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Learner Acceptance of a Multimedia-Based Learning System

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The present study applied the technology acceptance model to examine the determinants leading to learners' behavioral intention to use a multimedia-based learning system. Four exogenous constructs—multimedia self-efficacy, perceived richness of multimedia presentation, perceived learner control, and perceived system responsiveness—were externally added to the framework to improve its predictive power for the specific behavioral context. In addition, the second-order construct of cognitive engagement was created based upon the dimensions of curiosity, attention focus, and interest and was subsequently incorporated into the framework. The hypothesized conceptual framework was validated using sample data collected from 286 respondents who completed an online survey instrument. Results from structural equation analysis revealed that (a) behavioral intention was jointly determined by attitude and perceived usefulness; (b) attitude was jointly determined by perceived usefulness and cognitive engagement; (c) multimedia self-efficacy, perceived richness of multimedia presentation, and cognitive engagement were immediate antecedents to perceived usefulness; and (d) cognitive engagement was a key intervening variable linking the four exogenous constructs with perceived usefulness.

1. INTRODUCTION

Over the past decades, multimedia-based learning (MBL) has been one of the most widely studied and growing fields in human–computer interaction literature (Hoogeveen, 1997; Kim, Steinfield, & Whitten, 2009). The term refers to learning through the concurrent use of various educational modules, including text, pictures, animation, movies, sound clips, and interactive applications (Pastore, 2010). Quite extensive efforts have been made to provide insights into educational and cognitive underpinnings of learning with multimedia (e.g., Allen, Bourhis, Burrell, & Mabry, 2002; R. C. Clark & Mayer, 2003; D. Y. Lee & Shin, 2011).

A weakness in the literature is the scarcity of empirical documentation regarding learner acceptance of the multimedia-based learning system (MBLS). The present study defines "learner acceptance of a MBLS" as a learner's demonstrable willingness to employ such a system for learning (Dillon & Morris, 1996; Teo & Schaik, 2012). It has been stated that this acceptance is one of the crucial factors leading to the success or failure of a MBLS. This is a seemingly logical statement because, though the potential of multimedia as a tool for enhancing learning is presumably compelling (Shah & Freedman, 2003), its value is guaranteed only when learners accept to use it (Teo, 2011). In response, the present study performs research to investigate potential determinants leading to learners' behavioral intentions to use an MBLS.

Given the nature of technology-driven MBLS, a conceptual framework of the technology acceptance model (TAM; Davis, 1989) seems particularly appropriate for the present study. The TAM has been applied to a wide variety of settings to help understand user acceptance of computer technologies and information systems. Notably, the predictive power of the TAM is expected to vary across different domains and situations (McFarland & Hamilton, 2006). A substantial volume of empirical work has incorporated domain-specific external variables into the TAM in a complementary manner to better understand users' deliberate acceptance behaviors (Venkatesh, 2000; Venkatesh & Davis, 2000).

In the present study, findings from educational, cognitive, and social theories provide the basis for the addition of four external variables—multimedia self-efficacy, perceived richness of multimedia presentation, perceived learner control, and perceived system responsiveness—to the TAM. In addition, cognitive engagement was incorporated as a second-order variable dimensionalized by curiosity, attention focus, and interest. The conceptual framework underlying the present study is presented in Figure 1.

This article begins with a detailed review of the TAM along with several external variables and their implications in the context of MBL. These discussions directly lead to the development

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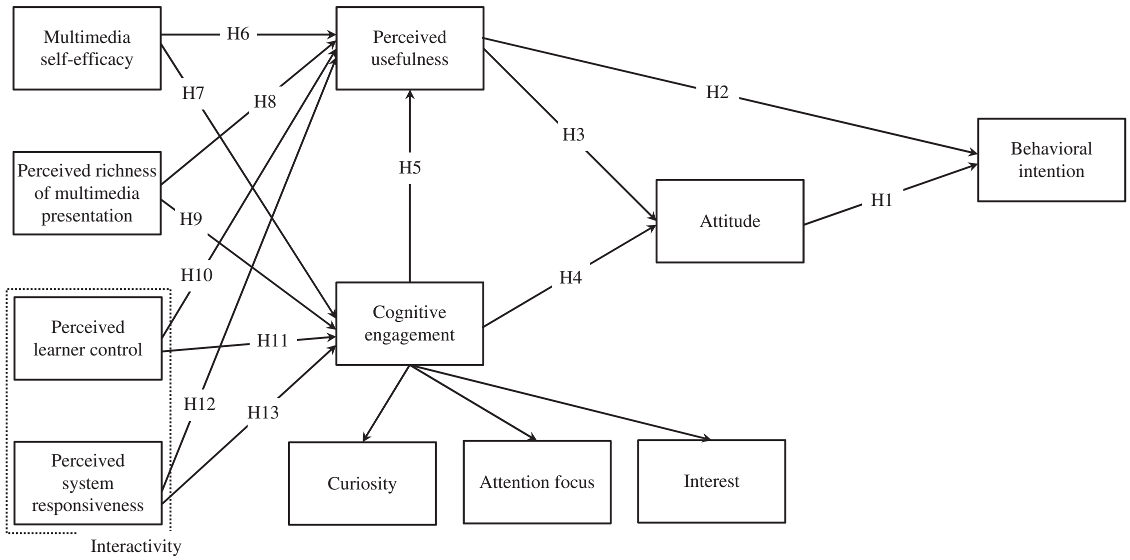

FIG. 1. Proposed conceptual framework for learner acceptance of a multimedia-based learning system.

of a conceptual framework and a series of research hypotheses presented in the text that follows. The methodologies and statistical data analysis are presented. Finally, the results of this study are presented, followed by a discussion, conclusions, and limitations.

2. LITERATURE REVIEW AND DEVELOPMENT OF RESEARCH HYPOTHESES

2.1. Technology Acceptance Model

The TAM has its theoretical basis in the theory of reasoned action (TRA; Ajzen & Fishbein, 1980). According to the TRA, the likelihood of performing the target behavior is determined by the behavioral intention to do so. The TAM adapted the TRA to explain a domain of user acceptance of an information system or computer technology (Davis, 1989). A central feature of the TAM is that user acceptance of a technology is directly determined by the user's behavioral intention to use the technology. The TAM further hypothesizes that attitudes toward the technology—the user's judgments as to whether using the technology is favorable or unfavorable—serve as the basis of whether the user intends to use the technology. In the TAM, the user's attitudes are jointly determined by beliefs that the technology is useful and easy to use. These two behavioral beliefs—perceived usefulness and perceived ease of use—refer to "the degree to which a person believes that using a particular system would enhance his or her job performance" and "the degree to which a person believes that using a particular system would be free of effort," respectively (Davis, 1989, p. 320). The TAM postulates that perceived usefulness has an immediate effect on behavioral intention, whereas perceived ease of use has an indirect effect on behavioral intention by impacting perceived usefulness. Simply stated, a technology or information system that is easy to use and is useful will lead to a positive attitude and behavioral intention for its use.

The TAM has received much attention in research into user acceptance of technology due to its easy applicability, understandability, simplicity, and parsimony (Chau, 1996). It is important to note that the influence of domain-specific or usage-context factors has been assessed by incorporating external variables into the original version of the TAM (Straub, 2009; Venkatesh, 2000; Venkatesh & Davis, 2000).

Contrary to the conventional expectation from the TAM, however, the construct of perceived ease of use has shown inconsistent and less significant effects on determinants of user acceptance (Agarwal & Prasad, 1997; M. K. O. Lee, Cheung, & Chen, 2005; Szajna, 1994). For instance, Chau and Hu (2001) stated that "contrary to the assertion of TAM and the findings reported by some prior research (e.g., Venkatesh, 1999), perceived ease of use was not found to have any significant effects on perceived usefulness or attitude" (p. 712). This may be a case in which individuals perceive that a technology is useful but not easy to use, implying that perceived benefits of the technology usage are related to the perceived effort that they exert on the technology (Davis, 1989). Davis, Bagozzi, and Warshaw (1992) and Serenko, Bontis, and Detlor (2007) noted that the effect of perceived ease of use on behavioral intention is likely to be mediated by both extrinsic motivation and intrinsic motivation when these two variables are explicitly involved in TAM. The present study thus does not include the construct of perceived ease of use in predicting the behavioral intention (Chin, Marcolin, & Newsted, 2003).

