



The effects of various multimedia instructional materials on students' learning responses and outcomes: A comparative experimental study



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ABSTRACT

We examine whether an e-learning curriculum involving various multimedia instructional materials (MIMs) can stimulate learners' socialness perceptions, and whether the difference in style has a specific effect on the students' emotional states (arousal, pleasure, and flow experience) that consequently affect the students' learning motivations and learning outcomes. We apply an experimental design to three groups of students and compared three types of presentation methods: (a) a PowerPoint presentation (b) a PowerPoint presentation guided by a human-like animated character; (c) a PowerPoint presentation guided by a monster-like animated character. The analysis results show that various types of MIMs result in various social cues that have a significant effect on the students' socialness perceptions, arousal, pleasure, flow experience, learning motivation, and learning outcome. We contribute to the field of e-learning by integrating MIM, social response theory, flow theory, and learning theory into an innovative model, which sheds light on the perspective that the three groups of various MIMs stimulate an emotional state of students and maximize their learning outcomes. Therefore, when designing the e-learning curricula with animated characters, we recommend that teachers consider how these designs affect students' emotional responses to ensure the best learning outcomes.

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1. Introduction

Because of the popularization of electronic learning (e-learning), teaching curricula have been expanded from traditional oral lectures to include digital multimedia instructional materials (MIMs), which combine text, graphics, audio, and animation. This approach allows plain text to be presented in various ways that draw the attention of students to improve their learning outcomes. However, employing diverse multimedia instructional materials (MIMs) does not necessarily correspond with a superior design of multimedia instructional materials. Mayer's (2001) concept of limited capacity in the multimedia learning cognitive theory is consistent with the study on cognitive load theory proposed by Chandler and Sweller (1991), which showed that an excess of complex words, pictures, and audiovisual effects could burden students.

Furthermore, the inappropriate design and application of MIM can distract students and inhibit their learning outcome (Lin & Li, 2003). Numerous scholars have studied the effect of MIMs on learning outcomes (Chen, 1999; Chou, 2003; Mousavi, Low, & Sweller, 1995; Wu, 2005); however, because their conclusions have been inconsistent, an effective combination of the various media that comprise MIMs remains a worthy topic for discussion. Therefore, we demonstrate how various types of MIMs affect the learning responses and outcomes of students.

Research on social response theory has indicated that people tend to regard computers as a type of social actor, and that the extent in which people interact with computer varies according to the type of social cues, such as language, emotion, and voice (Moon, 1998). Previous studies have shown an emergence of MIMs that employ various pedagogical agents—usually animated characters—to assist in creating an immersive environment that elicits a social response from learners and engages them in a socially interactive e-learning experience (De Vries, 2004). Animated characters can project human characteristics by expressing movements, gestures, facial expressions, voice, and dialogue (Gulz, 2004). Previous studies have shown that multimedia animations that express emotion in the computer–human interaction environment assist learners (Kim, Baylor, & Shen, 2007; Veronikas & Shaughnessy,

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2005; Wang, 2008; Yu, Jannasch-Pennell, Digangi, & Kaprolet, 2009). For example, research has shown that animated characters that express a sense of caring are perceived to respond sympathetically, thereby improving negative emotions experienced by learners (Chen, 2007; Lee, 2006). In addition, many MIM studies have shown that animated characters exert a positive effect on computer-aided learning environments (Chou, Chan, & Lin, 2003). Ryokai, Vaucelle, and Cassell (2003) conducted experimental research on the effects of a virtual peer on children's storytelling and demonstrated that children who played closely with the virtual peer imitated the virtual peer and told advanced stories with more quoted speech and spatial expressions. However, previous studies have not fully addressed the emotional response of students when they perceive various animated characters during the learning process. If inappropriate MIM induces negative emotions through cognitive load (Mayer, 2001), both students' willingness to learn and learning outcomes are affected. This discussion shows that gauging the emotional response of students is critical in the learning process. Thus, we aim to measure the following emotional variables derived from social response theory and flow theory to examine their effect on learning outcomes: (a) arousal; (b) pleasure; and (c) flow. Furthermore, two critical outcome variables associated with e-learning, satisfaction and motivation, are discussed. Student satisfaction can be measured to indicate the success of a computer-based learning environment, and numerous studies have shown that students report a greater level of satisfaction in e-learning environments than in traditional learning environments in which no technological mediation of communication between teachers and students is required (see Berge & Collins, 1995; Hiltz, 1994; Tallent-Runnels et al., 2006; Ahmad, Edwards, & Tomkinson, 2006; Bekele, 2010; Day, Raven, & Newman, 1998; Lim, Morris, & Kupritz, 2007; Rodriguez, Ooms, Montanez, & Yan, 2005). Thus, we also examine the effect of various social cues (i.e., instructional materials such as animated characters) on learning outcomes.

