EXTENDED TRANSACTIONAL DISTANCE THEORY FOR EXPLORING THE EFFECT OF INTERACTION BETWEEN AVATARS AND LEARNERS IN THE E-LEARNING ENVIRONMENT

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Abstract
As a result of dazzling advancement of web technology, e-learning system has emerged as a very effective venue with which learners can interact with online contents to get a full understanding on target subjects. Despite such success, empirical studies on e-learning performance lack rigorous theory with which learners’ e-learning participation intention is analyzed. In this sense, we propose an extended transactional distance theory (ETDT). Transactional distance (TD) is the physical separation that leads to a psychological and communications gap, a space of potential misunderstanding between the inputs of the instructor and those of the learner. This study focuses on e-learning environment where avatar instructor is used. To prove the validity of the ETDT, we assumed that dialogue is represented by avatar types (attractive vs. expert) and structure by contents difficulty (easy vs. difficult), and that TD_PI is represented in a reverse proportion to path coefficient from either avatar trust (AT) or contents trust (CT) and learners’ PI (Participation Intention). Results from experiment with valid 205 questionnaire revealed that (1) both TD_AT_PI and TD_CT_PI decrease when dialogue is administered by expert avatar and structure is composed of easy contents, and that (2) TD_CT_PI shows no difference between easy contents and difficult contents when dialogue is administered by attractive avatar.

Keywords: E-learning, Transactional Distance, Avatar Instructor, Content Difficulty, Avatar Trust, Contents Trust.
1 INTRODUCTION

As a wide variety of web-based applications take crucial positions in our daily life using Internet, distance education is observing significant changes in its way of supplying education service to learners. Accordingly, e-learning systems that are basically assumed to base its main service mechanisms on the web recently emerged as major type of distance education, becoming broader trends in higher education market (Popovich and Neel 2005; Sitzmann et al. 2006). Previous studies have been also active on analyzing antecedents and critical factors that are deemed to affect e-learning performance (Ho and Kuo 2009; Santhanam et al. 2008; Shroff et al. 2007; Simmering et al. 2009). From those previous studies, we found that e-learning performance is heavily dependent on learners’ computer-learning self-efficacy and attitude (Ho and Kuo 2009; Santhanam et al. 2008; Simmering et al. 2009) as well as intrinsic motivation (Shroff et al. 2007).

However, it is surprising that there exist no previous studies focused on interaction between instructor and learners, and between e-learning contents and learners, and investigating its effect on e-learning performance. Instructor is supposed to influence learners’ attitude towards e-learning contents to some extent (Marakas et al. 2000; van Mulken et al. 1998). Learners’ e-learning performance is also affected by e-learning contents themselves (Haimerl and Fries 2009; Jung and Kim 2006; Moore 1989). If it is sure that such interaction between learners and instructor and contents have some influence on e-learning performance, this is an important research issue to be explored. This study attempts to tackle this issue with Transactional Distance Theory (TDT) (Moore 1980; Moore 1989).

E-learning is composed of instructor, contents, learners, and web-based education service system. The interaction perspective implies that if the web-based education service system is set aside as a given infrastructure condition, then the e-learning performance is determined by the interaction between learners, contents, and instructor.

Previous studies on e-learning were based on several theories such as social cognitive theory (Bandura 1991), intrinsic motivation theory (Deci and Ryan 1985), theory of self-determination (Ryan and Deci 2004), and TRA (Theory of Reasoned Action) (Fishbein and Ajzen 1975). For example, on the basis of social cognitive theory, Simmering et al. (2009) examined how subjects’ characteristics normally associate with effective training (i.e., initial motivation to learn and self-efficacy). Similarly, Santhanam et al. (2008) proposed a hypothesis that instructional strategies need to persuade learners to follow self-regulated learning strategies. With the aid of the two theories like intrinsic motivation theory and theory of self-determination, Shroff et al. (2007) investigated how much learning activities and technologies affect intrinsic motivation in an online learning environment. By referring to TRA, Ho and Kuo (2009) elicited the determinants of the IT professionals’ e-learning outcomes by investigating the effect of IT professionals’ computer attitudes on two personal outcomes- self-perceived flow experience and learning outcomes.

However, previous e-learning studies fail to theorize interaction among learners, contents, and instructor to come up with a rigorous research model. Interactions among learners, contents, and instructor seem crucial for the sake of improving learners’ e-learning performance. We know that interactions in the e-learning environment are often limited due to physical separations, leading to increase psychological distance between learners-and-learners, learners-and-instructor, and learners-and-contents. In this sense, studies about how to reduce such psychological distance received attention in the field of e-learning (Garrison 2000; Gunawardena and Melsaac 2004). Recently, using avatar instructors instead of human instructors in the cutting-edge e-learning system is closely related to those attempts to reduce the psychological distance.

