Multi-dimensional Interactivity for Learners' Satisfaction with e-Learning

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Abstract

Interactivity has been referred to as an important element promoting students' active participation in virtual classes. Assuming that interactivity cannot be defined by a single dimension, this study proposes multi-dimensional interactivity. Multi-dimensional interactivity includes all types of interactivity in e-learning. This study explored multi-dimensional interactivity which affects learners' satisfaction with e-learning. Data were collected from 132 students who had attended e-learning courses and the relationship between multi-dimensional interactivity and learners' satisfaction levels were tested through regression analysis. The result of this study showed that mechanical, reactive, and creative interactivity were positively related to learners' satisfaction. However, social interactivity seemed not to be related to learners' satisfaction. This study provides new insights on interactivity and verifies the importance of the multi-dimensional interactivity. The result of this study is expected to provide practical implications for interactivity strategies in e-learning.

Keywords : Multi-dimensional Interactivity, e-Learning, Learners' Satisfaction

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1. Introduction

e-Learning has become a major tool of learning at various stages of education and training. It provides convenience and flexibility with anytime and anywhere accessibility and has many advantages, including ease in updating content, personalized instruction, cost savings, as well as increased learner control, self-pacing, and access to information. Despite the advantages of e-learning, some have argued that, for several reasons, e-learning is not comparable to traditional classroom education. One of the main reasons is the lack of interaction. Mantyla and Gividen [1997] point out that a learner-centered mindset is not established and continuously reinforced in e-learning and that there is not enough meaningful interaction between remote-site learners and trainers. In the absence of the physical pressures of a traditional classroom, students tend to avoid or neglect learning. For this reason, many studies have emphasized the importance of interactivity which is an inherent quality of the technology that allows various types of interactions in cyberspace.

Prior research has shown that interactivity positively influence learning. This is because interactivity allows learners to adjust the instruction to their needs and capabilities [Weller, 1988] and it provides critical support for learning and retention in all educational activities. Some scholars defined it as a part of the communication process [e.g., Steuer, 1992], some considered interactivity as medium features [e.g., Hoffman and Novak, 1996], while others focused on the individual perceptions [e.g., McMillan and Hwang, 2002]. Like this, each field and researcher provides various definitions and concepts of interactivity. However, it is more persuasive that interactivity is a media's attribute which enable learners control over their mediated learning experiences. Through interactivity, learners can interact with systems, learning material and others (instructor, tutor or other learner), and enjoy more interesting and useful experiences in the cyber space.

Recently, related technologies such as communication tool and authoring tool have evolved rapidly and as a result, learners can interact more efficiently with various components of e-learning. It thus seems necessary to redefine the concept of interactivity from an integrated perspective. This study assumes that there can be a single common feature of interactivity for IP-based services; multi-dimensional interactivity. Multi-dimensional interactivity is organized in accordance with user control and target of interaction. In this study, multi-dimensional interactivity is divided into four types : mechanical, reactive, creative, and social interactivity. To investigate the role of multi-dimensional interactivity towards learners' engaging experiences in WBI, quantitative research and experimental studies were performed.

This study assumes that interactivity cannot be defined on the basis of a single dimension and there can be common types of interactivity in e-learning. Based on this assumption, this study proposes a multi-dimensional interactivity from an integrated perspective and investigates the role of multi-dimensional interactivity in affecting learner satisfaction.

2. Theoretical Background

2.1 Interactivity in Education

Many scholars have emphasized that increased levels of interaction result in increased motivation, positive attitudes toward learning, higher satisfaction with instruction, more meaningful learning and higher achievement. Due to these reasons, interactivity has been referred to as the most important element for successful e-learning.

In general, interactivity is defined as a medium's ability to let users control the content or form of the mediated communication [Jensen, 1998]. Interactivity, portrayed as an inherent quality of the technology, allows users to interact with the system, content, and other individuals in cyberspace.

