The Importance of Synchronous Interaction for Student Satisfaction with Course Web Sites

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ABSTRACT

As more affordable synchronous communications are becoming available, the use of synchronous interactions has not been noted in course Web sites as often as asynchronous communications. Previous research indicated that the integration of synchronous tools into course Web sites has made a positive impact on students. While most of the previous studies were limited to open-ended questions and qualitative inquiries, this study extended the study of synchronous interaction by performing a sequence of quantitative and in-depth data analyses to explore how important this factor is relative to other factors and how this factor affects satisfaction of students majored in Information Systems with course Web sites. In a sample of 102 undergraduate students who were taking classes offered by Department of Computer Information Systems, the 89 percent of those students were majoring in Computer Information Systems while the rest of them, except a few, were pursuing a minor in Computer Information Systems. Findings in this study suggest that improving student satisfaction with synchronous interactions will effectively raise their overall satisfaction with course Web sites. While the delivery of educational materials is undergoing a remarkable change from the traditional lecture method to dissemination of courses via Web-based teaching-support systems, improving student satisfaction with course Web sites is closely linked to quality of day-to-day teaching.

Keywords: synchronous interaction, course Web site, student satisfaction, principal component analysis, logistic regression

1. INTRODUCTION

Information technology is considered by many researchers a significant breakthrough that facilitated the exchange of information and expertise and provided opportunities for learners. The delivery of educational materials is undergoing a remarkable change from the traditional lecture method to dissemination of courses via Web-based teaching-support systems (Robin et al., 1997; Keeney, 1999; Glahn et al., 2002; Morgan, 2003). Available technologies have made it possible to easily and efficiently set up course Web sites that included components such as course material storage and delivery, email communication, survey forms, online tests, online student grade inquiry, electronic document drop-box, whiteboard, asynchronous discussion board, and synchronous chat (Harvey et al., 2001; Koszalka et al., 2001). Moore (1989) identified the importance of interaction in distance education although the distance education might not be Web-based at the time the study was conducted. Since then, there have been a huge number of studies devoted to course Web sites, in which authors found the importance of interaction (Jonassen et al., 1995; Flottemesch, 2000; Liaw et al., 2000, Jonassen et al., 2001; Northrup, 2001, Ehrlich, 2002; Hirumi, 2002; Northrup, 2002; Bolliger et al., 2004; Dahl, 2004; Kelly, 2004; Su et al., 2005). For years, online instruction has relied primarily on asynchronous delivery of content, email exchanges and text-based discussion boards. Asynchronous interaction learning environment may increase student participation on learning activities (Picciano, 1998). Picciano (1998), Swan (2001), and Shea at el. (2002, 2003) reported that learner-instructor and learner-learner interactions are strongly correlated with student satisfaction and perceived learning. Richardson et al. (1999) compared the perceptions of two groups of students about the asynchronous interactions of instructor-learners and learners-learners. They found that students perceived learning was much more affected by the interaction between instructors and learners. Instructors' involvement and guidance and incentive for participation on discussion were found to be important to a meaningful and effective online discussion (Jiang et al., 2000; Shea et al., 2003). Swan et al. (2000) examined factors affecting the success of asynchronous online learning, and found that factors, such as consistency in course design, contact with course instructors, and active discussion, had been consistently shown significant impact on the success of online courses. Thurmond (2003) considered the asynchronous nature of a Web-based course as an advantage over the traditional classroom courses, and indicated that the absence of face-to-face meetings might create challenges when developing the Web-based classes. Bourne (2000) emphasized the need for faculty development programs by which faculty could learn interaction in asynchronous learning network courses. But Asynchronous methods are still insufficient, and synchronous tools need to be integrated (Barron et al., 2005; Shi et al., 2006).

However, Burnett (2003) believed that constructive models require online instructors to be aware of synchronous interaction for being proactive in enabling rather than directing learning. Synchronous tools commonly include two-way instant messaging for text-based, audio, and/or video communications, polling tools, instant feedback (Barron et al., 2005) and electronic handwriting tools (Loch et al., 2007). A vast body of research indicated that the integration of synchronous tools into course Web sites has made a positive impact on students (Barron et al., 2005; Pan et al., 2005; Sparks et al., 2006; Shi et al., 2006; Loch et al., 2007; Park et al., 2007a; Park et al., 2007b). Students are often frustrated by asynchronous communications when their questions are left unanswered and feedback lags (Park et al., 2007a). Instant messaging gives students a way to ask quick questions that will get immediate answers (Sparks et al., 2006). Park et al. (2007b) found that learners valued synchronous tools for spontaneous feedback, meaningful interactions, multiple perspectives and instructors' support (Park et al., 2007b). Synchronous Web-based communications allow educators to build connections with and among students more effectively and to increase the potential for interaction (Barron et al., 2005).