Meanwhile, the concept of transactional distance (TD) is often observed in the e-learning because instructor and learners are physically separated, which leads to a psychological and communications gap, and a space of potential misunderstanding between the inputs of the instructor and those of the learners (Moore 1980; Moore 1989). When dialogue between instructor and learners is well-controlled, TD would be reduced. When structure of the contents is good, TD would be low. TDT proposed by Moore (1980) ignited a series of studies about how to configure e-learning systems by using three elements like learners, contents, and instructor (Bischoff et al. 1996; Bunker et al. 1996; Chen and Willits 1998; Kanuka et al. 2002). However, when considering that e-learning learners
usually perceive trust towards instructor and contents and that such trust would lead to more intention to study, TDT is insufficient for developing more practical research model in which learners’ intention to participate in the e-learning activities is tested on the basis of instructor trust and contents trust.

In this sense, we argue that a new theory called Extended Transactional Distance Theory (ETDT) is necessary for explaining why e-learning learners possess trust towards instructor and contents, and why the learners are motivated to participate in e-learning activities like obtaining information from the e-learning system required by instructor as well as contents. Main objectives of this study are as follows.

First, the target e-learning system is assumed to be composed of avatar instructor, contents, and learner, and learners are assumed to have trust towards avatar instructor and contents. Henceforth, first objective is to compute TD based on avatar trust and contents trust. Second, the research model is proposed to test for types of TDs like TD from avatar trust-to-participation intention (TD_{AT-PI}), TD from contents trust-to-participation intention (TD_{CT-PI}). Third, all the experiments are performed by classifying the questionnaire data into four subsets- two types of avatar instructor (attractive vs. expert), and two types of contents difficulty (easy vs. difficult).

This study is organized in five sections. Next section describes theoretical backgrounds where previous studies about e-learning and TDT are summarized with emphasis on why ETDT is needed to investigate effects of interaction on understanding the e-learning performance. Section 3 addresses basics of the proposed ETDT, comparing it with TDT. Research model is suggested in section 4 where theoretical support is sought from the ETDT. Experiments are explained with results and implications in section 5. This study is ended in section 6 where further research issues are proposed.

2 THEORETICAL BACKGROUND

2.1 E-learning

E-learning is usually defined as “an environment in which the student interactions with course materials (e.g., readings, assignments, and exercises), peers, and/or instructors are mediated through advanced information technologies” (Alavi and Leidner 2001, 2p). It improves training by providing current content anytime, anywhere and offering learners a customized, interactive, just-in-time experience. E-learning usually uses the web technologies in all the activities of education and training (Gil 2000). Essentially, e-learning is composed of time, place, space, technology, interaction and control as its main elements (Abram 2003). Typical software used for e-learning is known as Learning Management Systems (LMS) in which every feature included is accompanied by explicit guidelines on the best method of their use to effect pedagogically sound instruction.

Interaction has always been regarded as important factors that influence the e-learning performance in distance education (Anderson 2003; Lou et al. 2006; Moore 1989). Instructor’s attitude and ability affect learners’ attitude toward e-learning, and instructor’s teaching style affects learners’ participation, and attitude toward e-learning (Dillon and Gunawardena 1995; Webster and Hackley 1997). An empirical study on student attitude towards using e-learning reveals that instructor characteristics are the most critical factor in e-learning success, followed by IT infrastructure and university support (Selim 2007). A recent study shows that e-learning course quality affect learners’ perceived satisfaction (Sun et al. 2008). E-Learning learner’s interpretation of message and attitude depends on how learner feels about message sender’s characteristics such as attractiveness, profession.

Instructors who play an important role in delivering the information to learners have been studied as one of the key factors which influence the e-learning performance (Hong et al. 2004; Ryu 2003; Son and Ju 2008). Since the e-learning is widely open to adopting cutting-edge IT once it is going to prove useful for improving e-learning performance, avatars are recently taking the role of human instructor in the e-learning systems (Hendaoui et al. 2008; Moore et al. 2005; Payr 2005). In the e-learning environment, avatars can interact with learners instead of the instructors. Utilization of an avatar connecting the real world and cyber space, are, firstly, to give a fast understanding by visualizing the
communication partner, and secondly, to help learners to more easily feel presence (Lee 2005). Thus, adding an avatar as an instructor in the e-Learning system has proved useful and effective for improving e-learning performance (Johnson et al. 2000; Hamburger and Tecuci 1998), which is aligned with argument by Trogemann (2003) in which he insisted that relationships are more likely to develop if the computer technology is represented using human.