Linking attitude to behavioral intention. In the present study, attitude is operationally defined as learner judgment as to whether learning with multimedia is favorable or unfavorable. An important assumption in the TAM is that a user's usage behavior of a given information system is under volitional control (Yen, Wu, Chen, & Huang, 2010). A volitional setting exists where a user perceives use of the system to be a willful choice (Teo, 2010). On the other hand, a mandatory or nonvoluntary setting (i.e., workplace or organization) is where the use of technology is perceived by the user to be compulsory (Sukkar & Hasan, 2005). Attitude-behavioral intention relationship in the TAM has been found to be strong when a user feels that he or she has a choice of whether or not to use the technology (Teo, 2009; Winter, Chudoba, & Gutek, 1998). Learning with multimedia technology should reflect the volitional control or voluntary behavior of a learner, and this should be related to the proposition as to whether the user is free to implement acceptance or rejection decision. Culpan (1995) noted that, no matter how capable and sophisticated the technology, its effective implementation largely depends on users having a positive attitude toward its use. It seems logical to predict that positive or negative attitudes toward learning with an MBLS should lead to greater or lesser behavioral intention to learn with multimedia, respectively. Thus, the present study formulates the following hypothesis:

H1: Attitude toward using an MBLS positively affects the behavioral intention to use the MBLS.

Linking perceived usefulness to behavioral intention. A relationship of perceived usefulness with behavioral intention is based upon the assumption that behavioral intention to use an information system is influenced by the expected improvement in job performance regardless of attitude (Davis, 1989). Perceived usefulness also represents extrinsic motivation (M. K. O. Lee et al., 2005), which refers to performance of a goal-driven activity that leads to achievement or reward (Ryan & Deci, 2000; Thong, Hong, & Tam, 2006). Law, Lee, and Yu (2010) investigated the effect of motivation in an e-learning environment and found that constructs of extrinsic motivation had a significant effect on learning performance among undergraduate students. In the case of an MBLS, usefulness is a general perception about the effectiveness and efficiency of learning with multimedia technology in the provision of instructional interventions. Hence, the perceived usefulness in the present study can be understood as a particular expected value of a MBLS for enhancing learning performance (Davis, 1989). Perceived usefulness has consistently proven to be a robust determinant of behavioral intention to use a technology (Karaali, Gumussoy, & Calisir, 2011; M. K. O. Lee et al., 2005). It is expected that the higher the degree of perceived usefulness, the stronger the behavioral intention for learners to use the MBLS.

H2: Perceived usefulness of an MBLS positively affects the behavioral intention for its use.

Linking perceived usefulness to attitude. The hypothetical relationship between perceived usefulness and attitude is justified by the expectancy-value model underlying the TRA (Davis, 1993; Fishbein & Ajzen, 1975). The assumption in the model is that individuals are goal oriented and choose behaviors based on the expected outcome and the values attributed to the outcome. In the model, attitude formation is an iterative process by which the subjective evaluations of a given outcome (values) determine the attitude in proportion to the strength of salient beliefs (expectations; Armitage & Conner, 2001). For example, if individuals believe that adoption of a technology meets their expectations for improving job performance, they then develop a positive attitude toward the technology (LaRose & Atkin, 1991). In particular, a recent meta-analysis of e-learning technology acceptance conducted by Šumak, Heričko, and Pušnik (2011) reveals a high coefficient value for the influence of perceived usefulness on attitude. The following hypothesis is developed:

H3: Perceived usefulness of a MBLS positively affects attitude toward using the MBLS.

2.2. Intrinsic Motivation—Cognitive Engagement

Intrinsic motivation is a necessary precondition to learning progress, leading to desired learning achievement (Patrick, Ryan, & Kaplan, 2007; Sansone, Fraughton, Zachary, Butner, & Heiner, 2011). It denotes an inherent motivator to engage in activity for its own sake, without external rewards or reinforcements (e.g., extrinsic motivation; Pintrich, Schunk, & Meece, 2008; Ryan & Deci, 2000). Numerous studies have demonstrated that the degree to which the educational setting facilitates intrinsic motivation plays a significant role in promoting the success of the mode of learning (Davies, 2002; Paulus, Horvitz, & Shi, 2006). Within motivation literature, cognitive engagement is one important outcome of intrinsic motivation (Walker, Greene, & Mansell, 2006) and has been measured on the basis of the multidimensional constructs of curiosity, attention focus, and interest (Webster & Hackley, 1997; Webster & Ho, 1997). The distinction between curiosity and interest is that the former is characterized by "a desire for new information or experience afforded by new media environments" (Arnone, Small, Chauncey, & McKenna, 2011, p. 185), whereas the latter concerns "whether the learner's curiosity is aroused, and whether this arousal is sustained appropriately over time" (Keller, 1983, p. 395). The relation between curiosity and interest is sustained by attention focus (Webster, Trevino, & Ryan, 1993). To summarize, triggered curiosity is supposed to maintain interest through effortless attention, ultimately leading to cognitive engagement (Arnone et al., 2011).

Linking cognitive engagement to attitude. The present study conceptualizes intrinsic motivation as cognitive engagement that learners experience as they interact with an MBLS. Webster and Hackley (1997) revealed a significant and positive correlation between attitude toward using multimedia technology for distance learning and engagement that was assessed by the measures of curiosity, attention focus, and interest. The mechanism of attitudinal consistency (Conner & Armitage,

1998) using the theories of self-perception (Bem, 1972) and cognitive dissonance (Festinger, 1976) may be appropriate in justifying the relationship. The basic idea is that people tend to rationalize their actions through cognitive dissonance reduction (Agarwal & Karahanna, 2000).

For example, people may need to resolve an inconsistent cognitive gap between attitude and experience when their behavior contradicts their attitude. To reduce the psychological incompatibility, they may change their attitude but not their behavior (Smith & Hogg, 2008). In cases where learners experience cognitive engagement through the use of MBLS where they are intrinsically committed to learning, an attempt is then likely to be made to change their attitude accordingly as a result of subjective assessment of their behavior. In the TAM setting, the attitudinal consistency mechanism was articulated by an earlier study (Agarwal & Karahanna, 2010) in which the authors tried to justify the causal relationship of cognitive absorption to perceived usefulness. The relevance of the theories also seems to lie in understanding the relationship between cognitive engagement and attitude. Based on these discussions, the following hypothesis is developed:

H4: Cognitive engagement with an MBLS positively affects one's attitude toward its use.

Linking cognitive engagement to perceived usefulness. Past studies on the TAM examined the effect of intrinsic motivation on perceived usefulness. H. H. Chang and Wang (2008) found that intrinsic motivation conceptualized as flow was a significant predictor of the perceived usefulness of an online communication tool. The observed pattern is similar to the findings of Agarwal and Karahanna (2000) and Saadé and Bahli (2005), in which a multidimensional construct of cognitive absorption significantly influenced perceived usefulness. Research has indicated that intrinsically motivated people are likely to demonstrate the behaviors of concentration and investment, as well as effective and productive activities (Csikszentmihalyi, 1990; Jablon & Wilkinson, 2006). Perceived usefulness is a construct associated with assessment of the extent to which people believe that effectiveness and productivity of their activities will be enhanced by using a technology (Yi & Hwang, 2003). In this regard, learners intrinsically motivated with an MBLS may perceive the MBLS as being useful to improve their learning performance.

H5: Cognitive engagement with a MBLS positively affects its perceived usefulness.

