect how students experience instruction, construct and process knowledge [4]. However, in either a blended or a pure e-learning course, the quality of the e-learning application is undoubtedly the most important aspect. In this regard, student's satisfaction with the application is considered highly significant in higher education. Considering the number and differences of students' basic skills, their social and cultural background made author lay down a fundamental question: How can we deliver the e-learning content in a way that would have the best impact on all of students?

2 Research Purposes

The main objective of this study was to assess student's satisfaction towards blended e-learning system for the Programming course at Ritsumeikan Asia Pacific University. Furthermore, this study focuses;

1. To investigate students' preference of various types of the e-learning system features;
2. To determine the significant factors for students perceived satisfaction of the different types of e-learning content and its features; and
3. To determine level of degree of the factors affect the students' satisfaction.

The study of this paper addressed the following research questions;

RQ1: What are the significant factors for students' perceived satisfaction of e-learning systems?
RQ2: What features are associated with more effective e-learning contents in the Programming course?
RQ3: What are the students' preferences of the e-learning contents for Programming course?

3 Related Work

Many Studies were conducted to evaluate e-learning application systems. Those studies generally fall in two categories; those that concentrate on the students attitudes toward e-learning; and those that concentrate on student satisfaction with e-learning systems.

Student attitudes towards e-learning have been identified as critical to the success of e-learning [5]. Attributes used to assess the attitudes towards ICT of students, teachers

and principals have been categorized in two groups: demographics (age and gender) and computer experience (training, years of using computer, ownership of computer, access to a computer, intensity of computer use) [6]. Yacob et al. have examined the awareness of e-learning that involves students [7]. Multiple regression analysis was performed on the students' perceptions in relation to gender, year of study, faculty, technology usage and the awareness of e-learning implementation. The result shows that males and female have a significant awareness towards e-learning. Liaw and Huang explored individual's attitudes and behaviors in using e-learning with regard to gender difference, computer related experience, self-efficacy, and motivation aspects [8]. The results demonstrate male students have more positive e-learning attitudes than female students do, computer related experience is a significant predictor on learners' self-efficacy and motivation toward e-learning. Mehra and Omidian examined factors that predict students' attitude to adapt e-learning [9]. The results show that there are five factors that can be used in modeling students' attitude to adapt e-learning. These factors are intention toward e-learning, perceived usefulness of e-learning, perceived ease of e-learning use, pressure to use e-learning and the availability of resources needed to use e-learning. In addition, Bhuasiri et al. found that the most significant factors were related to increasing technology awareness and improving attitude toward e-learning, enhancing basic technology knowledge and skills, improving learning content, requiring computer training, motivating users to utilize e-learning systems, and requiring a high level of support from the university [10].

Student satisfaction with e-learning environments was examined in several studies [11]. Positive learning climate and performance expectations affect student satisfaction, and performance expectations provide the greatest contribution to learning satisfaction. Students and instructors will hold positive attitudes towards e-learning if they recognize that it would help them improve their learning and teaching effectiveness and efficiency [12]. Research study conducted by Chen et al. stated that understanding student attitudes can help expand e-learning system functions and meet student needs, which should further increase the impact of learning and enhance satisfaction with the learning process [13]. Aixia and Wang conducted a study to investigate the critical factors affecting learners' satisfaction in e-learning environment [14]. The findings presented that the perception of e-learning is positively influenced by its flexibility in knowledge management, time management and widening access to information.

However, little attention has been paid to the issue of assessing the existing e-learning application systems for Programming course. This study aims to assess student's satisfaction towards e-learning contents for Programming course at Ritsumeikan Asia Pacific University, Japan.

4 Research Methodology

A cross-sectional study was conducted in which a survey was administered to participants. Cross-sectional study has been known as an effective method to provide a snapshot of the current behaviors, attitudes, and perspectives of participants [15]. This method was used to measure what factors are associated with student satisfaction level in online learning.

Table 1 shows the statements used to evaluate the content of e-learning. The students were requested to select one of five choices ranging from strongly agree (score = 5) to strongly disagree (score = 1).