People usually use the terms interaction and interactivity interchangeably, but a subtle difference exists between the two concepts. Philosophically, interaction is defined as reciprocal events that require at least two objects. When seen in the context of education, interaction implies active learner participation in the learning process. Conversely, interactivity may be seen as some technical aspect of a medium which enables interaction between people and other objects. Comparing these two concepts, while they are closely related, they do have a conceptual difference in that one is a people's activity, and the other is an aspect of the interactive medium.

In prior research, it was revealed that interactivity positively influenced learning [Gunawardena and Zittle, 1997; Hillman, 1999; Kanuka and Anderson, 1998; Ronteltap and Eurelings, 2002], affects learning performance, self-efficacy and satisfaction [Hillman, 1999; Lobry de Bruyn, 2004]. Recently, the development of information and communication technologies (ICTs) has led to interactivity becoming more effective and interesting. Interactive technology has been developed on a level that is leading users' specific behaviors and providing a similar experience as face-to-face interaction. Credit to recent developments in ICTs and the academic development of instructional design, interactivity is becoming a valuable way of improving the quality of e-learning.

2.2 Type of Interactivity

Though interactivity allows users to experience a series of exchanges by means of technology, it involves more than simply clicking an icon or menu on the screen, and implicates higher-level activities, such as discussion, inquiry, problem-solving, configuration, analysis, evaluation, synthesis, and reflection. Thus, interactivity is a complex mechanism that covers a wide range of activities. It can be dissected, as follows :

1) Time : Interactivity can be designed to occur synchronously or asynchronously. Asynchronous interaction occurs when people are not in the same place at the same time. It occurs via email and bulletin board systems (BBS) and provides a high degree of interaction between participants who are separated both

geographically and temporally by allowing them to access the course and its instructional materials at any time and from any location with an Internet connection [Mayadas, 1997]. However, this interaction can be delayed, from as little as an hour or to as long as a few days. In contrast, synchronous interaction occurs via real-time computer-mediated communication via chat rooms, online messaging, or video conferencing. Although synchronous interaction is the most effective way to communicate or exchange opinions, implementing it entails challenges for instructors, as lectures are provided 24 hours per day, seven days per week for many students.

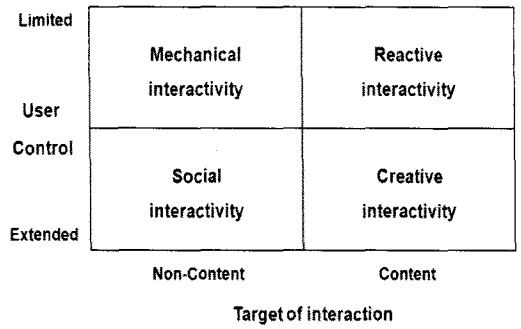
2) Target of interaction : Researchers concerned with computer-based education have identified types of interactivity. Representatively, Moore [1989], presenting the most well known taxonomy in the field of e-learning, delineates three types of interaction : learner-content, learner-instructor and learner-learner interaction. Hillman et al. [1994] argue that Moore's three types of interaction do not account for interaction that occurs between learners and the technologies, adding the learner interface to Moore's taxonomy. More recently, Kennedy [2004] emphasizes that users should establish a dynamic relationship with educational multimedia programs because an educational multimedia program cannot function by itself, though it has the potential to do so. Based on this reasoning, Kennedy involves the interaction between the user and the instructional source. This distinction is due to the interaction of the target. Synthesizing these assertions then, interaction in e-learning can be addressed as follows : (1) learner-content and (2) learner-non-content interaction.

3) Learner control : The frequency and quality of interaction depends on the degree of learner control. The concept of control is central to theories of intrinsic motivation, which view people as seeking to control their own actions and choices rather than being controlled by external forces [Webster and Ho, 1997]. Learner control is degree to which learners can direct their own learning experience [Shyu and Brown, 1992]. Unlike traditional learning, e-learning allows student to control the speed, time, and order of learning, and these learner control may increase feelings of competence, self-determination, and may increase intrinsic interest [Lepper, 1985]. Hannafin and Peck [1988] also argue that the granting of control to learners affects their status in a positive fashion. Thus, learner control seems to be an essential element of e-learning.