Traditionally, many studies about e-learning adopt limited number of theories such as social cognitive theory (Bandura 1991), intrinsic motivation theory (Deci and Ryan 1985), theory of self-determination (Ryan and Deci 2004), theory of reasoned action (Fishbein and Ajzen 1975), media richness theory (Daft and Lengel 1986), and TDT (Moore 1980). Table 1 shows its summary.

<table>
<thead>
<tr>
<th>Authors (Year)</th>
<th>Main theme</th>
<th>Important variables</th>
<th>Underlying theory</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen et al. (2012)</td>
<td>Investigating the relative effectiveness of the 3-D virtual world learning environment and face-to-face learning environment when different instructional strategies (direct vs interactive) are used</td>
<td>Perceived learning, Classroom interactivity, Satisfaction</td>
<td>Transactional Distance Theory (Moore 1980) Media Richness Theory (Daft and Lengel 1986)</td>
<td>182 students from the college of business from a large Midwest U.S. university</td>
</tr>
<tr>
<td>Simmering et al. (2009)</td>
<td>Examining how subjects’ characteristics normally associate with effective training (i.e., initial motivation to learn and self-efficacy)</td>
<td>Computer Self-Efficacy, Motivation</td>
<td>Social Cognitive Theory (Bandura 1991)</td>
<td>190 students from a large university in the southeastern United States</td>
</tr>
<tr>
<td>Shroff et al. (2007)</td>
<td>Investigating how much learning activities and technologies affect intrinsic motivation in an online learning environment</td>
<td>Challenge, control, curiosity, engagement</td>
<td>Intrinsic Motivation Theory (Deci and Ryan 1985) Theory of Self-Determination (Ryan and Deci 2004)</td>
<td>Qualitative analysis of semi-structured interviews with students in an online MBA program.</td>
</tr>
<tr>
<td>Ho and Kuo (2009)</td>
<td>Eliciting the determinants of the IT professionals’ e-learning outcomes by investigating the effect of IT professionals’ computer attitudes on two personal outcomes (self-perceived flow experience and learning outcomes).</td>
<td>Computer attitude, Flow experience</td>
<td>Theory of Reasoned Action (Fishbein and Ajzen 1975)</td>
<td>239 questionnaire collected from 50 technological companies</td>
</tr>
</tbody>
</table>

Table 1. Underlying theories adopted by e-learning research

2.2 Transactional Distance Theory

In the process of e-learning, learners are physically separated from other learners, and instructor. Learners interact with instructor and respond to instructor's guides and direction of contents. TDT explicates how interaction affects learners’ psychological perceptions of distance (Moore 1980). Within the context of TDT, TD is basically caused by the physical separation between learners and instructor, and transformed into a psychological and communications gap, which represents a space of
potential misunderstanding between inputs of the instructor and those of the learner. Learning performance is maximized where TD is minimized. Therefore, e-learning should aim to shorten the TD by combining contents, learners, and instructor in a way of maximizing learners’ learning performance.

From the view of TDT, contents are referring to structure which is concerned with the elements of the course design. Also, interaction between instructor and learners is a dialogue (Moore 1980). Therefore, TD is determined by the status of dialogue and structure. In learning environments where the learner receives directions and guidance through both a high degree of structure of the course and a high degree of interactive dialogue, then there is a low level of TD. Alternatively, where learners make their own decisions about strategies and have little, if any, dialogue, there is a high level of TD (Kanuka et al. 2002).

This theory was further supported by empirical researches. Saba and Shearer (1994) tested a system dynamics model consisting of dialogue, structure, learner control, and instructor control. They found that TD generally decreases as dialogue and learner control increase and as teacher control and structure decrease. Bischoff et al. (1996) surveyed 221 students' perceptions of structure, dialogue, and TD in a distance education course mediated by interactive television. Results showed that "dialogue" and "transactional distance" were inversely proportional; that is, as dialogue increased, TD decreased. Bunker et al. (1996) tried to measure the effect of changes in structure on dialogue in an international, multicultural distance education course taught via audio-conferencing. The research setting was a course that brought together a virtual class of approximately 100 students at nine different sites located in four countries. They found that different types of question-asking behaviour had a role in predicting and determining dialogue (learner participation). Chen and Willits (1998) studied the experiences of 121 learners in a video conferencing environment. They found that dialogue reduces TD. They also noted that the relation between dialogue and TD depended on the type of dialogue involved and how TD was measured. Chen (2001) measured the impact of individual and instructional variables on learners' perceived TD in a World Wide Web learning environment. Seventy-one students participated in the study. Chen (2001) concluded that alternative measures of TD (i.e., objective measures and qualitative measures such as observation and interviews) will help expand our understanding of this phenomenon.