All aforementioned studies replied on qualitative inquiry, interviews, direct and participation observation, and open-ended survey questions. There has not been a quantitative and in-depth data analysis in past synchronous interaction research. Wang (2008) conducted a two-sample t-test to find a significant difference between online and face-to-face students in terms of the sense of social community and computed a correlation coefficient to show a significant association between attending chat sessions and grades. He found that the frequency of a student's attending chat sessions, which were equipped with synchronous communication tools, was significantly related to the student's course grade ($r = .626$). Although all authors, including Wang, agreed on the importance of synchronous interaction, those studies were not specifically focused on Information Systems students. Further, IS educators not only want to know the importance of synchronous interaction but also want to know how much improvement can be made with student satisfactions if they add the synchronous interaction components in course Web sites to support their day-to-day teaching.

This study performed a sequence of comprehensive quantitative data analyses. The results of analyses not only indicated the importance of synchronous interaction to student satisfaction with course Web sites but also a stronger effect of synchronous interaction on student satisfaction than the effect of other factors. A logistic regression model provided a clear pattern showing how synchronous interaction and other factors affect student satisfaction. The findings of this study indicated that professors of Information Systems should adopt the synchronous interaction components in their course Web sites for their day-to-day teaching.

2. THEORETICAL BACKGROUND

2.1 Constructivism

Constructivism is the theory that individuals construct their own knowledge by interaction with the world. Constructivist theory suggests that learning should be interactive, active, relevant, and learner-centered. Constructivist theory has become common in today's classroom. According to constructivist theory, learning occurs through interacting with others and with learning materials (Jonassen et al., 1995). However, correspondence and broadcast modes of communication in distance education tend to reinforce the more traditional transmission model, an instructor-centered approach of education (Rumble, 2001).

2.2 Three Types of Interactions

A well-recognized classification of interactions in distance education was the three types of interactions (Moore, 1989), which included learner-instructor, learner-learner, and learner-content interactions. Moore pointed out that the learner-instructor interaction "is regarded as essential by many educators and highly desirable by many learners." Palloff et al. (1999) stated that the keys to the learning process are the interactions among students themselves, the interactions between faculty and students, and the collaboration in learning that results from these interactions. Empirical studies indicated that increasing interaction can lead to increased student course satisfaction and learning outcomes (Zhang et al., 1994; Zirkin et al., 1995). While most learner-instructor interactions in face-to-face classroom are synchronous, Web-based distance education impedes synchronous interactions. Hirumi (2002) pointed out that interactions which occur in face-to-face environments must be carefully planned and sequenced as an integral part of E-learning.

3. DATA AND METHODOLOGY

Data were supplied by a sample of 102 undergraduate students who were taking classes offered by Department of Computer Information Systems. The 89 percent of those students were majoring in Computer Information Systems, and the rest of them, except a few, were pursuing a minor in Computer Information Systems. The sample contained students from freshman to senior classes. At the end of semester, the survey was conducted online through course Web sites in a way that students had to complete the survey before they were able to get to the homepage of course Web sites. Instructors used the university course management system to set up their own course Web sites, which included major components such as synchronous chat, online testing with instant feedback, asynchronous discussion board, course materials storage and delivery, email communication, survey forms, online student grade inquiry, electronic document drop-box, and whiteboard. The survey form (Appendix) included 15 questions and employed a five-point Likert scale ranging from Strongly Disagree (1 point) to Strongly Agree (5 points). To assess the face validity of this survey form, which ensures the researchers to obtain the information they are attempting to gain by using a survey instrument, this survey form was developed and reviewed by a group of course instructors, system developers, and educational administrators. The last question in the survey form was overall student satisfaction with course Web sites. The means and standard deviations are presented in Table 1.