2.3 Multi-dimensional Interactivity

Developing Lee and shin's research [2008], this study proposed multi-dimensional interactivity in accordance with user control and the target of interaction. As previously mentioned, user control is the degree to which a user can govern their own activity. Lawless and Brown [1997] see two types of control in a multimedia environment : learner control and program control. Learner control is the opportunity for learners to control their process of learning where-

as program control refers to the specific limits set up by a multimedia computer program, to which all users must comply. Depending on the scope of control, learner control can be implemented as various types. In this study, user control is presented as being divided into two types : limited user control and extended user control. Limited user control permits a restricted range of user control. For instance, non-linear navigation seems to offer learners more opportunities to select their route, but factually, learners can move only on a predetermined route. Conversely, with extended user control, learners can create an opportunity to interact with others and control their activity according to their will. For instance, participation in chatting can occur based only on learner effort. According to the target of interaction, the features of interactivity also appear differently. Learners can interact with an instructor, other learners, learning content, and systems in e-learning environments. Among these, learner-content interaction is essential to the e-learning process. Thus, types of interaction can be divided into two types : content interaction and non-content interaction.



〈Figure 1〉 Dimension of Interactivity

Based on user control and target of interaction, four dimensions of interactivity are proposed as follows : mechanical, reactive, social and creative interactivity. The dimension of interactivity in e-learning is shown in <Figure 1>.

1) Mechanical interactivity : Mechanical interactivity is a property of media to enable interaction with systems. Although mechanical interactivity is not essential in learning activities, it is of great importance as it is the most basic function for e-learning. Key elements of mechanical interactivity are thus; navigation and speed of response. Navigation is the process of self-directed movement through a computer-mediated environment [Hoffman and Novak, 1996]. This makes an interactive multimedia module easy to use [Kensworthy, 1993] and allows the learner to control over events [Schvier and Misanchuk, 1993]. Navigation can be divided into linear and non-linear : linear being that active content progresses without any navigation control for the user, whereas non-linear content offers user interactivity to control the progress of activity and as such, self-paced learning [Rahman, 2008]. Non-linear navigation permits more interactive learning and presents more choices to learners than linear navigation.

Another issue is response time. McMillan and Hwang [2002] insist that immediacy of response is an important issue to promote perceived interactivity. Response time should be as fast as possible because it affects user's satisfaction and the experience of Flow. Flow is the mental state of being immersed, or the feeling of success in the process of the activity. A study by

Novak et al. [2000] suggested that the speed of interactivity influences Flow and focused attention. Although mechanical interactivity seems to provide extended user control to learners, a system actually provides a pre-programmed path on which learners move forwards or backwards on the predetermined route. Therefore, mechanical interactivity factually allows limited user control.

2) Reactive interactivity : Reactive interactivity is a property of media enabling people to interact with content. It occurs when users read content on the screen or in some way interact with resources. Reactive interactivity can be implemented in various ways such as clicking a hyperlink, mouse dragging and typing through the keyboard. Through reactive interactivity, learners can have access to a wealth of information. Many researchers have studied reactive interactivity. They researched the technical characteristics of reactive content and presented the elements of reactive interactivity to be as follows : accessibility [Bucy, 2004], relevance [Bailey and Pearson, 1983], vividness [Steuer, 1992].

In e-learning, reactive interactivity is a very important property because most learning activities are done through interaction with the content. Reactive interactivity allows learners to manipulate, organize, synthesize, and have access to the learning content, these being essential for higher e-learning. The importance of reactive interactivity in e-learning is stated by Moore and Kearsley [1996, p. 133], arguing that "it is not too difficult to present information over a distance, but getting people to participate and making learning active at a distance is much harder." When learners respond to a question that a computer generates, the computer analyzes the learner's response and provides relevant feedback. In this, relevant and exact reactions assist user's access to content, but irrelevant reactions confuse and frustrate users. Additionally, learners should be afforded adequate opportunity to interact with the content, or learners may feel bored and their attention and satisfaction may be reduced. Therefore, effective design of instructional events or tasks that promote a variety of interactions is important. Reactive interactivity motivates learners to respond to the stimulus of systems, so learner control is limited. However, reactive interactivity seems the most fundamental interactivity of the four types as it most closely related with substantial learning activity.