Though the review of the existing studies relating to the theory showed the use of a variety of functional definitions of TD that reveals an absence of consensus (Giossos et al. 2009), and tautology (Gorsky and Caspi 2005), the TDT has still values for the distance education researches (Garrison 2000; Jung 2001; Murphy and Collins 1997). Judging from the previous studies regarding the TDT, it seems clear that how to operationalize the TD typifies the nature of the study itself. The e-learning which is under consideration in this paper is a web-based distance education, and the TD can materialize in several formats depending on the characteristics of the three e-learning components like instructor, contents, and learner.

### 3 EXTENDED TRANSACTIONAL DISTANCE THEORY

#### 3.1 Overview

ETDT is a new interpretation of TDT from a perspective of interaction. The proposed ETDT has three premises. First premise is that learners engaged in e-learning activities are interacting with instructor and contents. Second premise is that learners perceive trust towards contents and instructor through interaction with them. Third premise of ETDT is that once trust is initiated among learners’ interaction with contents and instructor, then learners are naturally prompted to have more intention to participate in the e-learning activities by trying to obtain education information from the e-learning system, as well as respond to the e-learning guidelines by submitting his/her study results on time. Therefore, ETDT posits basically that interaction plays a crucial role in determining the learners’ e-learning performance.

Interaction has a deep root in sociology. Theory of Interaction was originally proposed by Thilly (1901), in which he argued that both mind and body are in an interactive mode, and therefore there
exists causal relationship between mind and body. At that time, such an argument was against the parallelism which had dominated for so long. However, the concept of interaction was refined by Simmel (1950), and effectively introduced into sociology. As long as a form of society lasts, it is quite natural that interaction among members essentially exists. Interaction is distinguished from mere action such that the latter refers to the doings of an agent, and the former indicates at least two agents acting upon one another, either reciprocal form or mutual form. First type of describing interaction was based on colliding billiard balls example (Park and Burgess 1924). Since this description of interaction is too crude, Mead (1934) refined notion of interaction by introducing a concept of symbolic interactionism which was coined by Herbert Blumer (1969). According to Mead (1934), a gesture becomes a significant symbol when it evokes within oneself the same incipient response (i.e., "meaning") that it does within the other(s) who observe that gesture. Symbolic interactionism positsthat people interact with each other by interpreting or defining each other's actions instead of merely reacting to each other's actions. Their response is not made directly to the actions of one another but instead is based on the meaning which they attach to such actions. Thus, human interaction is mediated by the use of symbols and signification, by interpretation, or by ascertaining the meaning of one another's actions (Blumer 1962, 1969).

Accordingly, in the context of e-learning, each element has its unique symbol and interacts with each other based on understanding of other's symbol. Instructor is supposed to direct, recommend, and help learners to learn from him/her and contents. Learners have a right to ask questions to instructor and obligation to follow instructions and guides by instructor and contents. Especially, dialogue between learners and instructor is well-guided and facilitated by the e-learning system, learners would be highly motivated to participate in the e-learning activities and feel satisfied a lot with education and training itself which is administered by the e-learning system.

3.2 Trust

One of the premises by ETDT is trust initiated by interaction between learners and instructor. When trust is built enough to encourage learners to follow instructor’s pedagogy and instructions, trust will play a role of antecedent for influencing learners’ intention to take part in the e-learning activities. When instructor is human, the level of interpersonal trust between learners and instructor becomes an issue of consideration (Morrison 2009). Trust has long been an important topic in the field of marketing, and information systems (Doney and Cannon 1997; McAllister 1995; Qiu and Benbasat 2009). A key component of any successful training or education effort is believability. To learn, students must perceive some level of trustworthiness in the information presented to them, regardless of who, or what, is the instructor (Morrison 2009). In contrast, the gravity of trust between learners and instructor did not receive proper attention from the e-learning researchers. Depending on the effectiveness of dialogue, avatar instructor can also exert trust to learners through interaction. Dialogue interaction between avatar instructor and learners will be influenced by the types of avatar such as attractive avatar and expert avatar (Holzwarth et al. 2006). Attractive avatars will be more influential in affecting learners when proper conditions for e-learning are set. In the meantime, expert avatars can have a significant impact on learners’ intention to study in an appropriate e-learning environment. Various types of avatar instructors have been studied in the field of e-learning. However, avatar trust which is believed to originate from learners through appropriate interactions between learners and avatar instructor is a new research issue deserving to be attempted.