In summary, this study is intended to determine how using distinct social cues to present the same instructional materials affects the emotional response of students while learning, and how this affects their motivation to learn, as well as the learning outcomes. Because animated characters have been employed successfully to present simulations of real events and many studies have looked into the effect of different appearances or various degree of realism of the animated characters on learning (Gulz & Haake, 2006; Holzwarth, Janiszewski, & Neumann, 2006; Sumi & Mase, 2004; Wang, Baker, Wagner, & Wakefield, 2007), both human-like animated character and monster-like animated character were used in MIMs in this study to provide additional approaches for teachers to employ MIM in their curriculum designs. We applied an experimental design to three groups of students and compared three types of presentation methods: (a) a PowerPoint presentation (b) a PowerPoint presentation guided by a human-like animated character; (c) a PowerPoint presentation guided by a monster-like animated character. We further discuss how the three groups of various MIMs stimulate an emotional response from students and maximized their learning outcomes. We contribute to the field of e-learning by examining how various MIMs stimulate students' emotions (through arousal, pleasure, and flow experience), consequently affecting the students' learning motivations and learning outcomes.

2. Review of relevant literature

2.1. Multimedia

Multimedia learning has been defined as a learning activity that involves using pictures (such as animation) and words (such as narration) to offer a powerful tool for improving students' understanding of instructional material. Because people receive

information through their visual and auditory cognitive senses in the cognitive process, Mayer (2001) proposed the Cognitive Theory of Multimedia Learning (CTML) based on the following three assumptions: (a) "dual channels" refers to the processing of visual/pictorial and auditory/verbal representations through separate channels during the multimedia learning process (Baddeley, 1992; Mayer, 2001; Paivio, 1986); (b) "limited capacity" refers to the limited information that people can process simultaneously through their visual and auditory channels (Baddeley, 1992; Chandler & Sweller, 1991); and (c) "active processing" is meaningful learning that occurs when people engage in cognitive processes by organizing the learned information into coherent knowledge based on similarities with prior knowledge, and subsequently integrating it with prior knowledge (Mayer, 1999).

The CTML states that learners use visual and auditory cognitive senses to process forms of information such as sounds, pictures, and words. Based on the CTML, Mayer (2001) proposed the following two MIM design principles: (a) the modality principle refers to the fact that the learning outcomes from integrating both animation and narration into instructional materials is superior to the application of animation and on-screen text; and (b) the redundancy principle implies that the learning outcomes from incorporating both animation and narration into instructional materials is superior to those from incorporating animation, narration, and on-screen text. These principles are based on the dual-channel assumption, indicating that the auditory and visual channels have a limited capacity; therefore, balancing both channels can reduce the cognitive capacity and improve the learning outcomes. Moreover, although numerous variations of MIMs exist, a greater number of combinations does not necessarily improve learning outcomes (Mayer, Heiser, & Lonn, 2001; Mayer & Moreno, 1998). Numerous studies on the learning outcomes of MIMs have shown that an audiovisual presentation approach can facilitate learning outcomes that are superior to those attained through other approaches (Mousavi et al., 1995; Wang, 2008; Wu, 2005). Therefore, this discussion shows that determining the appropriate type of MIMs depends on the content and nature of the learning program; any MIM must be designed according to the subject and learning program.