3) Social interactivity : The third dimension is social interactivity. An interpersonal or social interaction is a critical component to interaction online. According to Chung [2004], the highest level of interactivity occurs in human-to-human communication. Recently, a large number of communication devices have become available for the support of human interaction in computer-mediated environments (CMEs), and these focus more and more on levels of communication as opposed to the transmission of the message. Social interactivity is a property of interactive media to enable communication between various participants in virtual space. Concisely, it can be viewed as the attribute and

the ability of the media that enables social interaction. In e-learning environments, social interactivity occurs when learners receive feedback as personal encouragement and motivational assistance from the instructor or other students [Donnelly, 2009]. Garrison [1990] insists that students who interacted regularly with their instructor and other learners were more highly motivated and had better learning experiences. To motivate learners and facilitate learner interaction, an instructor usually provides support and feedback, and sometimes builds a learning community. These activities can be implemented using asynchronous techniques such as bulletin boards and e-mail, or by synchronous solutions such as video conferencing and instant messaging. These tools increase the level of interaction and allow learners and instructors to reduce the psychological and physical distance between them [Lemak et al., 2005]. Sometimes, however, a learner only interacts with the content and not with others. This is due to a lack of willingness on the part of the participants or a technical problem. In a traditional class, questions may be answered or feedback may be given immediately, but in virtual classes, feedback would be delayed as little as an hour or as long as a few days. This situation would cause learner dissatisfaction with e-learning. Even if powerful communication tools are provided but learners simply do not actively participate in communication, social interaction would not occur. Social interactivity requires learners to act as well as to watch of and listen, and encourages learners to express their opinions and idea actively. Thus, implementation of social interactivity seems to be strongly influenced from learner's willingness to participate in communications.

4) Creative interactivity : Creative interactivity is a property of media that enables the learner to modify the content or to create new content. This is related to Web 2.0 paradigms, which are characterized by openness, sharing with others and users' active participation, all having a strong impact on individual and business environments. For example, user created content (UCC) has become more and more popular due to its huge impact on society, and offers people an opportunity to produce information and content on their own. UCC changes a media user's attitude from passive to active and obscures the delineation between a supplier and a consumer. Collective intelligence, the ability of group intelligence to solve problems, can be easily found on a BBS where each participant's shared knowledge and ideas can solve a problem. According to Constructivism, which is a dominant perspective in the field of education, the ability to share and create knowledge is an essential element of learning, and as such, technical features supporting these activities should be under the category of interactivity, and called creative interactivity.

Steuer [1992] claimed that interactivity is the extent to which users can participate in modifying the form and content of a mediated environment. Namely, one of the representative features of interactivity is giving the user control over the content. As a result of creative interactivity, various learning resources can be

conceived in the form of workbooks, reflection journals, e-portfolios, and project deliverables. For instance, the e-portfolio is a personal place that belongs to the student in which to create and showcase their work. The e-portfolio allows learners to build a record of achievement throughout their learning, an outcome that has a great deal of value to learners on a personal level. Accordingly, interactivity leads to internalization and personalization of content. Like reactive interactivity, creative interactivity allows learners' control over the content, differing in that it provides more control to the learner when compared to the reactive interactivity.

3. Research and Methodology

3.1 Research Model and Hypotheses

Many previous studies have indicated the necessity of student participation in achieving success in learning and interaction is referred to as the most important element that motivates students to participate actively in virtual classes. Because it provides critical support for all educational activities, interaction is commonly mentioned as an essential condition for effective e-learning.