In the e-learning environment, contents are also likely to receive trust from learners in accordance with its level of structure. Contents are composed of education materials which are deemed necessary for training the learners. According to the level of education, contents are organized in such a way of controlling its contents difficulty. Contents trust that learners perceive will change depending on the contents difficulty of contents and the quality of dialogue with instructor.
3.3 Intention

According to the third premise of ETDT, learners are assumed to possess intention towards the e-learning activities. In the web-based instruction environment, it was empirically proved that both facilitation and direction by instructor are influencing learners’ intention towards online participation (Jung et al. 2002). Perceived social interaction is a behavioural tendency displayed by an interactive IT user to cultivate and maintain online relationships with others via mutual communications. It has been found that the greater the degree of interactivity, the more likely the Web site will be considered a popular one, suggesting that the perceived social interaction may substantially influence online users’ pleasant experiences toward the IT, strengthening their satisfaction and usage intention (Lin et al. 2008). High satisfaction and usage intention are achieved through such an optimal experience of pleasant social interactions with online others. Similarly, the importance of social interaction in promoting user’s intention to use mobile TV was proven too (Choi et al. 2009).

4 RESEARCH MODEL

4.1 Basics

The proposed research model is basically based on using the ETDT mentioned in section 3. Also, we assume that the target e-learning system is using an avatar instructor instead of human instructor. Learner is supposed to interact with the avatar instructor and contents. Therefore, trust constructs are avatar trust and contents trust, and intentions basically mean participation intention. The proposed research model is simple. First, avatar trust is assumed to affect learners’ e-learning participation intention positively. Second, contents trust is also assumed to learners’ participation intention positively too. To add more rigor to experiment process, data will be segmented into four groups depending on the contents difficulty (easy vs. difficult) and the avatar type (attractive vs. expert).

4.2 Avatar Trust and Intention

In the context of e-learning, avatar instructor is playing as an information provider for the learners. In general, information providers possess a number of traits to draw information receivers’ attention-similarity, attractiveness, specialty, trustworthiness, accessibility, favorableness, and tenacity (Feick and Higie 1992). Among them, it is proven that information providers’ trustworthiness is the most important trait in persuading information receivers to adopt the provided information (McGinnies and Ward 1980). In the e-learning environment, learners are information receivers, while avatar instructor is an information provider. Based on the simple logic like this existing between information providers and receivers, we can easily conjecture that e-learning learners receive information provided by avatar instructor depending on avatar’s appearance.

This conjecture is justified again by Kelman (1961)’s explanation about the three processes of social influence and its affect on message recipient’s acceptance of a message. The first process focuses on the recipient’s identification with the communicator. In this case, the recipient adopts the attitude of the communicator through imitation or internalization of the message. The interpersonal attraction of the communicator is a prerequisite for motivating the recipient to adopt the communicator’s position. The second process concerns the recipient’s perceptions of the communicator’s credibility as a consequence of the expertise of the communicator and the trust that develops between the communicator and the recipient. In this case, the credibility of the communicator plays a key role in persuasion. The third process pertains to the compliance of the recipient. The recipient is more compliant if he or she feels controlled by the communicator and/or the communicator can provide rewards and punishments. When avatar instructor looks attractive, its social influence matches with the first process suggested by Kelman (1961). But when avatar instructor seems expert-like on a learning topic, its social influence is explained by the second process (Kelman 1961). Similar explanation can be found in online shopping areas. Holzwarth et al. (2006) claimed that consumers
show difference about satisfaction towards (avatar) sellers, attitude towards products, and purchase intention depending on the expert-like avatar sellers and attractive avatar sellers.

4.3 Contents Trust Intention

The importance of contents for the success of e-learning cannot be overemphasized. Especially, appropriateness and usefulness of e-learning contents are extremely crucial for improving e-learning performance (Haimerl and Fries 2009; Jung and Kim 2006; Peltier et al. 2007). For example, Haimerl and Fries (2009) verified the significant role of contents’ appropriateness in controlling learners’ learning performance. Contents quality was also an essential component as one of influential factors to affect learning effect.

E-learning can be described as a process of mutual interactions occurring among instructor and learners, and between contents and learners. If such interaction between learners and contents is effective in helping learners achieve what they intend to obtain from the e-learning activities, learners’ understanding and perspectives are changed accordingly (Moore 1989). In order to maximize such favourable change, it is needed to develop appropriate contents that fit learners’ level of education and aspiration (Jung and Kim 2006).