2.3. Multimedia Self-Efficacy

According to Wood and Bandura (1989), self-efficacy refers to "beliefs in one's capabilities to mobilise the motivation, cognitive resources, and courses of action needed to meet given situational demands" (p. 408). The concept concerns one's self-assessed, judged, or perceived ability to perform a particular behavior. The basic principle behind self-efficacy is that an individual possessing a high level of self-efficacy for a given activity is more likely to engage in that activity based on the associated positive perceptions (Thatcher & Perrewé, 2002). Based on this conceptualization, it is clear that self-efficacy is of central importance to acceptance behavior, such that an individual must feel confident in using information systems or technologies in order to effectively employ them (Kinzie, Delcourt, & Powers, 1994).

The construct of self-efficacy has been refined to explain user acceptance of a particular domain varying across tasks and situations. In particular, research has indicated that a specialized construct of self-efficacy that matches the desired task performance criteria is a better predictor of performance outcome than is a general self-efficacy measure (Agarwal, Sambamurthy, & Stair, 2000; Fagan, Neill, & Wooldridge, 2003). Within the domain of computer-based or e-learning, computer self-efficacy has been found to have a significant impact on learner acceptance (S.-C. Chang & Tung, 2008; Roca & Gagné, 2008). More important, Christoph, Schoenfeld, and Tansky (1998) conceptualized "multimedia self-efficacy" as a specialized construct of self-efficacy concerning the use of multimedia-based training. The authors defined "multimedia self-efficacy" as "a self-assessment of one's capability to understand and learn from multimedia-based training" (Christoph et al., 1998, p. 29). Although their study did not build upon the TAM, it implies that low levels of multimedia self-efficacy may act as a barrier to acceptance of a MBLS.

Linking multimedia self-efficacy to perceived usefulness. The present study operationalizes multimedia self-efficacy as learner confidence in the abilities to use an MBLS in the accomplishment of a learning goal (Bandura, 1986; Compeau & Higgins, 1995). Self-efficacy is closely related to the concept of efficacy expectation (Igbaria & Iivari, 1995). In contrast, outcome expectation is defined as an individual's beliefs about possible consequences of his or her action (Bandura, 1997). It is important to note that efficacy expectation alone does not produce the desired performance, but it does have a high probability of predicting outcome expectation if the outcome is determined by the performance (Bandura, 1997). Perceived usefulness is regarded as a specific measure of outcome expectation in the TAM (Niederhauser & Perkmen, 2010). Computer self-efficacy has consistently been found to be predictive of perceived usefulness (Hasan, 2006; Hsu et al., 2009). However, this relationship has not been widely tested in learner acceptance literature. With regard to an MBLS, multimedia self-efficacy may reflect an important determinant of perceived usefulness. For example, learners should have a certain perception of capabilities to deal with an MBLS to expect positive outcomes from the usage. In addition, computer and multimedia ability are factors affecting self-efficacy, so it is reasonable to expect that the relationship identified in past studies should be also applied in an MBLS setting.

H6: Multimedia self-efficacy positively affects perceived usefulness of an MBLS.

Linking multimedia self-efficacy to cognitive engagement. The literature suggests that self-efficacy is an important source of intrinsic motivation. Pintrich et al. (2008) stated that learners with high self-efficacy are more likely to engage in learning. Shapka and Ferrari (2003) noted that, because low self-efficacy reflects unpleasant feelings and anxiety, low computer self-efficacy may result in disengagement from using computers. In the study of Walker et al. (2006), self-efficacy was found to have a significant correlation with the measure of intrinsic motivation in college students. Of interest, several studies have investigated the influence of intrinsic motivation on self-efficacy in a TAM setting (Yi & Hwang, 2003). For example, Scott and Walczak (2009) found that cognitive engagement measured by individual perceptions of curiosity, interest, and attention focus had a direct effect on the measure of computer self-efficacy of a multimedia ERP training tool. However, our present study is particularly interested in examining the proposition that the sense of self-efficacy in using multimedia will heighten perceptions of cognitive engagement. In other words, multimedia self-efficacy is proposed as a prerequisite for learners to experience cognitive engagement while using an MBLS. Thus, the following hypothesis is developed:

H7: Multimedia self-efficacy positively affects cognitive engagement with an MBLS.

2.4. Perceived Richness of Multimedia Presentation

Learner acceptance of an MBLS can be assessed by the perceived richness of information media that they deliver. Strauss and Frost (1999) proposed that the level of media richness or "capacity to process rich information" (Daft & Lengel, 1986, p. 560) is one of the key factors that influence instructional technology selection. Indeed, probably the most powerful feature provided by multimedia is its capability to encompass a variety of mode and modality combinations when presenting information. As noted earlier, multimedia technology integrates a wide array of text, graphics, animation, sound, and other digital media into a single package in a manner appropriate for the specific learning goals. The superiority of the multiple media format to the single format has been justified in several cognitive theoretical frameworks (J. M. Clark & Paivio, 1991; Mayer, 2005). The premise is based upon an assumption that the greater is the stimulation and media involved, the easier it is to learn.

Linking perceived richness of multimedia presentation to perceived usefulness

Empirical studies of user acceptance have examined the effect of perceived richness of media on perceived usefulness. For example, studies using the framework of media richness theory (Daft & Lengel, 1986) have found significant relationships in the Blackboard system (S.-H. Liu, Liao, & Pratt, 2009) and blog and podcast settings (Saeed, Yang, & Sinnappan, 2010). An MBL tool may be perceived as a less rich medium than face-to-face instruction (Webster & Hackley, 1997). However, it cannot be so "lean" because it offers multiple forms of verbal and nonverbal cues, in which the greatest amount of learning can be accomplished (Harris & Hartman, 2002). Because usefulness is related to the quality of instructional content in an educational setting (Joo, Lim, & Kim, 2011), the following hypothesis is developed:

H8: Perceived richness of multimedia presentation positively affects perceived usefulness of the MBLS.

Linking perceived richness of multimedia presentation to cognitive engagement. Perception of multimedia richness has been found to influence several important aspects of intrinsic motivation. For example, S.-H. Liu et al. (2009) argued that learners are motivated by curiosity afforded by rich media. Chapman et al. (1999) stated that a multimedia system captures learner attention. In Park and Lim's (2007) work, learners receiving multiple presentations of information reported favorable perceived interest toward the instructional material. Webster and Ho (1997) found that providing more features of multimedia (e.g., variety of representation) is more likely to keep learners engaged in learning than is multimedia designed to provide fewer of those features. Taken together, the use of multimedia seems to provide incentive for learners' intrinsic motivation. It is thus expected that the richer a multimedia presentation is perceived to be, the more likely it is that learners will experience cognitive engagement with the MBLS.

H9: Perceived richness of multimedia presentation positively affects cognitive engagement with the MBLS.

2.5. Perceived Interactivity—Perceived Learner Control and Perceived System Responsiveness

Within an MBL environment, interactivity is initiated by instructional treatment in which two-way communication occurs between the learner and multimedia technology (Hoffman & Novak, 1996; Siau, Sheng, & Nah, 2006). The description and interpretation of interactivity have rarely been clarified in the literature. However, a close review of past studies indicates that two separate elements of learner control and system responsiveness are highly ranked among factors explaining interactivity (Kettanurak, Ramamurthy, & Haseman, 2001; Moreno & Mayer, 2007). Wu (1999) described perceived interactivity as "a two-component construct consisting of navigation and responsiveness" (p. 255). It is the former case where learners are given control over navigating instructional materials, encouraging them to construct their own understanding or cognitive model of the information presented (Kennedy, 2004). On the other hand, system responsiveness reflects the degree to which a learning system offers feedback in response to learner requests in bidirectional communication channels (Moreno & Mayer, 2007). Chou (2003) described interactivity as "a continuous variable measuring how actively responsive a medium is to users" (p. 266). For example, an essence of the ability includes informative feedback of multimedia objects to be presented in a direct or instant fashion (Downes & McMillan, 2000; Kiousis, 2002).

