Journal of Universal Computer Science, vol. 22, no. 1 (2016), 124-145
submitted: 30/6/15, accepted: 20/12/15, appeared: 1/1/16 © J.UCS

Analyzing Communication Dimensions in a Ubiquitous Learning Environment

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Abstract: This study aims to investigate certain communication dimensions to assess the impact of Computer Mediated Communication (CMC) tendencies of students on ubiquitous environments. Communication dimensions were determined as message content, message interaction, semantic of message, emotional situation, and security. Message content was used as a determiner indicator to measure the effectiveness of communication methods in ubiquitous environments. The effects on the inclination to communicate in ubiquitous learning environments are explained in detail with Partial Least Squares Structural Equation Modeling (PLS-SEM). Message interaction, semantic of message, and security all have a great impact on the adoption of message content; therefore, they promote students' engagement through ubiquitous learning. According to the correlation values, we observed that the user is prone to participate in CMC if the message is meaningful, replied to immediately, sent from someone that looks familiar and sent to the right person.

Key Words: Ubiquitous learning, PLS-SEM, CMC, computer-supported cooperative work, LMS
Categories: C.0, D.1.7, H.2

1 Introduction

Nowadays, technology has completely become a part of people's communication style. People can convey messages, generally of mutual interest, either in oral or in written formats, for different forms of communication within the scope of Internet Technologies, which can provide round the clock services effectively anywhere in the world. For digital communications, with oral and/or written messages, the available digital interface capabilities, in a sense, have become the meeting points of the senders and the receivers.

Indeed, in order to increase the impact of the meaning of the text messages within the digital interface systems, special iconic symbols are being designed to represent different images, which can be important in facilitating better communication between people. Digital communications based on written messages have already

achieved high levels of contribution to the daily lives of the people, who enjoy the electronic capabilities that allow them to be constantly informed about each other's daily experiences.

It has become evident that personal information, related to where the people are, what they are doing, and how much time they spend confronting each other, has become part of the information required within the ways of life (e.g., Foursquare) in the ubiquitous learning environment [Jesse, 2013]. It is argued that continuous forms of communication, which are included in the lives of people, are reflected in their learning processes within the ubiquitous learning environment.

Currently, it is becoming increasingly more important that communication systems can establish information about what learners can achieve to learn, without being hindered by their locations in the world. Today, it is also becoming evident that the learning processes, required for sharing and interacting with the learners in the systems, are becoming located within the nature of the ubiquitous learning environment.

From historical considerations, starting with the early learning processes of individuals, the interactions of people were established on the basis of manual, visual and/or physical formats. However, today, these interactions have, mostly, become digitally based learning processes embedded within common IT systems. These days, the learning processes do not require the individuals to be experts in the use of the ubiquitous system because (a) these systems can be personalized, (b) generally, they are easy to use, and (c) they can be specifically established for the intended needs of the specific users. Because these systems can be personalized, they can also provide information in the appropriate formats, consistent with the learner's perceptions.

Learning from the ubiquitous environment can allow people to store information by using special technologies during their everyday lives, without expertise in these technologies. In the conventional sense, the learning processes are considered as continuous, also intermittent and, arguably, as invisible. Also, in the conventional sense, learning can be achieved intermittently by taking advantage of the real world, e.g., by visualizing distinct images and/or regions within the real world.

However, today it is argued that the continuity of the learning process must be considered as a requirement to ensure that ongoing work is not disrupted, even intermittently, at high levels. It is also argued that people should have access to all the required data, instantly, from anywhere in the world. These requirements define the main purpose of the establishment of the ubiquitous learning environment, which ultimately will be able to create the capabilities that will allow people to get instant answers to any and all questions they may have.

In addition, it is argued that the interactions between people must be established on the basis of continuous foundations so that the communications between experts and learners can be accomplished continuously. This argument leads to the requirement that the intermittent interactions between people must happen frequently. However, it is equally important that the argument does not impose, in any manner, any requirement for long durations. Consequently, according to this argument, there is no space or time restriction whatsoever on the individual, so that everyone becomes responsible for his or her own learning processes within the ubiquitous learning environment. Therefore, within the ubiquitous learning environment, a learner can get

information from a large number of different sources and from a large variety of different experts, as large numbers of different answers to the learner's questions.

Thus, it must also be realized that the capabilities of the ubiquitous learning environment cannot guarantee all the correct answers, from all the experts, to all the questions of all the learners. It is a well-established requirement that, within the ubiquitous learning environment, the utilization of the ubiquitous learning systems must be designed to achieve the required interactions between the learners within the environment as much as possible [Ramsden, 2003].

It is evident that the essential communication capabilities for the exchange of available information between people, as learners and experts, must be established on the basis of adaptation of portable electronic tools that are available to the learners for sharing information, asking questions, obtaining answers and for general purpose instant messaging. It is generally acknowledged that social interactions and social processes in a community automatically begin with ubiquitous learning because today, in all modern communities, there always exists an already established intercommunity interaction.

It is also suggested that the learning habits of people and their learning capabilities would change, and could indeed grow substantially, depending on the available capabilities of their ubiquitous learning environments. It is well realized that the interactions between people, during these ubiquitous learning communication processes, also constitute a class of knowledge support, which is considered essential to the education system at all levels.

Therefore, the importance of Computer Mediated Communication (CMC) in education is undeniable. Today, it is becoming more convincing that the contribution of ubiquitous learning environments can change the learning habits and the organizational structures of learning environments. It is also fully realized that learning by CMC is generally fast; it is instructional and, most importantly, it is enjoyable.