Moreover, when learners possess high level of contents trust, favourable change in learners’ understanding and perspective that e-learning contents intend to inspire will be likely much more. Basically, trust is the expectation that a person will match his/her words, keep his/her promise and perform certain work (or a role) well (Bhattacharya et al. 1998), a willing belief in a reliable exchange partner (Moorman et al. 1993), or a faith in and a goodwill to the object which one wants to believe in (Ganesan 1994; Kumar 1996). Therefore, trust plays an important role in facilitating interactions with each other. In other words, it can be considered that, the stronger the trust in the objects, the higher the tendency to establish an interrelationship. In a similar fashion, contents trust will facilitate learners’ favourable attitude towards contents and e-learning itself, leading to higher intention to participate e-learning activities required by contents and instructor as well.

5 EXPERIMENTS

5.1 Experimental Design

To add rigor to experiments, avatar instructor type was controlled to be classified into two types such as expert avatar and attractive avatar (Holzwarth et al. 2006), and contents difficulty was also categorized into two kinds such as difficult contents and easy contents (Campbell et al. 1987; Leach et al. 2001). Therefore, number of treatments used for experiment is four as shown in Table 2.

<table>
<thead>
<tr>
<th>Category</th>
<th>Expert Avatar</th>
<th>Attractive Avatar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy contents</td>
<td>Treatment 1</td>
<td>Treatment 2</td>
</tr>
<tr>
<td>Difficult contents</td>
<td>Treatment 3</td>
<td>Treatment 4</td>
</tr>
</tbody>
</table>

Table 2. 2x2 experimental design

Since our experiment should be based on an e-learning environment, a prototype is needed. For this purpose, we built a prototype e-learning website on a server. Related avatar instructor was invited from a well-known e-learning website, and related contents were also adapted from an established e-learning site. Detailed description is as follows.

5.1.1 Avatar instructor types

In line with social influence processes between communicator and message recipients (Kelman 1961), two types of avatar instructor were considered- attractive avatar and expert avatar. To secure validity about the finally chosen avatars, 12 types of male and female avatars (6 male avatars and 6 female avatars) were adapted from established e-learning companies. For the sake of pilot test, 40 people who are working in a system integration company and have experience in having taken e-learning courses
Before were invited to take a pilot survey test in which final avatar types to be used for the experiment are supposed to be determined. Survey participants were given an evaluation sheet and asked to mark their opinions about appropriateness of avatar types using 7-likert scale. Based on their responses about the 12 avatar types, one-way ANOVA test was performed- the most attractive avatar (Mean\textsubscript{male} = 5.7, S.D.\textsubscript{male} = 1.56, Mean\textsubscript{female} = 5.65, S.D.\textsubscript{female} = 1.61) and the most expert avatar (Mean\textsubscript{male} = 5.38, S.D.\textsubscript{male} = 1.29, Mean\textsubscript{female} = 5.78, S.D.\textsubscript{female} = 1.39). Then final four avatar types were selected-expert avatars (male and female) and attractive avatars (male and female). Figure 1 depicts avatar types.

![Avatar types](image)

**Figure 1. Avatar types**

We performed manipulation checks to see whether the avatar manipulations were effective to our research purpose. Participants perceived the attractive avatar (Mean = 4.53) as more attractive than the expert avatar (Mean = 3.97; F(1, 203) = 6.731, p < .05), and they perceived the expert avatar (Mean = 5.22) as expert-like than the attractive avatar (Mean = 4.89; F(1, 203) = 4.11, p < .05). Henceforth, avatar manipulations proved successful.

### 5.1.2 Contents difficulty

Target contents chosen for experiment are about “Java programming course” which was provided to learners as famous e-learning contents in Samsung Company. To control its difficulty, we consulted an e-learning administrator before determining its difficulty and asked him to recommend two parts of the contents- one is easy part, and the other is difficult part. Easy contents were about introduction to what Java programming is and how you can start with the Java programming. Difficult part was concerned with class inheritance which is typically known as one of difficult parts about Java programming. Then those two parts were tested against respondents to see whether they are aware of the contents difficulty correctly. For this purpose, ANCOVA test was adopted.

ANCOVA was used to test whether respondents were correctly aware of the difficulty level of the contents given to them during the survey process. Before ANCOVA test, enough caution was given to the fact that respondents’ experience about Java programming would not affect their perception of the contents difficulty. For this purpose, we had to make sure through F-test that there is no mutual interaction effect between respondents’ Java programming experience and contents difficulty. F-test results were that F = 2.016, p = 0.157 for difficult contents, and F = 0.232, p = 0.631 for easy contents. Therefore, we concluded that there was no mutual interaction effect between respondents’ experience about Java programming and their perception about contents difficulty. ANCOVA test results are summarized in Table 3, telling us that the manipulation of the contents difficulty is successfully valid. The respondents recognized the easy contents (Mean = 4.68) as easier than the difficult contents (M =...
3.98; p < 0.05), and the difficult contents (\(M = 4.09\)) as more difficult than the easy contents (\(M = 3.27; p < 0.01\)).