Linking perceived learner control and perceived system responsiveness to perceived usefulness. Selim (2007) attempted to categorize the factors of success of e-learning acceptance and found that one of the success factors was learner's perception of interactivity. From a learner acceptance perspective, earlier studies indicate that interactivity is highly valued by learners. Shen and Chuang (2009) demonstrated the significant role of interactivity in determining the perceived usefulness in the TAM framework of a whiteboard technology environment. Their measurement of interactivity included the constructs of control and responsiveness, which are similar to the two-dimensional approaches discussed in our study. The result is in line with the work of Pituch and Lee (2006), in which the authors observed the positive effects of system response on perceived usefulness of an e-learning system. Their measure of system response involved the degree to which the system's responsiveness to learner inquiries is fast, consistent, and reasonable (Pituch & Lee, 2006). A high level of interactivity is considered to be desirable for effectiveness of technology-mediated learning (Berge, 2002; Proske, Narciss, & Körndle, 2007). Our study proposes that perceived interactivity is a key determinant influencing the perceived usefulness of an MBLS.

H10: Perceived learner control of an MBLS positively affects its perceived usefulness.
H11: Perceived system responsiveness of an MBLS positively affects its perceived usefulness.

Linking perceived learner control and perceived system responsiveness to cognitive engagement. Not surprisingly, interactivity has been highly cited as a technology affordance that promotes intrinsic motivation in learning (Liaw, 2008; Northrup, 2001; Renkl & Atkinson, 2007). Muthukumar (2005) argued that features of interactivity should be designed for the multimedia learning system to provide learners with an incentive for engaging in learning. An example is the case in which the link between interactivity and cognitive engagement is the effect of speed or quality of system response on learner attention. Although the positive effect of perceived interactivity on cognitive engagement may seem to be quite intuitive, empirical evidence of the relationship has not been shown in any previous studies. The following two hypotheses are proposed:

H12: Perceived learner control of an MBLS positively affects its cognitive engagement.
H13: Perceived system responsiveness of an MBLS positively affects its cognitive engagement.

3. RESEARCH METHODOLOGY

3.1. Development of Measurement Instrument

A structured survey questionnaire was developed to collect data. Our conceptual framework included 10 first-order constructs: behavioral intention, attitude, perceived usefulness, multimedia self-efficacy, curiosity, attention focus, interest, perceived richness of multimedia presentation, perceived learner control, and perceived system responsiveness. Most of the measurements of the constructs were adapted from validated scales of previous TAM or related studies. One exception included two self-constructed items for the measurement of perceived richness of multimedia presentation. The items for each construct were carefully reworded to reflect the specific context of MBL. Attitude was assessed as the mean of four items on the 7-point semantic differential scale, whereas all other constructs were assessed as the mean of three to six items on the 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Three items were reverse-worded to minimize response bias. Table 1 presents the measurement instrument used in the present study.

The measurement instruments were reviewed and purified by three domain experts to identify problems in the questionnaire design. Based on their feedback, several items were revised with respect to wording, content, and organization in order to promote clear comprehension. Prior to the main survey, a convenient sample of 36 graduate students in Korea University were administered a pilot survey. The results of the internal consistency test indicated that Cronbach's alpha coefficients calculated for all subscales for each construct ranged from 0.712 to 0.878, indicative of acceptable fit (DeVellis, 2003). No further changes were made to the items.

3.2. Data Collection

The present study involved online survey research. The target sample was a selection of South Korean undergraduate students aged 19 to 25 years who had at least three experiences with an MBLS. A criterion for selecting a target MBLS was an electronic encyclopedia on CD-ROMs. The sample was drawn from a commercial survey agency.[1] An English version of the questionnaire was translated into Korean. An invitation to participate in the survey was randomly e-mailed to 15,306 qualified individuals. A total of 3,232 individuals accessed the online survey, and 360 individuals completed the survey. An important criterion for selecting the target sample was that respondents be able to make a distinction between e-learning and MBL. The terms *e-learning* and *multimedia-based learning* have often been used interchangeably. However, a distinction can be made such that not all e-learning applications or systems are necessarily MBLSs. All respondents were given four statements and

[1]The survey agency Embrain Co., LTD (http://www.embrain.com) administered the online survey from January 9 to 13, 2012.

TABLE 1
Measurement Instrument: Descriptions of Constructs, Items, and References

Description of Construct/Item	Reference
Behavioral intention	Shin (2007)
BI1: I intend to use an MBLS in the future.	
BI2: I intend to use an MBLS as much as possible.	
BI3: I recommend others use an MBLS.	
BI4: I intend to continue using an MBLS in the future.	
Attitude	Lee et al. (2005)
ATT1: The idea of using an MBLS is (very bad/very good).	
ATT2: Using an MBLS would be (very unpleasant/very pleasant).	
ATT3: The idea of using an MBLS is (very wise/very foolish).[a]	
ATT4: Using an MBLS is an idea that I (dislike very much/like very much).	
Perceived usefulness	Pituch & Lee (2006)
PU1: Using an MBLS will allow me to accomplish learning tasks more quickly.	
PU2: Using an MBLS will improve my learning performance.	
PU3: Using an MBLS will make it easier to learn course content.	
PU4: Using an MBLS will increase my learning productivity.	
PU5: Using an MBLS will enhance my effectiveness in learning.	
PU6: I find an MBLS useful in my learning.	
Multimedia self-efficacy	Ong & Lai (2006),
I could complete my learning activities using an MBLS . . .	Sánchez & Hueros
MSE1: . . . if I had never used a system like it before.	(2010),
MSE2: . . . if I had only the system manuals for reference.	Christoph et al. (1998)
MSE3: . . . if I had seen someone else using it before trying it myself.	
MSE4: I can use an MBLS without needing to be told how it functions.	
MSE5: Overall, I am familiar with the concept of an MBLS.	
Curiosity	
CU1: An MBLS excites my curiosity.	
CU2: An MBLS arouses my imagination.	Webster & Ho (1997)
CU3: Learning with an MBLS makes me curious.	
Attention focus	
AF1: When using a MBLS, I am totally absorbed in what I am learning.	
AF2: An MBLS holds my attention.	Webster & Ho (1997)
AF3: When learning with an MBLS, I am aware of distractions.[a]	
Interest	
ITR1: An MBLS is fun.	
ITR2: An MBLS is interesting.	Webster & Ho (1997)
ITR3: An MBLS is boring.[a]	
Perceived richness of multimedia presentation	Self-construction from
RICH1: I believe that a MBLS presents instruction with different types of media.	Kock et al. (2007) and
RICH2: I believe that a MBLS allows me to learn with a variety of different media.	Pituch & Lee (2006)
RICH3: An MBLS presents knowledge and facts with different types of media.	
RICH4: An MBLS offers multimedia (audio, video and text) types of instructional content.	
Perceived learner control	Shen & Chuang (2009)
LC1: An MBLS allows me to learn the instructional content at my space.	
LC2: An MBLS allows me to navigate the instructional content at my pace.	
LC3: An MBLS leaves it up to me to decide which link and when to click.	

(*Continued*)

TABLE 1
(Continued)

Perceived system responsiveness	Pitch & Lee (2006)
SR1: A MBLS provides direct feedback.	
SR2: A MBLS provides instant feedback.	
SR3: In general, the response time of an MBLS is consistent.	

Note. MBLS = multimedia-based learning system.
[a]Denotes the item that was reverse coded.

TABLE 2
Demographic Profile of the Respondents

Demographic	Frequency	%
Gender		
Male	142	49.7
Female	144	50.3
Age		
19	34	11.9
20	33	11.5
21	46	16.1
22	57	19.9
23	72	25.2
24	35	12.2
25	9	3.1
Grade		
Freshman	29	10.1
Sophomore	56	19.6
Junior	111	38.8
Senior	90	31.5
Total	*N* = 286	100.0

asked to verify if each statement was true or false. The following is one of the four statements: "Multimedia-based learning refers to text-only learning presented through a computer" (false). The participants were screened to exclude individuals who had not correctly identified all the statements as true or false. Usable questionnaires were returned by 286 screened respondents, yielding a net response rate of 8.85%. Of the 286 respondents, 50.3% were female. The mean age of all respondents was 21.8 years ($SD = 1.64$). Most of respondents were aged from 19 to 24, making up 96.9% of the total. Juniors (38.8%) were overpresented in the respondents, followed by seniors (31.5%), sophomores (19.6%), and freshmen (10.1%). Table 2 illustrates the demographic profile of the respondents.