As indispensable items of communication, the interfaces being developed for digital environments are being designed as asynchronous interfaces, with interaction communications being realized at different times, and also as synchronous interfaces, with interaction communications being realized immediately, at the same time. For asynchronous interfaces, when a message is sent at a certain time, it is generally received at a later time (intentional or unintentional, it is a sufficiently large time delay). For synchronous interfaces, when a message is sent at a certain time, it is received simultaneously (within limits of communication time) and, therefore, it can be answered within a short time.

The impacts of text-based CMC on online social presence in this environment is described by the statement that communication is dealt with via mobile telephones, voice mail, chat rooms, blogs, audio and video transmission, pedagogical agent based communication forums, social networks, real-time computer conferencing, and discussion platforms [Tu, 2002].

During the digitally based communications, with the individuals being in different environments, CMC is actively involved in the learning process due to its capabilities, which can allow the use of written and visual formats of communication, such as voice and video format combinations, which can be activated simultaneously, i.e., computer-mediated communication offers an enhanced ability to interact with a

desired target audience and potentially establish stronger links between sender and recipient [Nicovich et al., 2005]. Asynchronous communication environments are generally used for the transmission of information in special formats, as data formats for written languages and as special data formats for visual images.

In digitally based environments, a written communication can be established in different formats, designed according to their presentation contents and evaluation levels, as information concerned with assigned homework messages, asynchronous discussion messages, practice examination messages, warning messages, forwarding messages, announcements, and short briefings. Participants in these environments can use the information individually and can also share the information among other participants, by using chat rooms and discussion blogs. The distributed use of the information generally increases the efficiency of learning by supporting the collaboration processes among the participants of the systems [Kapoun and Milkova, 2014].

Currently, it is also suggested that with the considerations of the required time periods intended for measuring the outcomes of the learning processes, their could be an increase in the cooperation efforts in sharing the information. It has been established that sustainable digital communication in the ubiquitous environment can support and improve the characteristics of interactions among people. In this context, the communication contents and the interactive features have been considered more carefully, and in a more detailed way, than the other communication features.

It has also been determined that written communications used by digital media, special text messages, homework participations, discussions and interactive participations could also be considered within the contents of the courses. The relative qualities of the digital interfaces, based on the perceptions of learners and the content of the messages, are undergoing significant improvements in all ubiquitous learning systems and the collaborative communication levels are increasing rapidly [Yang 2006].

Importantly, the levels of collaborative communication opportunities supported by ubiquitous environments are also improving. The volume of collaborative communications relating to tests, which also represent the class of communications that provide support to the learning scenarios, is also increasing rapidly. In addition, it is becoming more evident that training, supported by pedagogical models, can help in the establishment of more disciplined and sustainable places with the power and the structure of digital communications within the ubiquitous learning environment. Digitally based communication, depending on the effectiveness and efficiency of learning from the previous studies, are discussed. The studies about essential business elements, such as communication dimension, content, and impact are very rare. These features of communication are referred to and CMC elements used by adapting to digitally mediated communication. In this study, it was observed which dimensions of CMC affect learners' inclination of using the ubiquitous learning environment. CMC includes digitally based interface environments. It covers not only computer, but all digital interface tools.

2 Consideration of Asynchronous CMC

Asynchronous CMC allows learners to conduct research without any constraints of time and resources. Some of its opportunities can be specified as research and investigation, access to information, and study with different people within groups. Also, learners can ask questions to their teachers through the system and get quick responses from them with interactive communication. Learners can take lessons from any place, with any tools, at any time independently. They can listen to the same course again, can ask questions whenever they want, and can communicate among themselves. In addition, working as a group is possible. There is also a platform to exchange information about the issues they discuss. Taking the word of everyone in the class is not possible due to time constraints, yet it is possible with a digitally based interface. Learners can determine their own learning style and time. They can interact with members mutually on the education system by being sensitive to the socio-technologic events in the environments, which take their attention.

2.1 Previous studies

In this study, the effect of computer-mediated communication on learning is examined in ubiquitous learning environments. The implication of ubiquitous learning on education is a key point of this research. Through this point of view, Arkun and Askar [2010] tried to analyze the purpose, principles, characteristics, and main components of ubiquitous learning. Also, this review study focused on ubiquitous computing and ubiquitous intelligence term, and showed the effect of ubiquitous learning on teacher learning.

In this study, the different categorized advantages of ubiquitous learning are described and the main components of ubiquitous learning are listed. At the end of the study, some results show that learners have different learning methods and capabilities. Therefore, they have to be educated by customized education strategies and materials; it also has positive effect on teacher training.

The other survey study was carried out by [Nguyen 2008] to understand the implementation of CMC in collaborative learning from Vietnamese learners' points of view and the advantages of taking the course, and their attitudes in the class supported by technology in the College of Foreign Languages in Danag University in Central Vietnam. It was thought that learners' perceptions affect the effectiveness of technology and tried to find the effect of CMC in language learning. This study is a combination of both quantitative and qualitative data analysis, meaning it is mixed research. 28 female and 2 male teacher learners participated in the survey, which included 24 questions with 4-point Likert scale items, 6 open-ended questions and transcripts of 15 teacher learners out of 30 who contributed to the questionnaire. Answers were analyzed with SPSS 17. As a result, all learners liked learning with these technological classes, 23.3% learners strongly liked computer-based learning and half of them were interviewed and described the class positively as modern.

[Joo and Kim, 2009] conducted a survey study to measure the learner's satisfaction with online and offline communication software. A method related to efficient ubiquitous teaching and learning model has been offered. Learners selected the type of task according their level and prepared the final report by themselves or with a group. There was no place and time limitation. Learners were in the fifth grade

of elementary school. The learners were satisfied with u-learning and self-directed learning in ubiquitous environment.