Animated characters employed in MIMs are often presented in human form (Kim & Baylor, 2007), or portrayed in a fantasy realm as talking animals, insects, or cartoons (Atkinson, 2002; Louwerse, Graesser, Lu, & Mitchell, 2005; Craig, Gholson, & Driscoll, 2002; Lester et al., 1997). Previous studies have examined the effects of the appearance of animated characters and the degree of realism of animated characters on students' learning and cognition (Baylor, 2007; Kim & Baylor, 2007; Rosenberg-Kima, Baylor, Plant, & Doerr, 2008). Some studies have shown that students who use realistic animated characters exhibit superior performance and more positive effects than those who use unrealistic animated characters (i.e., cartoon appearance) in their learning (Kim, 2004). However, other studies have revealed that students do not exhibit significant differences in their learning achievement based on using highly realistic or unrealistic agents (Moreno, Mayer, Spiers, & Lester, 2001; Sahimi et al., 2010). The research results appear conflicting and this subject requires further elucidation. Therefore, to further examine the effect of the degree of realism of animated characters on learning outcomes, both a human-like animated character (representing a highly realistic appearance) and a monster-like animated character (representing an unrealistic appearance) were used in MIMs in this study.

This research differs from previous studies on multimedia because it not only focuses on how various MIMs affect learning outcomes, but it also measures students' affective sensitivity and degree of investment. We also examined sets of slides based on identical learning content and various types of multimedia

(on-screen text and narration, human-like animation, on-screen text, and narration, and monster-like animation, on-screen text, and narration), as well as how the different sets of slides affect the students' emotional responses (e.g., arousal, pleasure, and degree of investment), and whether these factors inhibit the students' learning motivation and learning outcomes. In addition to presenting the human-like (highly realistic) animated characters, monster-like animated characters were used to assist students in visualizing the learning contents to help people understand the type of animated characters used in the instructional material that can fit the students' requirements and expectations in the e-learning environment.

2.2. Social response theory

Nass, Fogg, and Moon (1996) proposed social response theory and considered computers to be social actors. They showed that, when a user interface is embedded with simple social cues, the computer is equipped with personality traits that arouse the socialness perceptions of users. They used the term "socialness" to describe the phenomenon in which people treat computers as social actors (Reeves & Nass, 1996; Steuer & Nass, 1993). For example, users might answer the computer in a polite manner (Nass, Moon, & Carney, 1999), offer benefits to computers for their assistance, and show interdependent relationships with computers (Moon, 2000; Nass et al., 1999). Accordingly, users tend to prefer interacting with computers that project similar personality traits, and enjoy using computers that offer praise (Fogg & Nass, 1997; Nass & Lee, 2001). Nass and Moon (2000) explained that computers might elicit a social response from users because of mindless reactions. In other words, when a computer interface is embedded with social cues, users might respond to it subconsciously based on their previous experiences and interpersonal communication techniques. Steuer and Nass (1993) indicated that, according to studies related to social response theory, language, human voice, interactivity, and social roles might contribute to the socialness perceptions of users. First, regarding language, Nass, Moon, Fogg, and Reeves (1995) showed that when various tones (e.g., strong or weak) are applied to text in a computer, the computers were imbued with dominant and submissive traits. Second, Steuer and Nass (1993) reported that computers equipped with various human voices to respond to users can create the perception that the different responses are from different social members. This shows that the human voice can facilitate the development of an interpersonal relationship between computers and users (Reeves & Nass, 1996; Steuer & Nass, 1993). Third, interactivity plays a key role in interpersonal communication; users can engage in two-way communication by providing immediate feedback to computers (Liu & Shrum, 2002). Finally, because users might regard computers as members of society, the computer effectively has a social role, which can be regarded as human-like characteristics (Wallace, 1983). We modified the definition of social cues proposed by Steuer and Nass (1993) to be suitable for e-learning systems; thus, in this study, social cues are defined as the MIMs of language, human voice, and social roles of e-learning curricula; while socialness perceptions are defined as the extent to which students treat computers as social actors after the use of social cues on MIMs.

2.3. Emotional states

Scholars have held various opinions toward emotions; thus, a consensus has not been reached regarding a definition. According to Mehrabian and Russell (1974), the M-R model divides emotions into the following three emotional structures: (a) pleasure; (b) arousal; and (c) dominance. Accordingly, they applied a semantic