Table 1. List of statements to evaluate the system

No.	Statements to assess the impacts of the system
Q-01	Objectives are clearly defined in the digital textbooks
Q-02	Content is presented clearly and logically
Q-03	Vocabulary level is appropriate for learners
Q-04	The digital books are clear & understandable
Q-05	The digital books are useful
Q-06	The digital books are not confusing
Q-07	Color is used appropriately in the digital books
Q-08	Overall content of the digital books is good
Q-09	Graphics and flow-charts used are motivational
Q-10	The graphics and flow-charts are clear & understandable
Q-11	The graphics and flow-charts are useful
Q-12	The graphics and flow-charts are not confusing
Q-13	Color is used appropriately in the graphics and flow-charts
Q-14	Overall content of the graphics/flow-chars are good
Q-15	The videos are motivational
Q-16	The videos are clear & understandable
Q-17	The videos are useful
Q-18	The videos are not confusing
Q-19	Color is used appropriately in the videos
Q-20	The content of videos is systematic designed
Q-21	Overall content of the video is good

5 Data Collection

At Ritsumeikan Asia Pacific University, duration of classes normally continues for 90 min and is held twice a week and total 15 times lecture in one quarter. The questionnaire sheets were distributed in the last lecture, after students have completed the entire course target. Due to the capacity of computer classroom of the Programming course, the maximum number of the student was 65 students per class. There is a single Programming during a semester. The data was collected twice from two separate classes on July 25th, 2019 and on February 20th 2020.

After the data collection was undertaken, the questionnaires have been ordered according to the users' attributes. Each questionnaire was numbered for data entry into SPSS (Statistical Package for Social Sciences) so that entry errors could be corrected. All questions were tested using a frequency table approach for incorrect ranges and unusual responses, and the source questionnaires were double checked for accuracy of data entry.

6 Statistical Analysis

The following data analyses are used in this study. Descriptive analysis and factor analysis are used to show the data tabulation and determine the significant factors for students' perceived satisfaction.

6.1 Descriptive Statistical Analysis

Table 2 shows the descriptive statistic of score of each statement to evaluate the impact the learning content and its features. N, Range, Min, Max, Mean, and Std. Dev in the tables indicate a number of valid respondents, range value of responses, minimum value, maximum value, average, and standard deviation, respectively.

6.2 Factor Analysis

Factor Analysis is adopted to show significance variables and detect structure in the relationships between variables and students' preferences to the e-learning system. The factor analysis attempts to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables.

Table 3 shows a result of statistical testing of the evaluated variables from Q-1 to Q-21 with Kaiser Meyer Olkin and Baetlett's testing method. The significance level of the testing is equivalence to the 0.000 and it does indicate that variables' reducing is not needed. The factor analysis can be done to classify all of the variables.

Table 4 shows a result of a principal component analysis. The first column indicates the factors component. The second column is total of Eigen values which indicate the variance on the new factors that were successively extracted. In the third column, these values are expressed as a percent of the total variance. As shown in the table, factor 1 accounts for 59.360% of the variance, factor 2 for 8.119%, factor 3 for 4.848% and so on. The fourth column contains the cumulative variance extracted.

The author retains only factors with total Eigen values greater than 1. In essence this is like using that, unless a factor extracts at least as much as the equivalent of one original variable, we drop it. This criterion is the one most widely used in the factor analysis. In the data analyzed above, using this criterion, it would be retained new 3 factors of principal components. Table 5 shows factor loading that indicates correlations between the variables and the three factors.

Table 2. Rating of the impacts

No.	**N**	Min	Max	Mean	Std. Dev.
Q-01	117	1	5	4.42	0.779
Q-02	117	1	5	4.30	0.734
Q-03	117	1	5	4.21	0.886
Q-04	115	1	5	4.33	0.814
Q-05	117	1	5	4.41	0.832
Q-06	116	1	5	4.04	1.016
Q-07	115	1	5	4.41	0.805
Q-08	117	1	5	4.37	0.761
Q-09	115	1	5	4.23	0.859
Q-10	116	1	5	4.31	0.859
Q-11	114	1	5	4.29	0.828
Q-12	116	1	5	4.07	0.984
Q-13	115	1	5	4.28	0.894
Q-14	116	1	5	4.40	0.768
Q-15	115	1	5	4.17	0.967
Q-16	116	1	5	4.32	0.819
Q-17	117	1	5	4.47	0.794
Q-18	117	1	5	4.18	0.988
Q-19	117	1	5	4.31	0.876
Q-20	117	1	5	4.47	0.816
Q-21	117	1	5	4.35	0.813
Valid N (listwise)	108				

Table 3. Variables testing

KMO and Bartlett's test		
Kaiser-Meyer-Olkin measure of sampling adequacy		.915
Bartlett's test of sphericity	Approx. Chi-square	2035.295
	df	210
	Sig.	0.000