In another study, [Hammick and Lee, 2013] designed a virtual environment to analyze the effect of 3D virtual and face-to-face communications on the communication experience of people. They also tried to analyze the effect of differences between characteristics of people on communication experience of themselves. They chose 58 undergraduate learners aged between 18 and 23. There were 37 girls and 21 boys, who hadn't known each other before. They compared shy and non-shy people, and virtual setting and real-life setting in their study. They discussed drinking as the topic, one of the most common topics between these groups. Also, they were told that they would conduct a survey about their experience before discussion and after discussion. Through the results, shy people feel less concerned in online communication. In the face-to-face environment, shy peoples' personal minds change their behavior and are more dominant. As a result, in virtual reality the weakness of visual and acoustical tips affect the results of the study a great deal. In literature, there exist studies in which authors look from different perspectives.

[Remesal and Colomina, 2013] discussed social presence from a sociocultural perspective through its main component of computer supported collaborative learning. In their study, a computer supported collaborative writing workshop for 6 weeks with sixteen learner teachers, with bachelor degrees from educational psychology courses, was applied. This workshop is supported by a learning management system (Moodle). In this workshop, learners wrote argumentative and clear essays. Also, they evaluated the educational practices by applying the conceptual content of workshop. The questions asked in these surveys are as follows: "How does the participant contribute to the creation and maintenance of social presence in an asynchronous computer supported collaborative learning activity?", "What individual/group differences can be found?", "Do the individual contributions reveal any emergent roles or individually profiles during the process over time?" This workshop enabled us to make the definition of social presence again. Through the result, the authors say that social presence motivates learners to feel as though they are in a community, which supports the learning process. The resulting categories correspond to two different axes: individual versus group oriented, and task versus members oriented.

[Helm et al., 2013] conducted research about the extending effect of online applications on the effectiveness of traditional word of mouth. They asserted that the personality of users affect their motivation when they create content. The aim of their study is to connect some specific activities to some specific personal characteristics. Also, they aimed to design a research model, which can enable them to characterize and differentiate online opinion leaders. They applied more than 16900 surveys. Through the results of these surveys, when they attend the articulation and personality structure of opinion leaders, they cannot compare them with traditional leaders. Also, they assert that introverted people behave actively as online opinion leaders because they realize the community less than traditional leaders.

These results allow for the understanding of the role of opinion leaders in online environments through the overview of literature; we conducted a survey to learn the degree of relationships between the contents of CMC at Bahçehir University, Software Engineering Department. We chose undergraduate learners taking the

course of Engineering Ethics and applied a survey at the end of the course. Firstly, the learners' attitudes about using ubiquitous learning environment should be analyzed in terms of communication dimensions. It was considered that the social courses are more suitable for ubiquitous learning and learners may be selected by taking the ability of using communication tools, such as computer, tablets, and so on, into account. Thus, the Engineering Ethics course was selected as a sample because it has a social content and its learners study in the Software Engineering Department.

2.2 Development of the PLS-SEM Methodology

In this subsection, details of the latent variables of the questionnaire are given.

2.2.1 Characteristics of questionnaire

Survey questions are derived from the study of [Yen and Tu, 2008]. Variables were created and grouped in our research and they are studied in an asynchronous environment. The CMC questionnaire covers message content as an output. Latent variables were grouped as follows and the questionnaire organized as given in Appendix I:

1) Interaction of message.
2) Semantic of message.
3) Emotional situation.
4) Security of message.
5-7) Proficiency levels of participants using e-mail, threaded discussion, real-time chat.
8-10) How many years have they been using e-mail, threaded discussion, real-time chat.
11-14) How many hours have they spent on courses related with e-mail, threaded discussion and real-time chat for each week.
15) Gender.
16) Computer expertise of the user.

2.2.2 Description of variables of model

Each question was represented with a metric of this model and they were collected for each latent variable. The questions were classified into three different parts. Questions on the participants' perception of CMC were asked in the first part. Part 2 focused on habits of people. In part 3, gender and computer expertise related personal information was asked. As a communication tool, the social dimension, effectiveness, content, use, and intelligibility of CMC were investigated with the questions for Message Content as a latent variable. In total, ten questions were presented under the output variable. According to the participants' opinion about these questions, the answers to the questions were scaled with a 5-point Likert scale as strongly agree, agree, uncertain, disagree and strongly disagree. The Structural Equation Model of this study is shown in Figure 1a-1b.