4. DATA ANALYSIS

A series of research hypotheses was tested using structural equation modeling. Cognitive engagement is proposed to be a second-order construct consisting of three first-order constructs: curiosity, attention focus, and interest. Analysis of data was thus conducted though a two-stage approach to establish the nomological validity of cognitive engagement (Agarwal & Karahanna, 2000; Anderson & Gerbing, 1988). The first stage involved the analysis of the measurement model, whereas the second stage tested structural relationships among latent constructs. The purpose of the two-stage approach was to evaluate the reliability and construct validity of the measurement model to determine whether the measured constructs reliably reflected the theoretical constructs. The estimation of model parameters and overall fit was performed using the maximum likelihood approach. The data were processed using SPSS (Version 15.0) and Amos (Version 18) for Windows where appropriate.

4.1. Descriptive Statistics of Measurement Instruments

The descriptive statistics of the constructs and items are presented in Table 3. All means are above the midpoint of 4.00 on the 1-to-7 scale. The mean of perceived system responsiveness ($M = 4.10$, $SD = 0.96$) was rated lowest among the 10 first-order constructs, whereas the mean of behavioral intention was rated the highest ($M = 5.56$, $SD = 0.98$). It is essential to verify univariate and multivariate normality as these two important assumptions underlie structural equation modeling (Bowen & Guo, 2011; Kunnan, 1998). For checking the univariate normality, Lei and Lomax (2005) suggested that the absolute values of skewness and kurtosis should not exceed the value of 2.3 for maximum likelihood estimation. For all the items, the skewness ranged from –1.130 to 0.411 and kurtosis ranged from –0.681 to 1.893, as presented in Table 3. The results indicated that the survey data did not violate the assumption for univariate normality. Multivariate normality was examined through inspection of Mahalanobis distance and Mardia's multivariate skewness and kurtosis measures in AMOS 18 for Windows. The results revealed that the critical ratio for all cases was less than 1.96 at the significance level of $p < .05$ (Mardia, 1970). No multivariate outlier was detected in the data set.

4.2. The Measurement Model

Internal consistency. Internal consistency was evaluated to determine the degree to which all items within a construct measured the same dimension (Wasserman & Bracken, 2003).

TABLE 3
Descriptive Statistics of the Measurement Instrument: Mean, Standard Deviation, and Cronbach's Alpha Coefficient

Construct	Item	*M*	*SD*	Skewness	Kurtosis	Cronbach's α
Behavioral intention	BI1	5.71	1.04	−1.130	1.893	.924
($M = 5.56$, $SD = .98$)	BI2	5.53	1.09	−.682	.450	
	BI3	5.30	1.12	−.448	−.215	
	BI4	5.71	1.08	−1.081	1.765	
Attitude	ATT1	5.29	1.01	−.574	.756	.921
($M = 5.22$, $SD = .97$)	ATT2	5.25	1.10	−.433	.329	
	ATT3	5.19	1.14	−.463	.402	
	ATT4	5.15	1.09	−.295	−.024	
Perceived usefulness	PU1	5.37	.90	−.364	.018	.939
($M = 5.36$, $SD = .80$)	PU2	5.24	.92	−.205	.031	
	PU3	5.57	.89	−.693	1.113	
	PU4	5.26	.95	−.212	−.151	
	PU5	5.30	.97	−.234	−.216	
	PU6	5.43	.88	−.491	.179	
Multimedia self-efficacy	MSE1	5.40	.92	−.275	−.225	.872
($M = 5.46$, $SD = .75$)	MSE2	5.55	.84	−.234	−.180	
	MSE3	5.43	1.01	−.413	−.116	
	MSE4	5.29	.95	−.154	−.487	
	MSE5	5.65	.91	−.270	−.433	
Curiosity	CU1	4.92	.99	−.119	−.346	.874
($M = 4.73$, $SD = .94$)	CU2	4.45	1.07	.390	−.305	
	CU3	4.83	1.10	.002	−.681	
Attention focus	AF1	4.54	1.20	−.210	−.108	.881
($M = 4.41$, $SD = 1.09$)	AF2	4.51	1.22	−.153	.028	
	AF3	4.17	1.23	.065	−.452	
Interest	ITR1	4.91	.97	−.021	−.077	.906
($M = 4.90$, $SD = .89$)	ITR2	4.94	1.01	−.123	−.234	
	ITR3	4.84	.94	−.140	.090	
Perceived richness of	RICH1	5.47	.93	−.429	.303	.903
multimedia presentation	RICH2	5.21	.97	−.204	−.324	
($M = 5.35$, $SD = .82$)	RICH3	5.35	.88	−.522	.243	
	RICH4	5.37	.92	−.320	−.453	
Perceived learner control	LC1	4.70	1.17	−.178	−.634	.853
($M = 4.77$, $SD = 1.05$)	LC2	4.77	1.24	−.157	−.617	
	LC3	4.84	1.19	−.245	−.311	
Perceived system	SR1	3.95	1.08	.411	−.041	.873
responsiveness	SR2	4.16	1.21	.163	−.471	
($M = 4.10$, $SD = .96$)	SR3	4.20	.91	.214	.571	

As presented in Table 3, Cronbach's alpha coefficient calculated for all constructs ranged from 0.853 to 0.939. All coefficients exceeded the 0.70 threshold in accordance with the recommended guideline (DeVellis, 2003). The result indicated that the questionnaire items were well understood by the sample population.

Common method bias. Harman's single-factor test was performed to assess the extent of common method bias that might possibly exist in the sample data (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). All the items on the questionnaire were loaded into a single factor using unrotated principal component analysis. As a general rule, common method bias is of serious concern when the total variance explained by a single factor exceeds 50% (Nov & Ye, 2008). The results indicated that a single most important factor accounted for 37.78% of the total variance, implying that common method bias was not a problem in the present study.

Exploratory factor analysis. The appropriateness of factor analysis was verified by the Kaiser–Meyer–Olkin Measure of Sampling Adequacy (0.930) and Bartlett's test of sphericity ($p = .000$). An exploratory factor analysis was performed to identify the dimensionality of a set of measured items. A principal component analysis with Varimax rotation yielded 10 differentiated components that correspond to the 10 first-order constructs of interest in the present study. The 10 components collectively explained 79.1% of the variance, with eigenvalues greater than 1. Table 4 presents the item loadings for the 10 extracted components. The factor loadings of 0.7 or above are considered satisfactory (Carmines & Zeller, 1979). The item for the MSE3 that had a factor loading (0.566) lower than the recommended threshold was eliminated to obtain a better fitted model, resulting in 37 items that were suitable for further analyses.

Multicollinearity. The variance of inflation factor was assessed to check the multicollinearity of constructs. A series of regressions were conducted as approached by Barnes (2011). The results indicated that the values of variance of inflation factor ranged from 1.156 to 2.573, which are all below the recommended cutoff of 10.0 (Neter, Kutner, Nachtsheim, & Wasserman, 1996). Thus, multicollinearity was not a serious concern in the present study.

Confirmatory factor analysis. A confirmatory factor analysis was conducted to assess two types of construct validity for the measurement model: convergent validity and discriminant validity. Convergent validity was assessed by three criteria suggested by Fornell and Larcker (1981) and Hair, Black, Babin, Anderson, and Tatham (2006). First, standardized factor loading for each of the items ranged from 0.740 to 0.910 (see Table 5). All items exhibited a loading value higher than the recommended value of 0.7 on their respective constructs at the significance level of $p < .05$. Second, composite reliability for each of the constructs exceeded the cutoff value of 0.8 (see Table 6). Third, average variance extracted for each of the constructs exceeded 0.5, with the lowest value of 0.637 observed for cognitive engagement. To summarize, evidence of convergent validity was obtained in all cases such that multiple items of a construct designed to measure the same concept were related (Bearden & Netemeyer, 1999). For satisfactory discriminant validity, Fornell and Larcker (1981) suggested that square root of the average variance extracted of the individual constructs should exceed the corresponding interconstruct correlations. As presented in Table 6, the diagonal value was greater than the correlations between the construct and all others across all cases. The results demonstrated that all individual constructs were unrelated to the other constructs designed to assess dissimilar concepts.