This study explores the dimensions of interactivity that affect learners' satisfaction with e-learning. Learner satisfaction is an important intermediate outcome and a good predictor of retention. It is defined as the learner's perception and perceived value of the education obtained while attending an educational institution [Astin, 1993]. Furthermore, learner satisfaction is usually established as a dependent variable in e-learning research, because learner satisfaction influences a learner's level of motivation [Bolliger and Martidale, 2004]. Studies have shown that some degree of learner control lead to satisfaction with the learning experience [Chou and Liu, 2005; Kinzie et al., 1988; Merrill, 1994]. Especially in web based instruction (WBI) environments, learners can have control in determining the pace and sequence of learning and in responding to the various stimuli provided by content. By interacting with the system and content, learners satisfy their desire for knowledge and feel a sense of achievement. Especially, non-linear navigation and speedy response permits more interactive learning and learner-controlled events and hyperlinks enable learners to access to a wealth of information. In this study, the former was defined as "mechanical interactivity" and the latter was defined as a "reactive interactivity." On this basis, our first and second hypotheses are proposed as follows.

Hypothesis 1 : Mechanical interactivity is positively related to learner satisfaction.

Hypothesis 2 : Reactive interactivity is positively related to learner satisfaction.

Feelings of connection and belonging are some of the basic needs of humans as social animals. Especially, learners in virtual classes are separated geographically, so if a virtual community or communication channel does not exist, lear-

ners might feel disconnected from the instructor or other students and are more likely to feel loneliness and isolation.

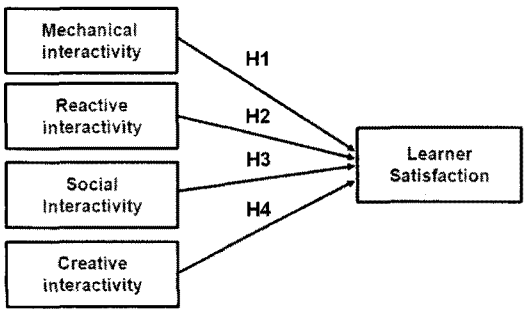
In general, e-learning provides an asynchronous or synchronous communication tool. These communication tools encourage the learners to share their opinion with others and to get feedback about course-related activities from an instructor. These activities can reduce learners' feelings of isolation and promote learners' critical thinking and interactive dialogue.

Kanuka and Anderson [1998] claim that interpersonal or social interaction between learners and an instructor can be attributed to learner satisfaction and the frequency of interaction in WBI. Yum [2009] insists that the higher level of interactions in the cyber educational setting leads the better the performance and positive motivation. Therefore, learners' satisfaction is likely to be closely related with the level of interactions between instructors and students or among students. On that basis, it was hypothesized :

Hypothesis 3 : Social interactivity is positively related to learner satisfaction.

According to Constructivism, which is a dominant perspective in the field of education, the ability to share and create knowledge is essential to learning. In e-learning, a learner can build knowledge and create content in workbooks, e-portfolios, reflection journals, and personal pages or blogs and reflect their learning by monitoring output and sharing information electronically via bulletins. Since creative interactivity, which enables learners to create or modify content, will help to satisfy the learner, the following hypothesis was formulated :

Hypothesis 4 : Creative interactivity is positively related to learner satisfaction.



〈Figure 2〉 Research Model

3.2 Measurements

A researcher lectured for e-learning courses at a university and conducted a survey of the learners enrolled in these courses. For this study, flash-based e-learning content including four dimensions of interactivity was developed. This content, under the title "Imagination and Creativity" was designed based on SCORM (Shareable Content Object Reference Model) 2004 and provided various type of interactivity such as non-linear navigation, event clicking, quizzing, discussions on BBS, creating workbooks, etc.

A survey methodology was used to collect data to test the research hypotheses. <Table 1> shows the formal definitions of the constructs. These constructs were measured using questions from prior studies to enhance validity.

Items were adjusted to the e-learning environment and scored on 5-point scales anchored from 'strongly disagree' to 'strongly agree.'