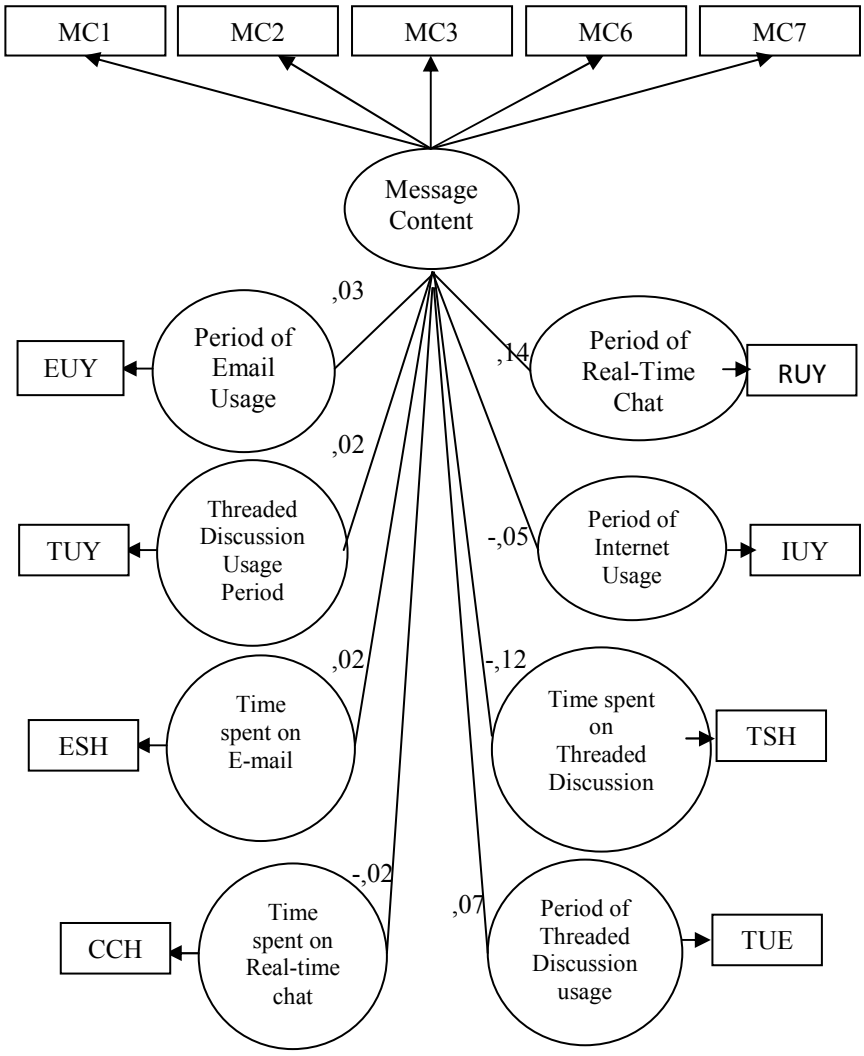


Figure 1a: PLS- SEM diagram for CMC

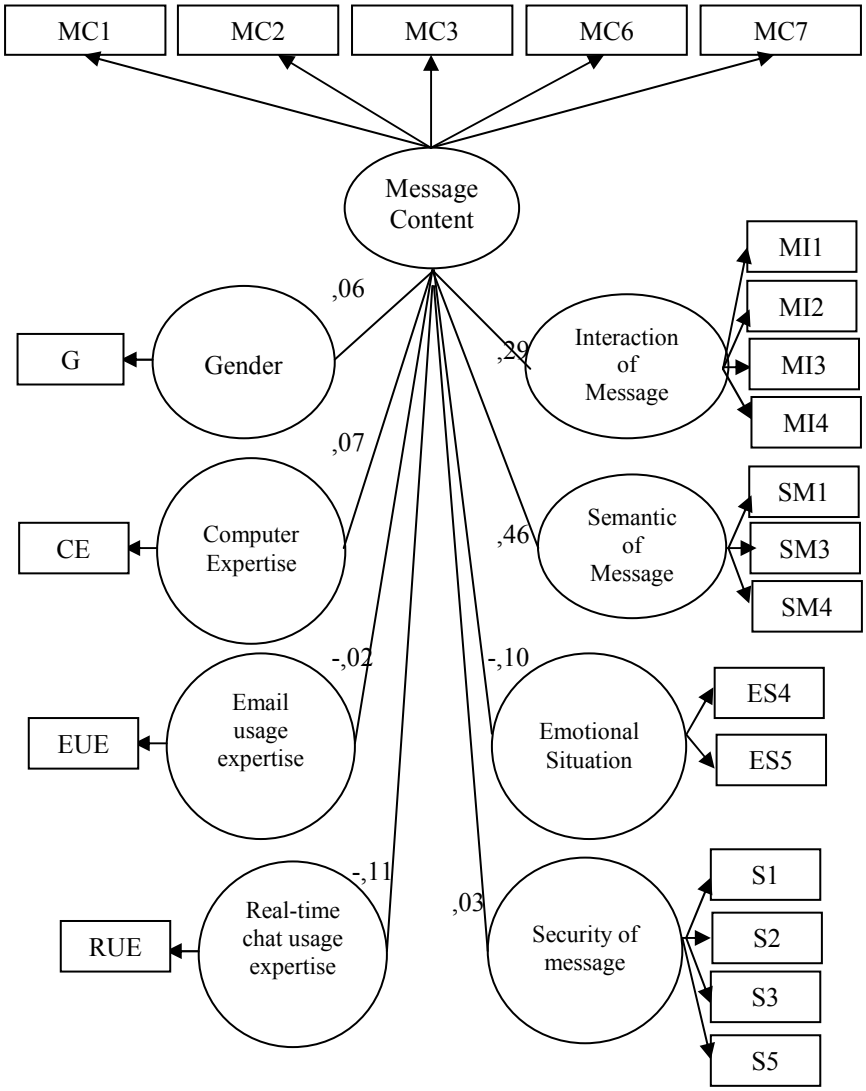


Figure 1b: PLS-SEM diagram for CMC

Message Interaction has five questions to investigate whether participants' relationships with the people have an affect on the message interaction. The recommendations, which are given to get a quick response to the message and the answer to examine the people acquaintance, are also scaled according to their degree of participation. The Message Semantic latent variable has four metrics. It has been questioned whether people effectively delivered their wishes to each other with CMC.