4.3. The Structural Model

Model fit. The structured model was tested against the observed data to determine its fitness. Six goodness of fit indexes were evaluated: the chi-square test statistics, the normed fit index, the comparative fit index, the goodness-of-fit index, the adjusted goodness-of-fit index, and the root mean square error of approximation. Table 7 presents the comparison of all model fit indexes provided by Amos 18 output with their corresponding recommended values. The ratio of χ^2/df was 1.303, which is below the maximum value of 3.0. The normed fit index, the comparative fit index, the goodness-of-fit index), the adjusted goodness-of-fit index, and the root mean square error of approximation values were all within acceptable levels. The goodness-of-fit index appeared to be lower than the commonly cited threshold. However, Etezadi-Amoli and Farhoomand (1996) and Doll, Xia, and Torkzadeh (1994) argued that a goodness-of-fit index above 0.8 can be interpreted as reasonable model fit. Thus, the model was judged to be adequate to estimate the structural relationships among the constructs.

Structural paths and hypotheses tests. Figure 2 illustrates the structural relationships tested in the proposed theoretical framework. The explanative power of the model is fairly high. The R^2 value for behavioral intention indicates that attitude and perceived usefulness together accounted for 42.6% of the variance in behavioral intention. Perceived usefulness and cognitive engagement together explained 48.0% of the variance in attitude. The amounts of explained variances in perceived usefulness and cognitive engagement were 57.2% and 54.2%, respectively.

Support for each hypothesis was evaluated by examining the sign, standardized beta coefficients, and statistical significance of the t values. Table 8 lists a summary of the results of testing for each hypothesis. There are 13 paths, which correspond to the number of hypotheses tested. As theorized in the TAM, and as consistent with the prediction, attitude (H1), and perceived usefulness (H2) both had significant and direct effects on behavioral intention at the $p < .001$ level. Furthermore, perceived usefulness (H3) had a significant direct effect on attitude at the $p < .001$ level. Cognitive engagement was found to significantly and directly influence attitude (H4) at the $p < .01$ and perceived usefulness (H5) at the $p < .001$ level. Significant effects of multimedia self-efficacy on perceived usefulness (H6) and cognitive engagement (H7) were observed at the levels of $p < .05$ and $p < .001$, respectively. Perceived richness of multimedia presentation had significant and direct effects on perceived usefulness (H8) and cognitive engagement (H9) at the $p < .001$ level. The influence of perceived learner control on perceived usefulness (H10) was not supported ($p > .05$), whereas perceived learner control on cognitive engagement (H11) was found to be significant at the $p < .05$ level. Last, it was found that the effect of perceived system responsiveness on perceived usefulness (H12) was not significant ($p > .05$), whereas the effect on cognitive engagement (H13) was significant ($p < .001$).

TABLE 4
Exploratory Factor Analysis: Rotated Component Matrix

	Component									
Item	1	2	3	4	5	6	7	8	9	10
BI1	.215	.139	**.838**	.168	.151	.068	.051	.063	.081	.044
BI2	.184	.169	**.814**	.159	.114	.115	.117	.057	.102	.062
BI3	.225	.134	**.792**	.246	.096	.063	−.006	.085	.118	.088
BI4	.233	.192	**.827**	.143	.135	.065	.044	.053	.059	.075
ATT1	.264	.144	.285	**.739**	.144	.067	.104	.132	.113	.077
ATT2	.253	.203	.188	**.792**	.150	.092	.057	.125	.123	.135
ATT3	.254	.160	.177	**.843**	.077	.062	.055	.071	.111	.059
ATT4	.196	.124	.148	**.790**	.126	.129	.112	.071	.030	.115
PU1	**.719**	.229	.209	.161	.203	.098	.062	.177	.119	.051
PU2	**.708**	.095	.209	.273	.197	.125	.132	.082	.216	.133
PU3	**.749**	.170	.179	.137	.185	.129	.111	.064	.061	.201
PU4	**.761**	.175	.191	.198	.195	.045	.058	.121	.182	.155
PU5	**.762**	.120	.164	.242	.126	.111	.131	.145	.224	.087
PU6	**.728**	.183	.279	.271	.170	.136	.037	.159	.148	.114
MSE1	.065	**.849**	.019	.142	.058	.027	.047	.109	.005	.048
MSE2	.170	**.789**	.108	.164	.153	.078	.122	.063	−.029	.140
MSE3[a]	.211	.566	.180	.154	.099	.135	.056	.113	−.065	.201
MSE4	.090	**.793**	.154	.063	.042	.009	.041	.161	.139	.002
MSE5	.197	**.790**	.212	.065	.164	−.044	.073	.045	.008	.094
CU1	.201	.161	.101	.108	.152	.084	.059	**.770**	.051	.256
CU2	.149	.135	.034	.088	.160	.139	.051	**.814**	.209	.095
CU3	.154	.213	.120	.158	.106	.159	.151	**.773**	.088	.262
AF1	.266	.074	.190	.181	.141	.189	.063	.161	**.708**	.276
AF2	.276	.056	.161	.128	.060	.175	.078	.154	**.766**	.270
AF3	.177	−.044	.058	.067	.095	.132	.086	.081	**.839**	.095
ITR1	.211	.166	.093	.146	.190	.196	.119	.274	.174	**.753**
ITR2	.182	.188	.111	.152	.171	.136	.109	.298	.215	**.753**
ITR3	.211	.149	.087	.114	.180	.109	.071	.167	.293	**.726**
RICH1	.206	.113	.140	.067	**.816**	.085	.113	.136	.027	.135
RICH2	.135	.133	.131	.062	**.776**	.114	−.017	.112	.101	.108
RICH3	.178	.091	.106	.172	**.808**	.149	.093	.097	.082	.104
RICH4	.216	.138	.103	.150	**.826**	.152	.144	.069	.075	.086
LC1	.091	.064	.023	.088	.077	.069	**.834**	.091	.113	.123
LC2	.116	.124	.057	.047	.107	.095	**.853**	−.036	.033	.035
LC3	.075	.064	.076	.094	.063	.051	**.863**	.138	.032	.035
SR1	.116	.048	.098	.144	.143	**.853**	.097	.100	.111	.099
SR2	.159	.029	.136	.079	.113	**.862**	.014	.143	.100	.125
SR3	.097	.056	.029	.055	.182	**.794**	.129	.080	.177	.086

Note. Exploratory factor analysis technique: Principal component analysis with Varimax and Kaiser Normalization. Rotation converged after seven iterations.

[a]MSE3 was eliminated from the further analyses.

5. DISCUSSION

5.1. Behavioral Intention, Attitude, and Perceived Usefulness

In line with the TAM mechanism, proximal constructs of attitude and perceived usefulness were identified as significant antecedents affecting behavioral intention to use a MBLS. In addition, perceived usefulness was found to be a significant predictor of attitude. Notably, the effects of perceived usefulness were found to be fairly strong. For example, the coefficient for perceived usefulness-behavioral intention ($\beta = 0.449$) was greater than that of the attitude-behavioral intention

TABLE 5
Confirmatory Factor Analysis: Standardized Factor Loading

Construct	Item	Standardized Factor Loading
Behavioral intention	BI1	.892
	BI2	.848
	BI3	.843
	BI4	.890
Attitude	ATT1	.856
	ATT2	.907
	ATT3	.896
	ATT4	.796
Perceived usefulness	PU1	.810
	PU2	.849
	PU3	.801
	PU4	.871
	PU5	.868
	PU6	.895
Multimedia self-efficacy	MSE1	.805
	MSE2	.830
	MSE4	.765
	MSE5	.813
Cognitive engagement	Curiosity	.770
	Attention focus	.745
	Interest	.873
Perceived richness of multimedia presentation	RICH1	.841
	RICH2	.740
	RICH3	.861
	RICH4	.910
Perceived learner control	LC1	.799
	LC2	.810
	LC3	.827
Perceived system responsiveness	SR1	.884
	SR2	.891
	SR3	.749

($\beta = 0.259$). Furthermore, the highest beta coefficient of all the causal paths in the structural model was found for the perceived usefulness-attitude relationship ($\beta = 0.517$).