Variable	1	2	3	4	5	6	7	8
Mean	3.54	3.50	3.57	3.47	3.51	3.23	3.46	3.59
Stdev	.98	.97	1.01	1.00	.98	.97	1.00	1.01
Variable	9	10	11	12	13	14	15	
Mean	3.71	3.41	3.44	3.43	3.05	3.25	3.60	
Stdev	1.07	.99	1.05	1.11	1.00	1.04	1.05	

Table 1. Means and Standard Deviations (Stdev) of Variables

4. RESULTS

4.1 Factors Extracted by Principal Component Analysis

The number of components initially extracted by the principal component analysis was equal to the number of the variables being analyzed. The result of initial extraction is shown in Table 2. The eigenvalue-one criterion (Kaiser, 1960) was used in determining the number of factors that should be retained. From Table 2, three variables had eigenvalues greater than one and thus three factors were retained. An orthogonal rotation resulted in three uncorrelated principal components. Table 3 shows the loadings on three components and communalities of observed variables. A loading is equivalent to a bivariate correlation between an observed variable and a component, and the communality refers to the fraction of variance in an observed variable that can be accounted for by the retained components (Hatcher, 1997). For explanation of variables 1 through 14, readers are referred to Questions 1 to 14 in the survey form (Appendix).

Variable	1	2	3	4	5	6	7
Eigenvalue	8.02	1.23	1.01	.76	.63	.42	.39
Variable	8	9	10	11	12	13	14
Eigenvalue	.30	.29	.25	.22	.21	.16	.11

Table 2. Eigenvalues of Principal Analysis

Variable	1	2	3	4	5	6	7
Component 1	.22	.42	.19	.18	.39	***.67***	.38
Component 2	***.64***	.49	.25	.23	***.59***	.27	***.68***
Component 3	.29	.38	***.84***	***.86***	.39	.39	.33
Communality	.55	.58	.83	.84	.66	.69	.73
Variable	8	9	10	11	12	13	14
Component 1	.34	.21	.68	.68	***.72***	***.82***	***.84***
Component 2	***.84***	***.87***	.48	.49	.34	.13	.24
Component 3	.15	.17	.07	.17	.08	.29	.15
Communality	.85	.85	.71	.75	.65	.79	.80

Table 3. Loadings and Final Communality Estimates from Orthogonal Rotation

Three factors were determined based on convergent validity, discriminant validity, and factorial validity. A survey instrument demonstrates convergent validity when it shows a correspondence between similar constructs while a survey instrument demonstrates discriminant validity when it discriminates between dissimilar constructs. The satisfactory validities assume that the loadings of all items within a construct should be high on that construct and low on the others. Hatcher (1997) suggested that an item loaded on a given construct only if the loading of that item was 0.4 or greater for that construct and was less than 0.4 for the other. The loadings in Table 3 showed strong convergent and discriminant validities for three factors, Factor 1 (variables 6, 12, 13 and 14), Factor 2 (variables 1, 5, 7, 8 and 9) and Factor 3 (variables 3 and 4). Factorial validity refers to ability of clustering survey items in groups, which make intuitive sense to researchers. The loadings of three factors showed that the survey items loaded on distinct constructs and, based on survey questions (Appendix), all factors were interpretable. Factor 1 (variables 6, 12, 13 and 14) was interpreted as Synchronous Interaction. Factor 2 (variables 1, 5, 7, 8 and 9) was interpreted as Utility. Factor 3 (variables 3 and 4) was interpreted as System Availability. Synchronous Interaction was defined by satisfaction with the synchronous chat sessions and the online tests with instant feedback. In this study, Questions 12 and 14 are variables measuring the synchronous interaction because the correct answer to a test question and the explanation of the answer were built in our online test system. Students thus would be able to get instant feedback upon submitting their answers for grading. The instant feedback enhanced student learning and led to student satisfaction with course Web sites. Utility was defined by satisfaction with the quality or condition of being useful. Variables underlying Utility reflected useful Web content for course performance, correct execution of stated Website functions, and easiness to learn and to use course Web sites. System Availability was defined by responsiveness of user help and Website connections.

4.2 Reliabilities of Factors

Reliability must be assessed when factors are developed from summated scales. The reliability is usually defined in practice in terms of the consistency of the observed scores. Researchers want to ensure that the same survey form would elicit the same response when the survey is re-administered to the same respondents. Cronbach's α is one of the most widely accepted indexes of internal consistency reliability. Cronbach's α reliability estimates were 0.87, 0.90, and 0.85 for the factors of Synchronous Interaction, Utility, and System Availability. All reliability estimates exceeded the minimum value of Cronbach's α (0.70) recommended by Nunnally (1978).