It is investigated to what extent the participants explained themselves and whether they had a meaningful communication or not by using a digitally based interface. Because it is important that the users be able to explain whatever they want to transfer to the other side while they communicate through these interfaces, it is important to understanding effective communication by the usage of CMC. To investigate the Emotional Situation, there were five questions. Participants were asked how they felt about the shared message in the learning environment seen by other people and how they felt when they took a wrong message [Yen and Tu, 2008] [Tuncay and Uzunboylu, 2010]. The user's emotional state is important in preferring the usage of CMC. According to [Chenault, 1998], people bring their real-life problems and personalities with them to their "virtual" lives and, therefore, CMC must inherently include all kinds of emotional content. For security issues, there were six questions about private messaging, the technical reliability of online communication, and the reliability of sharing information in an online environment. In Part II, email, threaded discussion, and real-time chat usage expertise related dimensions were asked in order to analyze how proficient users are in using CMC with e-mail, threaded discussion and real-time chat, respectively. A 5-point Likert scale was used as expert, above average, average, below average and novice. The questions asked to the participants were as follows: "How many years have they been using e-mail, threaded discussion, real-time chat as a form of CMC?" and "How many years have they been using the Internet?". In addition to these questions, hours spent for email, threaded discussion and real-time chat on the course were also asked. In Part III, gender and computer expertise of students are asked with 4-point Likert scale as no experience, novice, intermediate, and expert.

3 Preliminary Results of Application

This survey was applied in Bahçeşehir University because it is necessary to adapt to the ubiquitous learning of some courses of the University. For this purpose, we evaluated the communication dimensions, which have a direct or indirect effect on the learner's communication ability in ubiquitous learning environment.

3.1 Participation

The group consisted of 147 men and 61 women who contributed to the survey. All participants were undergraduate learners who took the Engineering Ethics course, which was an online lecture at Bahcesehir University in Turkey. These learners were selected for this study because they took social courses and were experts in information technologies.

3.2 Generation of information for PLS-SEM Application

Engineering students who registered to Engineering Ethics were included in this survey. They were informed about the keywords weekly. Learners were searching these keywords in a ubiquitous environment (UE) in various sources. Journals, articles, Twitter, books, and newspapers are examples of these resources. Each week had its own activity, such as case study, forum, quiz, homework, etc. on UE. There

was a presentation about the course and a lesson document with support of an Avatar. Also, the Avatar gave tips to learners and directed them according to each student's deficiencies. In this way, learners understood the parts where they were guided through the Avatar. The Avatar asked questions to the learners on particular pages and redirected them to pages where they could find the answers while the learners were learning. Figure 2 shows the third week of the Engineering Ethics course and the flow of the course given in Figure 3.

Figure 2: Example of a lecture for a week

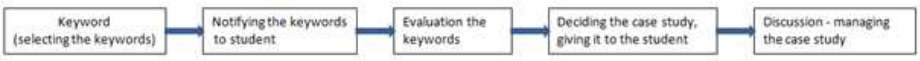


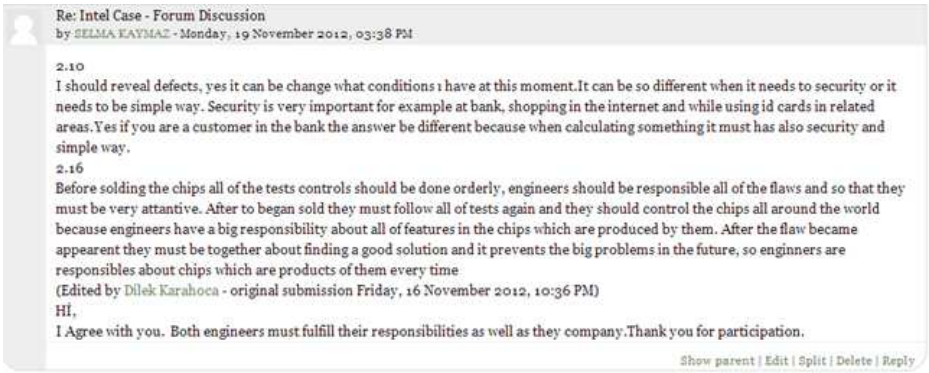
Figure 3: Flow of the course

It is observed in the systems' participation archive that learners were studying the Avatar supported course material more frequently. Audio supported content is mostly preferred in the pedagogical agent based learning environment. In this way, learners

listened to the content by tuning the speaking speed of the Avatar to understand and to learn more effectively. In Figure 4, there is a snapshot for pedagogical agent based learning environment.

Figure 4: Pedagogical agent based learning environment

The case study, The Space Shuttle Challenger and Columbia Accidents, which was on the 7th page of the Engineering Ethics [Fleddermann, 2004] book, was given to the learners who were asked to answer two questions. Although this study had no effect on grades, 180 learners participated. The learner linked the questions with the cases they had read and lesson contents, and then learnt to apply through the experiences of daily life. In this way, learners could continue to study outside of the class and the teacher had given them representative notes to evaluate their answers. The learners' answers to the case studies with teacher feedback are given in Figure 5 as a snapshot of the forum discussion. A forum area, in which the learners can have discussions via CMC, is located in the ubiquitous environment as well. It is observed that they didn't hesitate to share their ideas in an online area.

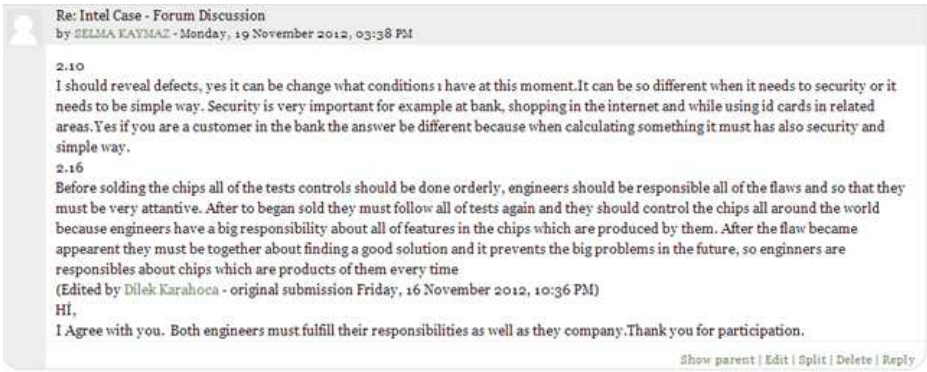

Re: Intel Case - Forum Discussion
by SELMA KAYMAZ - Monday, 19 November 2012, 03:38 PM