One plausible explanation may be that the effects of perceived usefulness depend on behavioral context. Davis et al. (1992) and Moon and Kim (2001) argued that effects of perceived usefulness on the TAM constructs are likely to be strong when the target behavior is related to a goal-oriented task. This follows because goal-oriented behavior is usually stimulated by extrinsic sources of motivation (Ryan & Deci, 2000), which is represented by perceived usefulness (M. K. O. Lee et al., 2005). In the present study, perceived usefulness was measured with six items, measuring the extent to which an individual learner believes that the use of an MBLS would improve his or her learning performance. As learning with a MBLS is a highly goal-oriented activity, our study underscores an idea that learner acceptance of an MBLS is largely influenced by extrinsic motivation to improve learning performance.

5.2. Cognitive Engagement

It should be noted that intrinsic motivation has been conceptualized by several related constructs, including cognitive absorption (Agarwal & Karahanna, 2000), flow (Csikszentmihalyi, 1990), playfulness (Venkatesh, 2000), and cognitive engagement (Scott & Walczak, 2009). There has been much debate as to their posited relationships. However, the present study was inspired by an idea that cognitive engagement is particularly considered to be a key determinant of salient beliefs about a learning-oriented system (Greene & Miller, 1996; Jacques, Preece, & Carey, 1995; Kearsley & Shneiderman, 1998). Relying upon established research (Scott & Walczak, 2009; Webster & Ho, 1997), we further tested the nomological validity of cognitive engagement by including three first-order constructs of curiosity, attention focus, and interest, explained by one single second-order construct. The confirmatory factor analysis results demonstrated acceptable fit indexes, indicating that the proposed theoretical framework can be judged as valid with our sample data. Consistent with the prediction, cognitive engagement was found to be a significant antecedent to perceived usefulness of using an MBLS. In particular, our finding that cognitive engagement influenced attitude is noticeable because there has been limited empirical documentation examining the causal relationship. It is important to note that the findings revealed that cognitive engagement is a key intervening variable in linking the four exogenous variables—multimedia self-efficacy, perceived richness of multimedia presentation, perceived learner control, and perceived system responsiveness—with perceived usefulness (Ngai, Poon, & Chan, 2007). The significance of cognitive engagement is further demonstrated by its direct effects on perceived usefulness and attitude. Increasing evidence in motivational and educational literature has suggested that intrinsic motivation can be drawn from a learning situation. Our findings thus imply that an MBLS should be designed so that learners can experience engagement that affects their attitude and perceived usefulness, thereby motivating them to use the system for learning.

5.3. Multimedia Self-Efficacy

The measure of multimedia self-efficacy was rated second highest in mean value, following behavioral intention. Judged by the modest level of multimedia self-efficacy reported here, it is reasonable to conclude that respondents believe themselves to be less susceptible to a barrier to the use of multimedia technology-driven learning (Christoph et al., 1998). The present

TABLE 6
Average Variance Extracted, Composite Reliability, and Correlations Among Constructs

Constructs	AVE	C.R	BI	ATT	PU	MSE	CE	RICH	LC	SR
BI	.754	.925	(.869)							
ATT	.748	.922	.562	(.865)						
PU	.722	.940	.619	.673	(.850)					
MSE	.646	.879	.443	.452	.482	(.804)				
CE	.637	.840	.483	.578	.715	.482	(.798)			
RICH	.706	.905	.420	.446	.566	.386	.560	(.840)		
LC	.659	.853	.230	.291	.332	.275	.388	.319	(.812)	
SR	.712	.881	.326	.354	.426	.196	.561	.425	.256	(.844)

Note. The value in parenthesis represents the square root of AVE. AVE = average variance extracted = (Σ standardized loading^2)/((Σ standardized loading^2) + $\Sigma\ \varepsilon_j$); C.R = composite reliability = (Σ standardized loading)^2/((Σ standardized loading)^2 + $\Sigma\ \varepsilon_j$); BI = behavioral intention; ATT = attitude; PU = perceived usefulness; MSE = multimedia self-efficacy; CE = cognitive engagement; RICH = perceived richness of multimedia presentation; LC = perceived learner control; SR = perceived system responsiveness.

TABLE 7
Model-Fit Indexes

Model-Fit Index	Measurement Model	Structural Model	Recommended Values	Reference
χ^2/df	1.296	1.303	$\leq$3.0	Gefen et al. (2000)
NFI	.911	.909	$\geq$.9	Hair et al. (1998)
CFI	.978	.977	$\geq$.9	Bentler (1990)
GFI	.876	.874	$\geq$.9	Hair et al. (1998)
AGFI	.854	.854	$\geq$.8	Bentler & Bonett (1980)
RMSEA	.032	.033	$\leq$.08	Browne & Cudeck (1993)

Note. NFI = normed fit index; CFI = comparative fit index; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMSEA = root mean square error of approximation (RMSEA).

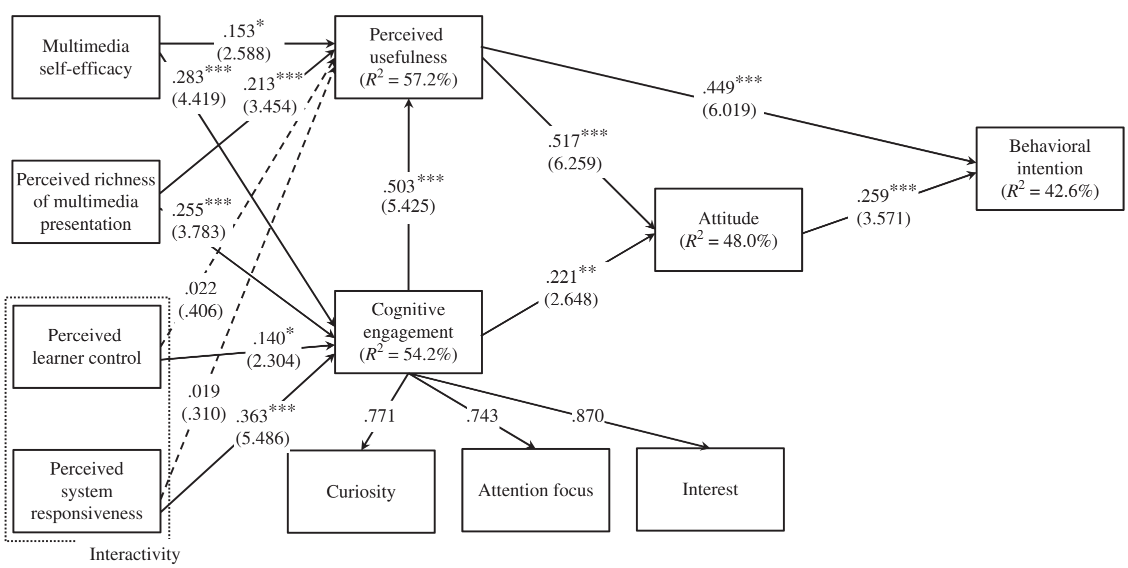

FIG. 2. Results of the proposed conceptual framework for learner acceptance of a multimedia-based learning system. *Note.* Dashed paths are not supported. *$p < .05$. **$p < .01$. ***$p < .001$.