4.3 Importance of Factors to Student Satisfaction

The importance of factors to student satisfaction was measured by correlation coefficients. An average score of all variables that make up a factor was computed for each factor, and then the correlation coefficients between each factor and the student satisfaction were computed and used to assess the importance to student satisfaction with course Web sites. The correlation coefficients and their p-values are shown in Table 4. All factors were significantly correlated with student satisfaction. The correlation coefficients of the first two factors were roughly the same while the correlation coefficient of Factor 3 was substantially lower. Those correlation coefficients indicated that Synchronous Interaction and Utility were more important in improving current course Web sites.

	Interaction	Utility	Availability
Satisfaction	0.7044 p<0.0001	0.7450 p<0.0001	0.4418 p<0.0001

Table 4. Correlations between Factors and Student Satisfaction

4.4 How Factors Affect Student Satisfaction

To investigate how the factors affect student satisfaction, a logistic regression model (Neter et al., 1996) was constructed. The logistic regression model predicts the probability that the event of interest occurs. The advantages of logistic regression are that (1) unlike the ordinary least squares regression models that allow the predicted value of dependent variable below 1, above 5, or non-integer when the student satisfaction assumes only values of 1, 2, 3, 4 and 5, the logistic regression model predicts the probability distribution of those five satisfaction scores; (2) it does not assume linear relationship as the ordinary least squares regression model does; and (3) a predicted probability distribution of student satisfaction provides more useful information than what is provided by a single predicted value of student satisfaction. The logistic regression model is shown as follows.

$$\text{logit}\left(\sum_{i=j}^{i=5} p_i\right) = \log_e\left(\frac{\sum_{i=j}^{i=5} p_i}{1-\sum_{i=j}^{i=5} p_i}\right) = \alpha_j + \boldsymbol{\beta}'\mathbf{X} \quad (j \in 2, 3, 4, 5) \tag{1}$$

where p_i is the probability of student satisfaction score = i; α_j represents the intercept of regression equations; $\boldsymbol{\beta}'$ is a vector of logistic regression coefficients; and X is a vector of independent variables.

Thus, the probabilities can be predicted by equations (2) to (4):

$$p_5 = \frac{\exp(\alpha_5 + \boldsymbol{\beta}'\mathbf{X})}{1+\exp(\alpha_5 + \boldsymbol{\beta}'\mathbf{X})} \tag{2}$$

$$p_i = \frac{\exp(\alpha_i + \boldsymbol{\beta}'\mathbf{X})}{1+\exp(\alpha_i + \boldsymbol{\beta}'\mathbf{X})} - \sum_{j=i+1}^{j=5} p_j \quad (i \in 2,3,4) \tag{3}$$

$$p_1 = 1 - \sum_{i=2}^{i=5} p_i \tag{4}$$

Using the student satisfaction scores collected by Question 15 (refer to the survey form) as the dependent variable and the three factors as independent variables, the best-fit model was generated by SAS proc logistic to predict the student satisfaction. System Availability was dropped from the model because its effect was not significant by the Wald statistic (p-value = 0.8). The best-fit model had two predictors: Synchronous Interaction (X_1) and Utility (X_2). The resulting logistic regression equations are shown as follows.

$$\text{logit}(p_5) = -13.6247 + 1.3984\,X_1 + 1.8892\,X_2 \tag{5}$$

$$\text{logit}(p_4 + p_5) = -11.2507 + 1.3984\,X_1 + 1.8892\,X_2 \tag{6}$$

$$\text{logit}(p_3 + p_4 + p_5) = -7.1087 + 1.3984X_1 + 1.8892X_2 \tag{7}$$

$$\text{logit}(p_2 + p_3 + p_4 + p_5) = -5.8239 + 1.3984X_1 + 1.8892X_2 \tag{8}$$

The log-likelihood test showed overall significance of the model (p-value < 0.0001). The Wald statistic tests provided the significance of individual predictors (p-value < 0.0001). Using this model, probabilities of student satisfaction scores were predicted by equations (2) through (4) (Table 5). The predicted probabilities of the highest student satisfaction (a score of 5) were plotted against Synchronous Interaction and Utility in Figure 1. The expected values of student satisfaction were computed by:

$$\text{Expected Value} = \sum_{i=1}^{5} i p_i \tag{9}$$

The expected values of student satisfaction were predicted (Table 5) and plotted against Synchronous Interaction and Utility (Figure 2). From Table 5 and Figure 1, when a student was very satisfied (a score of 5) with both Synchronous Interaction and Utility, the probability that the student was very satisfied with the course Web site (a score of 5) was 0.9434. The probability distribution indicated that Synchronous Interaction had a strong effect on student satisfaction. If the score of Synchronous Interaction dropped to 4 when the score of Utility remained as 5, the probability dropped to 0.8045. When the score of Synchronous Interaction was 3 and the score of Utility was 5, the probability that a student showed an overall satisfaction score of 5 was 0.5041. When the score of Synchronous Interaction dropped to 1 even if the score of Utility was 5, the probability of a student satisfaction score of 5 dropped to near zero (0.0584). Readers are able to perceive a clear pattern by examining probabilities resulting from the pairs of Synchronous Interaction and Utility. Consistent with but beyond previous studies, the results from our model not only simply show the importance of synchronous interaction but also provide quantitative evidence that in what degree student satisfaction can be improved if Information Systems educators decide to improve performance of synchronous interaction components in course Web sites. The expected values of student satisfaction showed the same pattern (Figure 2). For example, when both Synchronous Interaction and Utility had a score of 5, the expected value of student satisfaction was 4.9377. When Synchronous Interaction dropped to 4 and Utility remained unchanged, the student satisfaction score fell to 4.7820. However, if Synchronous Interaction dropped to 1 and Utility remained unchanged, the student satisfaction score fell further to 3.4283. It was notable in Table 5 that if both Synchronous Interaction and Utility were low (a score of 1), the probability of a poor student satisfaction (a score of 1) was 0.9267 and it was almost impossible to get a high student satisfaction (a score of 5 or 4).

Interaction	Utility	p_5	p_4	p_3	p_2	p_1	Mean
1	1	0.0000	0.0003	0.0211	0.0519	0.9267	1.0952
1	2	0.0002	0.0021	0.1242	0.2171	0.6564	1.4727
1	3	0.0014	0.0136	0.4743	0.2866	0.2241	2.2817
1	4	0.0093	0.0822	0.7722	0.0945	0.0418	2.9227
1	5	0.0584	0.3414	0.5769	0.0167	0.0066	3.4283
2	1	0.0001	0.0013	0.0801	0.1613	0.7573	1.3257
2	2	0.0009	0.0084	0.3605	0.3098	0.3205	2.0593
2	3	0.0057	0.0524	0.7370	0.1384	0.0666	2.7923
2	4	0.0366	0.2531	0.6728	0.0268	0.0107	3.2781
2	5	0.2007	0.5288	0.2646	0.0042	0.0016	3.9227
3	1	0.0005	0.0051	0.2585	0.3006	0.4352	1.8352
3	2	0.0035	0.0329	0.6673	0.1920	0.1044	2.6392
3	3	0.0227	0.1770	0.7404	0.0425	0.0173	3.1453
3	4	0.1332	0.4895	0.3677	0.0069	0.0027	3.7438
3	5	0.5041	0.4120	0.0825	0.0011	0.0004	4.4184
4	1	0.0022	0.0204	0.5699	0.2476	0.1599	2.4573
4	2	0.0140	0.1185	0.7733	0.0662	0.0280	3.0244
4	3	0.0860	0.4166	0.4819	0.0112	0.0043	3.5688
4	4	0.3836	0.4863	0.1278	0.0017	0.0007	4.2504
4	5	0.8045	0.1733	0.0218	0.0003	0.0001	4.7820
5	1	0.0086	0.0769	0.7692	0.1003	0.0449	2.9040
5	2	0.0545	0.3277	0.5928	0.0180	0.0071	3.4045
5	3	0.2759	0.5277	0.1925	0.0028	0.0011	4.0745
5	4	0.7159	0.2485	0.0351	0.0004	0.0002	4.6795
5	5	0.9434	0.0511	0.0055	0.0001	0.0000	4.9377