<table>
<thead>
<tr>
<th>Contents Complexity</th>
<th>Easy (n=113)</th>
<th>Difficult (n=92)</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy contents</td>
<td>4.68</td>
<td>3.98</td>
<td>5.573</td>
<td>&lt;0.05</td>
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<tr>
<td>Difficult contents</td>
<td>3.27</td>
<td>4.09</td>
<td>11.399</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Table 3. ANCOVA results for contents difficulty

5.1.3 Survey participants

Survey participants were invited from office workers who are employed by IT companies in South Korea where e-learning about various programming languages is rampant and popular among the workers. To promote participation, free gifts such as a notebook backpack and a ballpoint pen set were offered as an incentive to the participants. Total 219 participants joined the survey and were asked to experience our prototype e-learning website and answer the questionnaire online. After judging the quality of responses from number of incomplete answers, 205 responses were selected as final valid survey results. The demographic profile of the respondents is shown in Table 4. In summary, 83.9% of the respondents was male, and 16.1% female. 77.6% of the respondents was in their thirties. Regarding the Java programming experience, 54.1% was less than one-month, 17.1% one ~ six months, and 28.8% more than six months.

<table>
<thead>
<tr>
<th>Category</th>
<th>Treatment</th>
<th>Frequency</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>46 48 41 37</td>
<td>172</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>12 7 8</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>58 55 49 43</td>
<td>205</td>
</tr>
<tr>
<td>Age</td>
<td>21 ~ 30</td>
<td>15 11 14 6</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>31 ~ 40</td>
<td>43 44 35 37</td>
<td>159</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>58 55 49 43</td>
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</tr>
<tr>
<td>Occupation</td>
<td>Office worker</td>
<td>33 37 33 31</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td>Professional</td>
<td>25 18 16 12</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>58 55 49 43</td>
<td>205</td>
</tr>
<tr>
<td>Java Programming Experience</td>
<td>Less than 1 month</td>
<td>30 31 29 21</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Less than 6 months</td>
<td>12 7 5 11</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Less than 1 year</td>
<td>8 2 5 5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Less than 3 years</td>
<td>3 4 4 0</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Less than 5 years</td>
<td>3 7 3 2</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Less than 10 years</td>
<td>2 4 2 2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Above 10 years</td>
<td>0 0 1 2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>58 55 49 43</td>
<td>205</td>
</tr>
</tbody>
</table>

Table 4. Demographic information of survey participants

5.1.4 Survey procedures

A participant was given one of the four treatments (2 avatar types x 2 contents difficulty) on a random basis. Each experiment is framed to have the same quality but different avatar type and content difficulty. Participant was required to study the given contents for one or two minutes before answering the survey questionnaire. Then respondent is asked to fill in the questionnaire survey in
which there are items asking about avatar trust, contents trust, and e-learning participation intention. Figure 2 shows a snapshot of each experiment treatment. To help respondents check their participation intention, provided were supplementary materials such as lecture-related tips, FAQs, and on-line quiz at the end of contents.

![Figure 2. Snapshot of four treatments](image)

**5.1.5 Measurements**

All the items used to measure the three constructs such as participation intention, avatar trust, and contents trust were adapted from reliable literature. First of all, PI or participation intention was measured with items adapted from BGI (behavior to give information) studies which have been extensively studied in the virtual communities (Ridings et al. 2002; Straub et al. 1995; Wang and Fesenmaier 2004). Though sub-dimensions of trust are versatile (Butler 1991; McKnight et al. 2002; Schindler and Thomas 1993), it can be majorly classified into the three ones such as ability, benevolence, and integrity (Bhattacherjee 2002; Mayer et al. 1995). In line with this, avatar trust is defined as trust towards avatar instructor’s ability, and contents trust as trust towards contents’ quality and its benevolence. Item was measured on a 7-point likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Table 5 summarizes the three constructs and related items.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Operational definition</th>
<th>Measurement items</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation Intention</td>
<td>Learners’ intention to participate in the e-learning activities</td>
<td>PI1 Tired to check TIP or FAQ on learning contents through mouse click</td>
<td>Adapted from Ridings et al. (2002), Straub et al. (1995), Wang and Fesenmaier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PI2 Tired to check TIP or FAQ on learning contents given by each screen through mouse click</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PI3 Tired to obtain the information given in a lecture</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Summarizes the three constructs and related items.
Table 5. Measurement items