4. Result

The field study was conducted over a period of two weeks in November 2008, and 132 responses were obtained yielding a response rate of 88%. The ratio of males to females was 68.7% to 31.3%. As for level of schooling, the percentage of freshmen was 20.6%, sophomores 34.9%, juniors 14.7%, and seniors 9.8%. A majority of the respondents (96.2%) had sufficient computer-related skills required for e-learning courses.

For statistical analysis, SPSS 17.0 was used. The first stage of analysis was a reliability test. Cronbach's α is the most widely used index of the reliability of a scale. In this study, α values ranged between 0.727 and 0.905, and, as seen in <Table 2>, all scales showed a relatively high level of internal consistency.

The questions were tested for validity using factor analysis. Factor analysis with varimax rotation yielded five components with eigen values greater than 1. These five components corresponded to the five constructs in our research framework. Comrey [1973] argues that loadings from 0.63 to 0.70 are considered "very

<Table 1> Conceptual Definition of the Construct

Construct	Conceptual definition	Measurement variables	Related Research
Mechanical interactivity	Property of system to enable interaction with systems	1. Easy use of browsing menu, scroll and next button for navigation 2. Seamless browse 3. Correct responses from systems 4. Quick responses from systems	McMillan and Hwang [2002], Steuer [1992]
Reactive interactivity	Property of system to enable interaction with content	1. Get more learning content through hyperlinks 2. Access a wealth of learning content through icons and event click 3. Gain an appropriate learning content depending on learner's activity	McMillan and Hwang [2002]
Social interactivity	Property of system to enable interaction with other participants	1. Use the communication tools to confirm new information, to share learner's opinions and to ask a question 2. Express learner's opinion sufficiently using communication tools 3. Communicate well with others (professor and other students) using communication tools	Heeter [1989], Lemak et al. [2005]
Creative interactivity	Property of system to enable the learner to modify or create content	1. Make learner's own content easily 2. Upload content easily 3. Get lots of useful contents as a result of learning activity	McMillan and Hwang [2002]
Learner satisfaction	The learner's positive perception and perceived value of the education	1. Satisfaction with the class 2. Satisfaction with the learning activity 3. Satisfaction with the learning experience 4. Positive perceived value of the learning	Astin [1993]

〈Table 2〉 Reliability Test

Construct		Number of Items	Cronbach's α
Independent variables	Mechanical Interactivity (MI)	4	.905
	Reactive Interactivity (RI)	3	.727
	Social Interactivity (SI)	3	.796
	Creative Interactivity (CI)	3	.776
Dependent variables	Learner Satisfaction (LS)	4	.861

good." Analysis results showed that all questions had at least very good loadings for our intended constructs.

〈Table 3〉 Factor Analysis

Question	Factor				
	1	2	3	4	5
MI2	.871				
MI1	.871				
MI3	.813				
MI4	.761				
LS3		.815			
LS4		.741			
LS1		.741			
LS2		.738			
SI3			.849		
SI2			.830		
SI1			.800		
CI3				.784	
CI2				.745	
CI1				.655	
RI1					.779
RI3					.705
RI2					.690
Eigen value	3.260	2.890	2.280	2.182	2.090

A correlation analysis was performed on the scales to detect any multi-collinearity problems before regression analysis. According to Hair et al. [1998], acceptable collinearity is below a threshold of 0.7. In this study, correlation analysis showed that the largest correlation among predictor variables was 0.5, so that multi-collinearity was not a serious problem.

Hypotheses were tested through multiple regression analysis. A multiple regression procedure was used to determine the contribution of multi-dimensional interactivity to learner satisfaction. Regression analysis showed that the hypothesized relationships were statistically significant (F-ratio = 20.818, p-value = .000), meaning that the chance that the results of the regression were by random instead of constituting a real relationship is .000 [Hair et al., 1998].

〈Table 4〉 Correlation Matrix Among Factors

	MI	RI	SI	CI	LS
MI	1				
RI	0.402**	1			
SI	0.285**	0.242**	1		
CI	0.327**	0.439**	0.235**	1	
LS	0.483**	0.452**	0.139	0.500**	1

Note) ** Correlation is significant at the 0.01 level (2-tailed).