difference scale to measure the degree of emotional responses. Whether in a natural or artificial environment, the M-R model involves the assumption that an emotional state can be described using a pleasure–arousal–dominance dimension (PAD). The PAD scale was originally employed in the fundamental measure of environmental psychology, although it has since been adapted based on specific demands, such as in studies on e-shopping (Eroglu, Machleit, & Davis, 2003), TV shopping (Lu, 2008), product design (Helfenstein, 2005), and human–computer interaction (Agarwal & Mayer, 2009). Russell and Pratt (1980) revised the M-R model by removing the dominance dimension because their experimental results showed that its effect on environmental response was low. Consequently, two independent dimensions, arousal and pleasure, can be employed to explain various emotional characteristics, and can be applied to any emotional description. The basic emotional dimensions of arousal and pleasure comprise the following three features: (a) they can be applied to explain an emotional response; (b) the description of an emotional dimension is polarized; (c) all emotions can be defined as a certain combination of the two dimensions. Therefore, arousal and pleasure were used in this study to measure students' emotional responses to e-learning curricula. Based on the discussed research, we define arousal as the excitement, tension, and degree of arousal exhibited by students after participating in an e-learning curriculum, and pleasure is defined as the joy, fulfillment of expectations, relaxation, or emotional satisfaction experienced by students after participating in an e-learning curriculum.

2.4. Flow theory

In recent years, flow theory has been applied in numerous studies on computer-mediated technology and human–computer interaction (Chen, Wigand, & Nilan, 1999; Ghani & Deshpande, 1994; Novak, Hoffman, & Yung, 2000; Trevino & Webster, 1992; Webster, Trevino, & Ryan, 1993). Csikszentmihalyi (1975) proposed flow theory, which states that people tend to focus on themselves when they are completely engaged in an activity, and they tend to respond only to goals and feedback stimulated by the activity. Furthermore, they enter a flow state when they experience a sense of control that corresponds with their control over the environment. Csikszentmihalyi (1990) reported that when people are satisfied with a certain activity, they tend to take the initiative in balancing the challenges between their skills and difficulties of tasks so that they can experience a flow state (Csikszentmihalyi, 1990). Webster et al. (1993) stated that human–computer interaction is a type of flow experience that involves playful and exploratory features. During human–computer interaction, people can intuitively experience pleasure and involvement. Novak et al. (2000) asserted that people could experience pleasure from their interactions with computers during an online surfing process, as well as a series of reactions such as a loss of self-awareness and intensification of the self-concept. Many scholars have adopted various perspectives to classify the features of flow experience. For example, Csikszentmihalyi (1990) and Jackson and Csikszentmihalyi (1999) have proposed the following eight features of flow experiences: (a) specific goals and instant feedback: A person knows exactly what needs to be done in a task and is aware of the completion of task goals; (b) consistent challenge and skill: When the challenge of a task appropriately fits the skill of a person, flow occurs as he enjoys the process of overcoming the challenge; (c) sense of control: A person experiences a feeling that everything is at his command; (d) concentration on a task: A person consciously delves deeply into a task; (e) merging of action and awareness: A person's attention is intensely focused on an activity without being interrupted by reflections, thoughts, or feelings; (f) loss of self-consciousness: A person does not feel

separated from his or her actions and is completely immersed in the task; (g) an altered sense of time: A person's normal perception of time feels condensed; and (h) autotelic experience: A task is fulfilling or worth doing for its own sake.

Because of the rapid development of information technology, numerous scholars have examined flow experience in computer environments. R. Agarwal and Karahanna (2000) proposed and incorporated the concept of cognitive absorption into flow theory, and extended the application of flow theory to network usage situations. The concept comprises the following five dimensions: (a) temporal dissociation: An individual's inability to register the passage of time while engaged in an activity; (b) focused immersion: The experience of total engagement whereby other attentional demands are ignored; (c) heightened: The experience of captured by the pleasurable aspects of interaction; (d) control: A person's perception of being in control of an interaction; and (e) curiosity: The extent to which an experience arouses a person's sensory and cognitive curiosity (Agarwal & Karahanna, 2000, p. 673). Moreover, they showed that entering a flow state in such an environment tended to enhance learning behavior (Ghani, Supnick, & Rooney, 1991; Hoffman & Novak, 1996; Webster et al., 1993), exploratory behavior (Ghani & Deshpande, 1994; Ghani et al., 1991; Webster et al., 1993), and positive emotional responses (Chen, 2000; Trevino & Webster, 1992). Based on these definitions and concepts, we define flow experience as the state of joy and the loss of the awareness of time experienced by students who become curious and focus on learning the content of an e-learning curriculum.