5.2 Results

5.2.1 Measurement model

Partial least squares (PLS), a second-generation causal modeling technique (Chin 1998; Fornell 1982; Wold 1982), was used to test the research model. First of all, the measurement model was tested. For this purpose, internal consistency of the instrument items was calculated as shown in Table 6. All the reliability measures were 0.8 or higher, well above the recommended level of 0.70, indicating adequate internal consistency (Nunnally 1978). Convergent validity is therefore adequate when constructs have an average variance extracted (AVE) of at least 0.5 (Fornell and Larcker 1981). For discriminant validity to be significant, the AVE from the construct should be greater than the variance shared between the construct and other constructs in the model (Chin 1998). Table 7 lists the correlation matrix, with correlations among constructs and the square root of AVE on the diagonal. In all cases, the AVE for each construct is larger than the correlation of that construct with all other constructs in the model.

Table 6. Convergent validity

Table 7. Discriminant validity
5.2.2 Path analysis by treatments

TD for each treatment was calculated to suggest meaningful implications for practitioners as well as academicians. Table 8 shows a summary of TD values for each treatment. From Table 8, it is clear that once if learners come to perceive either avatar trust or contents trust, the e-learning environment where an expert avatar instructor is combined with easy contents guarantees lesser TD, i.e. better e-learning performance (see that TD_{CT.PI} and TD_{AT.PI} are largest in Treatment 1 compared with those in other Treatments). When learners, however, have to study difficult contents, it is more effective to use the attractive avatar instructor in order for the learners to gain better e-learning performance. This is because related TDs of expert avatar are large with regards to comparing TD_{CT.PI}s of avatar style in difficult contents (i.e., Treatment 4 vs Treatment 4).

<table>
<thead>
<tr>
<th>TD type</th>
<th>Treatment 1 (easy/expert)</th>
<th>Treatment 2 (easy/attractive)</th>
<th>Treatment 3 (difficult/expert)</th>
<th>Treatment 4 (difficult/attractive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD_{CT.PI}</td>
<td>0.508***</td>
<td>0.380**</td>
<td>0.267*</td>
<td>0.393***</td>
</tr>
<tr>
<td>TD_{AT.PI}</td>
<td>0.412***</td>
<td>0.247*</td>
<td>0.268*</td>
<td>0.310*</td>
</tr>
</tbody>
</table>

*p<0.10, **p<0.05, ***p<0.01

Table 8. TD values for each treatment

5.3 Implications and Discussion

Experiment results suggests that the proposed ETDT can provide sound basis for analyzing the process in which the interaction occurring in the e-learning environment influences learner's learning performance. Besides, unlike traditional TDT where the process about how to determine TD remained unclear, the ETDT suggests the process of measuring TD and investigating how structure and dialogue influence TD in a specific situation. TD, which was defined in this study, has a strong explanatory power as to the learning performance in the e-learning environment. As noted in the experiment procedures, TD was measured, not by learner's self-reporting method, by the assessment of trust and intention which is believed to be influenced by interaction. However, it is noteworthy to mention that values of TD_{AT.PI} and TD_{CT.PI} must be interpreted with caution. In other words, high TD_{AT.PI} indicates that TD between avatar instructor and learner is small. On the contrary, low TD_{CT.PI} means that the TD between contents and learner is large.

However, it is necessary for the avatar types used for this study to be checked carefully in other cultures in order to ascertain the generalizability of the results above. Depending on the culture and situations, users' perceived assessment of the avatars may vary. Therefore, future study can be done in this way of overcoming the limitation.

6 CONCLUSION

This study has a number of contributions. First, we extended TDT (Moore and Kearsley 1996), suggesting Extended TDT where trust and participation intention are considered. Second, the two types of interaction such as Instructor-Learner and Contents-Learner are analyzed with trust and participation intention considered. In this sense, TD was statistically determined through a path coefficient from trust to participation intention, which is another contribution. Third, the proposed ETDT is able to explain reasons why TD reduces or increases in some e-learning situations. Original TDT claims that TD is affected by structure of contents and dialogue between learners and instructor, and learners and learners. In the case that TD increases even when contents are highly structured and dialogue between learners and instructor is rich, it is almost impossible to explain its reasons. However, the ETDT can provide reasons by using trust and participation intention. Fourth, ETDT can provide a reliable ground on which TD is computed.
References

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