2.10
I should reveal defects, yes it can be change what conditions i have at this moment.It can be so different when it needs to security or it needs to be simple way. Security is very important for example at bank, shopping in the internet and while using id cards in related areas.Yes if you are a customer in the bank the answer be different because when calculating something it must has also security and simple way.
2.16
Before solding the chips all of the tests controls should be done orderly, engineers should be responsible all of the flaws and so that they must be very attantive. After to began sold they must follow all of tests again and they should control the chips all around the world because engineers have a big responsibility about all of features in the chips which are produced by them. After the flaw became appearent they must be together about finding a good solution and it prevents the big problems in the future, so enginners are responsibles about chips which are products of them every time
(Edited by Dilek Karahoca - original submission Friday, 16 November 2012, 10:36 PM)
HI,
I Agree with you. Both engineers must fulfill their responsibilities as well as they company.Thank you for participation.

Show parent | Edit | Split | Delete | Reply

Figure 5: Case study for Forum Discussion

Students have a tendency to discuss a particular topic in Engineering Ethics. Also the teacher can follow the posts in the forum and inform them rapidly. In Figure 6, forum discussion activity, comments, and feedback of the teacher are shown.



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Show parent | Edit | Split | Delete | Reply

Figure 6: Case study examples

Through this learning system, the participation of courses, forums and activities can be observed in Figure 7.

Activity	Views	Related blog entries	Last access
Make-Up Final Exam	6	-	Tuesday, 8 April 2014, 11:53 PM (5 days 16 hours)
Final Exam	1405	-	Tuesday, 8 April 2014, 11:52 PM (5 days 16 hours)
Research 1 - Grades (10%)	234	-	Tuesday, 8 April 2014, 11:49 PM (5 days 16 hours)
Research 2 - Grades (10%)	341	-	Wednesday, 30 January 2013, 02:36 PM (1 year 74 days)
Research 2 Project (Türkçe) - 1. Bölüm	223	-	Tuesday, 8 April 2014, 11:53 PM (5 days 16 hours)
Research 2 Project (Türkçe) - 2. Bölüm	526	-	Tuesday, 8 April 2014, 11:53 PM (5 days 16 hours)
Research 2 Project (English) - Part 1	27	-	Thursday, 17 January 2013, 02:17 PM (1 year 87 days)
Research 2 Project (English) - Part 2	182	-	Saturday, 12 January 2013, 03:15 AM (1 year 92 days)
Forum	4082	-	Monday, 14 April 2014, 04:35 PM (1 min 1 sec)
FORUM	1052	-	Monday, 14 April 2014, 04:35 PM (44 secs)

Figure 7: The participation of students in forums and research projects

3.3 Description of Partial Least Squares Structural Equation Modeling (PLS-SEM) Methodology

Structural Equation Modeling (SEM) and Partial Least Squares Structural Equation Modeling (PLS-SEM) are described briefly below.

3.3.1 What is SEM?

This method began to be used in the marketing sector. It allows us to inspect complex research problems, which have multiple independent and dependent variables by showing the relations between existing variables, a detailed and systematic way in a single process. SEM can be named as a second-generation technique [Bagozzi and Fornell, 1982]. In SEM, variables of the research problem can be defined in a single diagram and provides a result at once without testing them separately. There are two types of variables in SEM, observed and latent variables. SEM is a multivariate statistical analysis method, and it reveals the relationships with these variables, which are correlative and causative, combining a lot of different statistical analysis methods such as variance, covariance, factor analysis, and regression analysis. We explained the variables, constructs and some other content of SEM in accordance with [Sarstedt et al., 2014].

In figure 1a-b is a PLS-SEM diagram of this study. It actually can be a standard model with constructs. Constructs are shown by circles or ovals in a SEM. Research carried out using SEM tries to define the cause-effect relationship between these constructs. If latent variables are only dependent variables, then we call them exogenous variables. If latent variables are independent or dependent and independent variables, they are called endogenous variables. In this study, the exogenous latent variable is Message Content. Endogenous variables are the remaining indicators. These sixteen indicators explain the final target construct, which is Message Content.

Observed variables can be called metrics or manifest variables. In our model, observed variables are displayed in a rectangle. Observed variables are created from the survey questions.

Measurement theory determines the relation between observed variables and latent variables [Sarstedt et al., 2014]. There are two types of measurement for latent variable types. One is formative, the other is the reflective measurement method. Formative measurement methods measure the effect of metrics on the constructs. Reflective measurement method measures the effect of the construct on the metrics [Coltman et al., 2008]. For these two measurement models, there are two considerations; one is theoretical, the other is empirical. In the theoretical part nature of construct, directions of causality between items and the latent construct, and characteristic of items used to measure the construct considerations exist. In the empirical part, item in correlation, item relationship between constructs antecedents and consequences, and measurement error and collinearly considerations exist [Coltman et al., 2008].

Choosing the right measurement type is also important. It is known that a construct should be formative or reflective. It depends on the concept of construction, purpose of the research, and the role of construct in the model [Sarstedt et al., 2014]. Furthermore, the use of PLS-SEM enabled us to review all of the constructs conceptualizations and specify them as formative or reflective [Hair et al. 2011].