<Table 5> summarizes the results of the hypotheses tests. Hypothesis 1, proposing that mechanical interactivity would positively relate to learner satisfaction, was supported (t = 4.072, p = 0.000). Hypothesis 2, proposing that reactive interactivity is positively related to learner satisfaction, was also supported (t = 2.458, p = 0.015).

〈Table 5〉 Summary of Hypothesis Tests

Dependent variables	Independent variables	Std. Error	Beta	T	Sig.
LS	(constant)	1.911	-	0.324	0.747
	MI	0.071	0.318	4.072	0.000
	RI	0.139	0.199	2.458	0.015
	SI	0.077	0.077	1.049	0.296
	CI	0.138	0.327	4.157	0.000
	$R = 0.629$, $R^2 = 0.396$, Adjusted $R^2 = 0.377$, $F = 20.818$, $p = .000$				

Likewise, hypothesis 4, proposing that creative interactivity is positively related to learner satisfaction was supported ($t = 4.157$, $p = 0.000$). Social interactivity, however, seemed to have no significant relationship with learner satisfaction in WBI ($t = 1.049$, $p = 0.296$), so hypothesis 3 was not supported.

Even though social interactivity occurs frequent, learners may not feel a positive emotion such as a sense of belonging and intimacy. The absence of these positive feelings can lead to the decrease of learner motivation and satisfaction. Accordingly, this result gave an implication that powerful communication tools were not important in themselves, but that learner satisfaction would be increased through an immersed experience in which learners can feel as though they are actively communicating with others.

5. Conclusion and Implications

Interactivity is considered an inherent quality of a media system and has been subject to research in various areas, but each area yields different definitions and different dimensions of interactivity. Assuming that interactivity cannot be defined by a single dimension, this study proposed multi-dimensional interactivity based on user control and type of interaction and investigated the role of multi-dimensional interactivity in learner satisfaction. The findings showed that interactivity could be divided into four dimensions, namely, mechanical, reactive, social, and creative interactivity, and that all except for social interactivity are positively related to learners' satisfaction. Social interactivity was not related to learners' satisfaction, and the reason for this was estimated as follows : First, asynchronous communication tools provided by current LMS (Learning Management System) may have limits to sharing participants' opinions about learning; Second, most students passively interacted with one another. In fact, many students asked questions or communicated with instructors via phone or SMS, and posts on BBS, including questions and opinions about learning content, numbered fewer than 100. Moreover, 34% (45 of 132) of students were not involved in the interaction with a lecturer or peers at all.

The practical implications of this study are the following. Many scholars have agreed that interactivity cannot be defined as a single dimension. However, exploring interactivity dimensions separately has rarely been attempted.

Moreover, with the coming of digital convergence era, in which applications and services are mainly provided through one media, it is becoming necessary to define a new concept of interactivity in an integrated perspective. For that reason, this study proposes the concept of interactivity from an integrated point of view. Numerous studies have insisted that increased levels of interactivity result in higher satisfaction with instruction, deeper and more meaningful learning, and higher achievement, and this study's results are consistent with these propositions. In particular, this study proposed a multi-dimensional interactivity construct including a new dimension, 'creative interactivity' which had not been discussed in prior studies. This study is expected to provide a basic principle of interactivity based on the theoretical backgrounds and evidence through empirical study.

Like other research to date, this study has several limitations. A larger sample with more statistical power would have allowed for more sophisticated statistical analysis. In this research, statistical analysis was conducted on 132 respondents, somewhat small for generalizing. The second limitation was that we had used only asynchronous communication tools such as BBS and e-mail to communicate with students. With previous research, it was assumed that social interactivity affected learner satisfaction, but the results of this study did not support this proposition. Therefore, future studies should explore the relation between multi-dimensional interactivity and learner satisfaction in synchronous communication environments.

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