Table 5. Predicted Probabilities and Expected Values of User Satisfaction

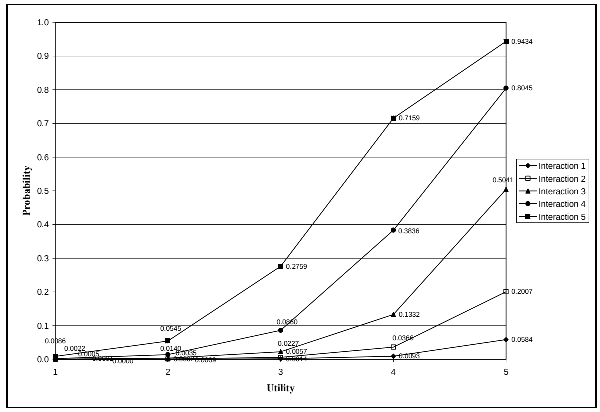

Figure 1. Predicted Probability of Highest Student Satisfaction

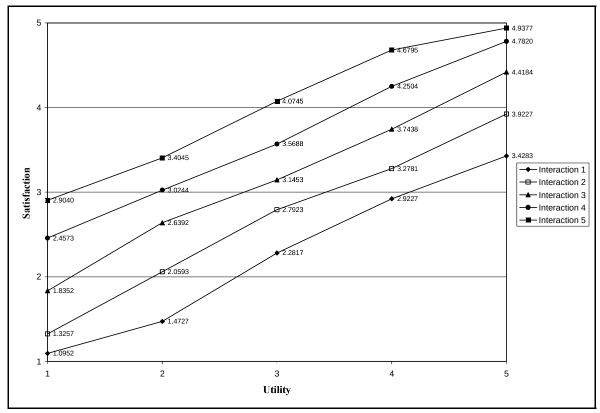

Figure 2. Expected Values of Student Satisfaction

5. DISCUSSION AND SUMMARY

The previous research in the synchronous interaction literature indicated the importance of synchronous communications in course Web sites. However, the studies were limited to qualitative inquiry and observations. Quantitative and in-depth data analyses have not been seen in past synchronous interaction research. The questions, such as how important the synchronous interaction is relative to other factors and how much improvement the synchronous interaction as well as other factors can make on student satisfaction, which is beyond an answer of whether or not, remained unanswered.

This study addressed the research gap in synchronous interaction literature by focusing on Information Systems students and conducting a sequence of comprehensive quantitative data analyses. The results of analyses not only simply indicate the importance of synchronous interaction to student satisfaction with course Web sites but also provide quantitative evidence that in what degree student satisfaction can be improved if Information Systems educators decide to improve performance of synchronous interactions in course Web sites for day-to-day teaching.

While the online synchronous interaction might be initially adopted for use in Web-based distance education, our study indicates that it is a preferred option for traditional face-to-face courses. As most students who are taking traditional face-to-face courses are living and working in a large campus or off campus, students are now expecting broader type and amount of online communications to compliment face-to-face meetings during instructor office hours. As Web-based synchronous interaction components have become technically and financially feasible, the synchronous interaction components should be integrated into course Web sites to help teaching.

This study is focused on the Web components of synchronous interaction. As seen in Section 4.1, the factor of synchronous interaction is a combination of Learner-Instructor (chat room), Learner-Learner (chat room), and Learner-Content (instant feedback from online test) interactions. One recommendation from reviewer for further research is to compare the impact of those three interaction components on student satisfaction with course Web sites.

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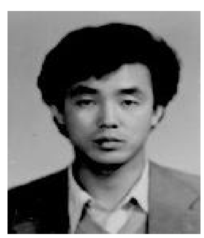

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APPENDIX 1

Survey Form

To better serve you, we would like to know your opinion of the quality of our course Web sites. Please indicate the extent to which you agree or disagree with the following statements. Circle the appropriate number using the scale below. Some statements are similar to one another to ensure that we accurately determine your opinion concerning our course Web sites.

1 – I strongly disagree with this statement (SD).
2 – I disagree with this statement (D).
3 – I neither agree nor disagree with this statement (N).
4 – I agree with this statement (A).
5 – I strongly agree with this statement (SA).

1. The information on Web pages contained what I needed to improve my course performance.
2. The information on Web pages was sufficiently detailed to help me understand the course subjects.
3. I waited a short period of time to get help when I had problem to use the system.
4. I waited a short period of time before a requested Web page showed up.
5. The instructor was quick to response when I sent him/her message through the course Web site.
6. The quality of way the instructor helped me in the "Chat room" was high.
7. The course Web site always performs the stated function perfectly.
8. I was able to learn about the course Web site in a short amount of time.
9. The course Web site was easy to use.
10. Online syllabus improved my course performance more than a paper-based syllabus.
11. Online course notes improved my course performance.
12. Online test was better than paper-based tests with respect to reflecting my knowledge of the course.
13. Chat room improved my course performance even though I could meet instructor in office.
14. Online comments on my tests help improve my course performance.
15. I am very satisfied with the course Web site.

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