3.3.2 What is PLS-SEM?

In PLS-SEM, there is no permission to make recursive relationships in the model. Therefore, the paths of structures in the model between latent variables only head in a single direction. As we mentioned before, there can be two types of measurement

models, and PLS-SEM can handle both of these models. A basic PLS-SEM algorithm has a two-stage approach. In the first stage, there exists a four-stage process in which the score values of latent variables are calculated. In the second stage, the algorithm calculates the final estimated scores of structural models path coefficients, outer weights and loadings [Hair et al., 2011].

3.4 Implementation of CMC PLS-SEM Methodology

In this research, the model was evaluated by partial least squares structural equation modeling (PLS-SEM). According to the Composite Reliability table, some metrics had low weights; therefore, they were removed from the initial model. According to the results, Rho values are over about 0.70 and the first Eigen values are bigger than the second ones. That means the reliability values of this model are acceptable, so the metrics of this model affect the model moderately. According to the Cronbach alpha values, the most effective variable is the content variable, which is 0.676. However, even this high effect is observed to remain moderate. Although the metrics affect the model moderately, different variations of interaction of different dimensions were tried to find more effective results. As a result of various tests, the most reliable values of the model are shown in the following Table 1.

	Dims	**Cronbach's alpha**	**D.G. rho (PCA)**	**Condition number**	**Critical value**	**Eigen values**
Message Interaction	4	0.433	0.682	1.627	0.815	1.279
						0.866
						0.632
						0.483
Semantic	3	0.485	0.745	1.551	0.797	1.186
						0.714
						0.493
Emotional Sit.	2	0.317	0.796	1.667	4.027	5.923
						2.132
Security	4	0.400	0.677	1.629	1.640	2.564
						1.591
						1.437
						0.966
Message Content	5	0.676	0.796	2.220	0.766	1.720
						0.694
						0.559
						0.505
						0.349

Table 1: Composite Reliability

The correlation table displays the impact of each manifest variable on its related latent variable (Table 1). The manifest variables Message Interaction 1(MI1), MI2 and MI4

have a greater effect on Message Interaction (MI) than MI3. Also, Emotional Situation 4 (ES4) has a greater effect on Emotional Situation (ES) than ES5. Manifest variables Security 1 (S1) and S2's effects on Security (S) are more than S3 and S5. Message Content 6 (MC6) and MC3 effect more than MC1, MC2 and MC 6 but all manifest variables of Message Content (MC) are effective. Reliable metrics were selected according to their standardized metric loading values, which are shown in Table 2. Their standardized metric loading values are mostly between 0.50 and 0.70 and they affect the model positively; therefore, they are not removed. They have positive impact on convergent validity and consistency reliability [Sarstedt et al., 2014]. ES5 was not removed; otherwise, Emotional Situation would have only one metric. That means it has a negative effect on the predictive validity of Emotional Situation constructor.

Latent variable	**Manifest var.**	**Standard. Load.**
Message Content	MC1	0.566
	MC2	0.538
	MC3	0.723
	MC6	0.805
	MC7	0.599
Message Interaction	MI1	0.640
	MI2	0.580
	MI3	0.282
	MI4	0.763
Semantic	SM1	0.652
	SM3	0.745
	SM4	0.711
Emotional Situation	ES4	0.980
	ES5	0.399
Security	S1	0.776
	S2	0.613
	S3	0.496
	S5	0.446

Table 2: Correlations (Dimension 1)

The Goodness of Fit Index (GFI) shows the amount of overall covariance between the observed variables, which is calculated by the default model [Sarstedt et al., 2014] [Saram et al. 2014]. Through the results, which can be seen in the goodness of fit index table, our absolute GFI value is about 0.50, which can be accepted in a real case model (Table 3). It is not a perfect model, but we can make some decisions about our model according to these values. The relative GFI is very high, which is equal to 0.937.

	GoF	GoF (Bootstrap)	Standard error	Critical ratio (CR)
Absolute	0.445	0.462	0.036	12.297
Relative	0.937	0.906	0.023	41.050
Outer model	0.980	0.963	0.014	70.315
Inner model	0.956	0.941	0.017	56.369

Table 3: Goodness of Fit Index table

In Table 4, a coefficient of determination, which is R of 0.470 can be considered moderate [Hair et al., 2011].

R	F	Pr >F	R (Boot-strap)	Standard error	Critical ratio (CR)	Lower bound (95%)	Upper bound (95%)
0.470	10.603	0.000	0.519	0.055	8.587	0.421	0.642

Table 4: Inner model (Dimension 1)

Interaction and semantic of message have important roles on content with path coefficients of 0.463 and 0.288. In addition, the hours a user spends on course related real-time chat each week has a significant effect on message content, which is 0.138. Average Variance Extracted (AVE) is a criterion of convergent validity [Fornell and Larcker, 1981] and if its value is equal to 0.50, that means the latent variable can explain more than 50% of variance of its metrics [Götz et al., 2010]. Only the AVE value of emotional situation exceeds 0.50, but AVE values of semantic and content are also about 0.50. Semantic, emotional situation, and content variables indicate convergent validity for all constructs. The construct explains over 0.50 of the variance of the items (Table 5).

We can conclude the effect type of independent variables on dependent variables through the path coefficient values of latent variables between each other. In the equation of model below, it is shown that variables affect Message Content positively and negatively (Equation 1). Through this equation, we can see that Message Interaction and Semantic have more positive effects than the other latent variables. For example, for Semantic, we asked questions about the extent to which participants can explain themselves, and whether they can have meaningful communication with other participants. We can say that if students can communicate meaningfully and explain themselves well, then the content of message will be better and more acceptable.