Table 4. The result of a components analysis

Total variance explained						
Component of factor	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of variance	Cumulative %
1	12.466	59.360	59.360	12.466	59.360	59.360
2	1.705	8.119	67.479	1.705	8.119	67.479
3	1.016	4.840	72.319	1.016	4.840	72.319
4	0.908	4.324	76.644			
5	0.735	3.501	80.145			
6	0.629	2.994	83.139			
7	0.474	2.257	85.397			
8	0.427	2.034	87.431			
9	0.417	1.986	89.417			
10	0.292	1.390	90.807			
11	0.290	1.381	92.188			
12	0.263	1.253	93.441			
13	0.234	1.114	94.555			
14	0.219	1.045	95.600			
15	0.190	0.907	96.507			
16	0.164	0.782	97.289			
17	0.154	0.734	98.023			
18	0.143	0.679	98.702			
19	0.115	0.548	99.250			
20	0.095	0.455	99.705			
21	0.062	0.295	100.000			

Extraction method: Principal component analysis

7 Finding

The result of descriptive analysis shown on Table 2 indicates that most of students perceived satisfaction on all evaluated features of the e-learning system. The mean of all evaluated items were greater than 4, indicates that some of students strongly satisfied with the entire feature of the system. The top five highest satisfactions was Q-20 (The content of videos is systematic designed), Q-17 (The videos are useful), Q-05 (The digital books are useful), Q-01 (Objectives are clearly defined in the digital textbooks) and Q-07 (Color is used appropriately in the digital books).

The factor analysis result as shows on Table 4 and 5, the significance impact of the e-learning system to the students can be classified to the 3 factors of the principal

Table 5. Factor loading

Rotated Component Matrix[a]

Code	Component		
	Factor1	Factor2	Factor3
Q-01	0.458	0.124	0.693
Q-02	0.340	0.316	0.748
Q-03	0.124	0.168	0.819
Q-04	0.629	0.401	0.310
Q-05	0.547	0.359	0.554
Q-06	0.715	0.215	0.245
Q-07	0.557	0.353	0.503
Q-08	0.624	0.382	0.495
Q-09	0.685	0.372	0.191
Q-10	0.665	0.458	0.255
Q-11	0.627	0.388	0.379
Q-12	0.799	0.204	0.125
Q-13	0.662	0.341	0.444
Q-14	0.700	0.368	0.345
Q-15	0.470	0.735	0.000
Q-16	0.313	0.775	0.269
Q-17	0.184	0.789	0.297
Q-18	0.306	0.688	0.170
Q-19	0.328	0.813	0.164
Q-20	0.207	0.847	0.251
Q-21	0.350	0.775	0.252

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

components. The Table 5 shows factor loading that indicates correlations between each impact and the three factor components. The most significant factors for students' perceived satisfaction of the e-learning system was factor 1 which was affecting 59.36% of students.

The factor 1 has high correlation with variable Q-04 (The digital books are clear & understandable), Q-05 (The digital books are useful), Q-06 (The digital books are not confusing), Q-07 (Color is used appropriately in the digital books), Q-08 (Overall content of the digital books is good), Q-09 (Graphics and flow-charts used are motivational),

Q-10 (The graphics and flow-charts are clear & understandable), Q-11 (The graphics and flow-charts are useful), Q12 (The graphics and flow-charts are not confusing), Q-13 (Color is used appropriately in the graphics and flow-charts), and Q14 (Overall content of the graphics is good). Base on the above component of the factor 1 content, the author called the factor 1 as "quality of graphics/flow-chart and usability of the digital book".

The factor 2 effect 8.119% of the students. The factor 2 is correlated to the satisfaction of variable Q-15 (The videos are motivational), Q16 (The videos are clear & understandable), Q-17 (The videos are useful), Q-18 (The videos are not confusing), Q-19 (Color is used appropriately in the videos), Q-20 (The content of videos is systematic designed), Q-21 (Overall content of the video is good). The author named the factor 2 as "quality of video instructions".

The factor 3 effect 4.84% of the students. The factor 3 has high correlation to the satisfaction of variable Q-01 (Objectives are clearly defined in the digital textbooks), Q-02 (Content is presented clearly and logically) and Q-03 (Vocabulary level is appropriate for the subject level and learners). The author called the factor 3 as "quality of digital textbook".

8 Conclusions

As overall, most of the students felt the e-learning system content give a positive impact and high satisfaction. The result of the factor analysis indicated that around 72.32% of the students' preference to the e-learning system can be explained by the three main components of the factors; the quality of graphics/flow-chart and usability of the digital boo, the quality of video instructions, and quality of sentences in the digital textbook. 59% of the students perceived satisfaction of quality of graphics/flow-chart and usability of the digital book and it's indicates that the graphics/flow-charts and its explanations were useful and helpful for the most of the students in following instructions of Programming course.

However, it is still not clear the correlation of each evaluated features with overall satisfaction. It is needed to answer what are the most important features inside each component of the digital textbook, quality of graphics and video instructions? For the future study, it is needed to do correlation analyses of each evaluated features. Additionally, Comparative study of first-half and later-half of course is needed to make more clearly relation with the students' instruction requirements and preferences.

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