TABLE 8
Results of Hypotheses Testing

Hypothesis	Path	Standard Coefficient	t Value	Hypothesis Acceptance
H1	Attitude → behavioral intention	.259***	3.571	Supported
H2	Perceived usefulness → behavioral intention	.449***	6.019	Supported
H3	Perceived usefulness → attitude	.517***	6.259	Supported
H4	Cognitive engagement → attitude	.221**	2.648	Supported
H5	Cognitive engagement → perceived usefulness	.503***	5.425	Supported
H6	Multimedia self-efficacy → perceived usefulness	.153*	2.588	Supported
H7	Multimedia self-efficacy → cognitive engagement	.283***	4.419	Supported
H8	Perceived richness of multimedia presentation → perceived usefulness	.213***	3.454	Supported
H9	Perceived richness of multimedia presentation → cognitive engagement	.255***	3.783	Supported
H10	Perceived learner control → perceived usefulness	.022	.406	Not supported
H11	Perceived learner control → cognitive engagement	.140*	2.304	Supported
H12	Perceived system responsiveness → perceived usefulness	.019	.310	Not supported
H13	Perceived system responsiveness → cognitive engagement	.363***	5.486	Supported

*$p < .05$. **$p < .01$. ***$p < .001$.

study was not designed to address the relationship between prior knowledge or experience with an MBLS and the subsequent self-efficacy perceived by respondents (Moos & Azevedo, 2009). However, a number of studies have argued that the amount of prior knowledge and experience with a task is highly related to confidence in task-related skills (Hill, Smith, & Mann, 1987; Potosky, 2002). With the prevalent use of multimedia technologies and applications, it is quite possible that competing levels of multimedia self-efficacy reported by respondents might arise from the source of enactive mastery of repeated multimedia-related experiences (Bandura, 1997; Gist, 1987).

A significant and direct path was found between multimedia self-efficacy and perceived usefulness. Several studies argue that self-efficacy influences outcome expectation, which is closely related to perceived usefulness (Liaw, 2002; X. Liu, 2010). Thus, the result suggests that respondents with greater confidence in their knowledge and skills in an MBLS might develop better outcome expectations regarding current and future learning prospects (Compeau & Higgins, 1995). A noteworthy finding is that multimedia self-efficacy had a significant effect on cognitive engagement. As mentioned earlier, we argue that individuals equipped with a certain level of self-efficacy will be more likely to experience cognitive engagement during interaction with an MBLS (Pintrich, 2003; Pintrich et al., 2008). That is, engagement may happen only for those who possess a minimum level of self-efficacy. However, other studies have found that intrinsic motivation conceptualized as cognitive engagement (Scott & Walczak, 2009) or enjoyment (Yi & Hwang, 2003) was an antecedent of self-efficacy. Yi and Hwang (2003) claimed that the state in which individuals perceive enjoyment in using a system will reduce their perceptions of anxiety, consequently leading them to have greater confidence in their abilities to use the system. In trying to relate our finding to the TAM literature, the present study presented the possibility of bidirectional causality between self-efficacy and intrinsic motivation.

5.4. Perceived Richness of Multimedia Presentation

Perceived richness of multimedia presentation was operationally defined as the perceived ability of an MBLS to provide multiple forms of instructional media (Pituch & Lee, 2006). As expected, it was found to be a significant predictor of perceived usefulness. A commonsense view is that an MBLS offers a variety of symbolic representations of multimedia interface modules combined with still photos, animation, movie, sound clips, and textual information presented in a graphical nature (Chapman et al., 1999). Shah and Freedman (2003) noted that such systems can be attractive and intrinsically motivating. Baggio (2010) stated that "multimedia should be engaging and not boring for the learner" (p. 101). Taken together with the finding that perceived richness of multimedia also significantly influenced the cognitive engagement, the results imply that learners are both intrinsically and extrinsically motivated by their perceived amount of learning scenario to be presented. Considering the unique characteristics of an MBLS, our aforementioned findings were expected.

5.5. Perceived Learner Control and Perceived System Responsiveness

A number of studies have stressed the notion of interactivity as an important feature of modern media (H. H. Chang & Wang, 2008; Domagk, Schwartz, & Plass, 2010). In our study, perceived interactivity was dimensionalized by the two separate constructs of perceived learner control and perceived system responsiveness. However, neither of them was a predictor of perceived usefulness of an MBLS, implying that neither was valued for its usefulness to respondents. Despite their considerable potential in educational literature (e.g., constructivism; Jonassen, McAleese, & Duffy, 1993; Lin & Hsieh, 2001; Zhang, Zhou, Briggs, & Nunamaker, 2006), the findings are contradictory to our expectation. One explanation of the weak effects on perceived usefulness may possibly be attributed to the mediating role of cognitive engagement. Respondents might also perceive that an MBLS typified by interactive features does not necessarily impact understanding (H. H. Chang & Wang, 2008; Domagk et al., 2010; Teo et al., 2003). This view is consistent with Sims (2003), who stated that "interactivity does not appear to be generating the educational outcomes predicted" (p. 89). The results indicate that the beta coefficient for the causal path of system responsiveness-cognitive engagement ($\beta = 0.363$) is more than twice that of the learner control-cognitive engagement ($\beta = 0.140$). This clearly implies that perceived system responsiveness had a greater impact on cognitive engagement than does perceived learner control. To be competitive, there is a need for design efforts that consider potential user preference for interactive features in shaping intrinsic motivation to use an MBLS.

6. CONCLUSION

The present study examined learner acceptance of an MBLS. Our theoretical framework was based on the modified version of the TAM, with three proximal constructs of behavioral intention, attitude, and perceived usefulness. Four additional constructs—multimedia self-efficacy, perceived richness of multimedia presentation, perceived learner control, and perceived system responsiveness—were added external to the framework to improve its predictive value for the MBLS context. In addition, a second-order construct of cognitive engagement was conceptualized with the three dimensions of curiosity, attention focus, and curiosity. Structural equation analysis provides evidence for most of the hypothesized causal relationships among the specified constructs. Two exceptions include the insignificant influences of perceived learner control and perceived system responsiveness on perceived usefulness. In conclusion, the present study supports the idea that TAM is a useful theoretical framework to understand learner acceptance of a MBLS. The current study can help designers, practitioners, and researchers understand more about guiding the development of educational interventions.

7. LIMITATIONS

There are several limitations in this study that should be acknowledged. First, it is important to recognize that the present study is limited by its purely predictive research. We measured the behavioral intention but not actual behavior due to our limited resources. Although the role of behavioral intention as an immediate antecedent to actual behavior has been well documented in the literature, future studies should include the measure of behavioral prediction to strengthen the utility of the TAM. A second possible limitation is that a proximal construct of perceived ease of use in the TAM was not examined in our theoretical framework given its inconsistent pattern in the literature (Chau & Hu, 2001; M. K. O. Lee et al., 2005). However, one may argue that our study neglected to include a key part of the TAM. Future study should include the measure of perceived ease of use further to make our findings more complete. Third, there is also a need to consider other external variables to improve the robustness of the proposed framework for more accurate prediction of specific behavioral context. For example, although interactivity has been considered to be essential to multimedia technology, it is still an elusive construct in the educational literature (Domagk et al., 2010; McMillan, 2002). As the present study addressed only two constructs of perceived learner control and perceived system responsiveness, it may be useful to examine other interactive features such as guidance (Moreno & Mayer, 2007) or feedback (Plass, Homer, & Hayward, 2009). It is also noteworthy to mention that computer anxiety may be another potential variable to be included in future research (Bandura, 1986; Compeau & Higgins, 1995) to explain its possible mediating effect on the relationship between cognitive engagement and multimedia self-efficacy. Fourth, the present study was not designed to ensure that all the respondents have used the same target system or product. Thus, our findings should be interpreted with caution, as potential confounding effects might not be excluded. However, this work was approached on a macrolevel to examine what aspects of multimedia learning are valued by users for their acceptance behaviors, but not to explore whether the single system provides an identical level of perceptions regarding system features or functions to users. Finally, our sample population was drawn from young adult undergraduate students in South Korea. It is therefore highly likely that the findings cannot be generalized beyond the study sample. Future work is needed to replicate our preliminary findings in a broader population sample to provide further support for the external validity.

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