	Mean Communalities (AVE)
Interaction	0.352
Semantic	0.496
Emotional Situation	0.560
Security	0.356
Content	0.428

Table 5: Discriminant validity (Squared correlations <AVE) (Dimension 1)

MC = (0.288MI) + (0.463SM) + (−0.097ES) + (0.026S) + (−0.021EU E)+ (0.069T U E) + (−0.110RU E) + (−.059EU Y) + (−0.023T U Y)+ (−0.118RU Y) + (0.015I U Y) + (−0.052ESH) + (0.138T SH)+ (0.021G) + (0.032C E))} (1)

On the other hand, Emotional Situation and Threaded Discussion Usage Expertise have negative effects on Message Content. For example, if students send their message to a wrong person, then their message content will become less acceptable. Another result, which is the value of R, generally helps us to understand the degree of explaining dependent variables by independent variables in the model. In our model, R value is 0.476. We can say that the independent latent variables explain Message Content moderately.

4 Conclusions and Recommendation

This study illustrates that in ubiquitous environments, digital and computer mediated communication, which is the main element of the digital environment, is investigated in terms of its dimension, effects and contents of communication. In a ubiquitous learning environment, messages that contain positive emotions and are meaningful and comprehensible encourage learners to communicate. According to Derk, Fischer and Bos's study, there is no indication that CMC is a less emotional or less personally involving medium than face-to-face communication [Derk, Fischer and Bos, 2007]. Message content has a high validate for this model and others are listed in order as follows: semantic, interaction, security and emotional situation. Messages, which contain positive emotional icons and details, encourage learners to communicate with each other and connect to the system. They are prone to communicate with people who send positive understandable messages that contain content properly. In asynchronous learning processes, the use of the ubiquitous learning environment and learning outcomes is expected to result in improvement.

In this sense, more learners will be provided the support of personal development by following through intelligent interfaces to asynchronous content. The asynchronous content and disclosures should be given by focusing on the content

structure of meaningful messages in interaction with a digital interface. Learners' participation and engagement with systems are affected positively by message content, which is meaningful, including active notification, the lack of classroom climate, insufficient visual cues, and loneliness. At this point, content means context and it defines the interface. While increasing the mobility of learners, it supports environmental awareness of learning processes [Jedlikowska, 2014]. Learners' motivation can be controlled by intrinsic motivation by the interface. Chang and Wang introduced the idea that attitude and behavioral intention are directly affected by users' internal and external motivation [Chang and Wang, 2008].

In further studies, variables can be analyzed and examined in synchronous environments because learners' emotions, expectations, and requests can differ from face-to-face education to the online learning environment [Karahoca and Kurnaz, 2014]. For example, the learner may think that an asynchronous learning environment is more reliable and motivating than a synchronous one. Thus, different learning environments may influence the learner's communication predisposition, achievements, and communication dimensions [Can, 2014]. Future studies also may need to use different variables, so different outcomes can be achieved.

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Appendix I

Message Content
01. CMC messages are social forms of communication.
02. CMC messages are an informal and casual way to communicate.
03. CMC messages convey feeling and emotion.
04. CMC messages are impersonal (do not have qualities or characteristics).
05. CMC is not confidential enough to use to communicate personal and/or sensitive information.
06. CMC is a sensitive means of communicating with others.
07. Using CMC to communicate with others is pleasant.
14. I am comfortable participating, if I am familiar with the topics.
15. I am uncomfortable participating, if I am not familiar with the topics.
21. What is the likelihood that someone might obtain personal information about you from the messages you send and/or receive?

Message Interaction
08. The replies to my CMC messages are immediate.
09. Users of CMC are normally responsive to messages.
16. I am comfortable communicating with a person who is familiar to me.
17. I am comfortable communicating with a person who is not familiar to me.
29. What is your professional RELATIONSHIP to other participants with whom you communicate?

Message Semantic
10. The language people use to express themselves in online communication is stimulating.
11. It is difficult to express what I want to communicate through CMC.
12. The language used to express oneself in online communication is meaningful.
13. The language used to express oneself in online communication is easily understood.

Emotional Situation
18. What is the likelihood that a computer system operator might read and/or re-post messages sent to or from you?
19. What is the likelihood that someone else might read and/or re-post messages sent to or from you?

20. What is the likelihood that you might accidentally send message(s) to someone other than the intended recipients(s)?
27. Do you know of any instance where someone has been personally or professionally embarrassed because of their online activities?
28. Which of the following statements most closely reflects how you feel about the possibility of you even being personally or professionally embarrassed through your online participation?
For each item below, please read the statement carefully and then indicate your response to the statement as it relates to e-mail, and the Pabols Forum, by selecting the appropriate answer.
Security
22. Do you consider your online communication to be technically RELIABLE (e.g., free of system or software errors that might compromise the reliability of your online messages reaching ONLY the target destination)?
23. How PRIVATE are your messages on CMC?
24. How IMPORTANT is privacy of a CMC?
25. How SECURE/SECRET is your online participation?
26. How RISKY is it to share personal and sensitive topics online?
30. If you are able to use online messages anonymously, how CONCERNED are you that your identity will be traced?

I) How proficient are you in using CMC? (e.g., expertise with software and system commands, keyboard skills, etc.) [E-mail]
II) How proficient are you in using CMC? (e.g., expertise with software and system commands, keyboard skills, etc.) [Threaded Discussion]
III) How proficient are you in using CMC? (e.g., expertise with software and system commands, keyboard skills, etc.) [Real-time chat]
IV) How many years have you been using e-mail as a form of CMC?
V) How many years have you been using threaded discussion as a form of CMC?
VI) How many years have you been using real-time chat as a form of CMC?
VII) How many years have you been using the Internet?
VIII) How many hours do you spend on course related e-mails each week?
IX) How many hours do you spend on course related threaded discussion each week?
X) How many hours do you spend on course related real-time chat each week?
XI) What is your Gender?
XII) Estimate your level of computer expertise