2.5. Learning motivation

Motivation can promote and induce behaviors, and encourage people to adopt an intrinsic driving force of behavior (Mook, 1995). It can also drive people to take initiatives, continue a learning activity, and enhance their willingness to study, thereby driving them to complete an activity (Slavin, 2001). Miller and Miller (2000) indicated that the learning motivation of students is the most fundamental element of successful e-learning because students with strong motivation can typically achieve superior learning outcomes. A shortage of capability might not be the only reason that the learning performance of certain students is poor; it could be because they lack the motivation to learn (Forrest, 2000). When students are highly motivated to learn, their attitude toward a course or subject tends to be positive, and they frequently take the initiative to improve their learning performance. When experiencing difficulties or challenges, highly motivated learners tend to employ effective learning methods and strategies and achieve a positive learning outcome (Slavin, 2001). Accordingly, the motivation to learn has a critical influence on learning outcomes. However, certain teachers over-emphasize learning outcomes and fail to cultivate learning motivation. Moreover, such teachers tend to focus on outcome-oriented learning, which results in poor learning motivation, and even creates a dislike for learning (Bain, 2004). Accordingly, numerous scholars have asserted that learning motivation could affect the efficiency of pedagogy and the learning outcome (Rezabek, 1995; Virvou, Katsionis, & Manos, 2005; Wilbourne, 2006). Porter (1997) indicated that self-motivation is a reason why people have succeeded in distance learning. Based on these definitions and concepts, we define learning motivation as the extrinsic or intrinsic factor that is required to achieve the goals set by teachers or students, respectively, while participating in an e-learning curriculum.

2.6. Learning outcome

Learning outcome refers to the development and achievement in students' knowledge, skills, behaviors, and attitudes when they

have completed instructional activities (Piccoli, Ahmad, & Lves, 2001). In addition to making them aware of their current learning state, it also provides a basis for improving and adjusting the pedagogy and delivery methods. Based on the model of the educational objectives proposed by numerous scholars (Bloom, 1969; Krathwohl, Bloom, & Masia, 1969; Pierce & Gray, 1981; Sharda et al., 2004), learning outcome has been divided into the following three domains: (a) the cognitive domain (i.e., mental skills), which refers to the outcome of prior and learned knowledge, and comprises six specific levels (knowledge, comprehension, application, analysis, synthesis, and evaluation; (Bloom, 1969); (b) the affective domain (i.e., attitude), which refers to the process of emotional responses, and comprises five specific levels (i.e., receiving, responding, valuing, organization, and characterization by a value or a value complex; (Krathwohl et al., 1969); and (c) the psychomotor domain (i.e., skills), which refers to the measures of physical movement, coordination, and instrumentation, and comprises seven specific levels (perception, set, guided response, mechanism, complex overt response, adaptation, and origination; (Pierce & Gray, 1981; Simpson, 1966). Pierce and Gray (1981) and Simpson (1966) indicated the connection among these domains by adjusting the content of each level and making the educational objective an efficient learning instrument. However, knowledge and ability cannot be measured directly because of the manner in which knowledge is implied in the minds of learners. Conversely, actions and behaviors performed while learning can be directly observed and measured (Alavi & Leidner, 2001). Accordingly, Sharda et al. (2004) divided learning outcomes into psychomotor outcomes (efficiency and accuracy of responses), cognitive outcomes (comprehension, knowledge, application, and analysis), and affective outcomes (positive evaluations of satisfaction, attitude, and learning experience). Sharda et al. (2004) detailed the measurement of educational objectives, which is more suitable in this research because we conduct experiments to measure how students respond emotionally to various forms of multimedia. Therefore, we applied the perspective of Sharda et al. (2004) to measure the learning outcomes of students by focusing specifically on the cognitive and affective domains. The cognitive domains are measured according to reactive thinking, whereas the affective domain is measured according to satisfaction and cognitive learning outcome.

3. Hypotheses

3.1. Relationship between socialness perceptions and flow experience

Chou et al. (2003) stated that animated character can have a positive effect on the learning environment. In other words, employing language, sound, or pedagogical agents as a teaching aid can provide students with a greater degree of socialness perceptions than using only text can. In a study on retail websites, Wang et al. (2007) showed that socialness perceptions of users are related more closely to high-social-cue websites than to low-social-cue websites. Moreover, their research results showed that social cues could promote the development of the socialness perceptions of websites. Novak et al. (2000) showed that highly interactive websites could enhance the flow experience of users. The curiosity of users can be enhanced by employing human-computer social cues to arouse their socialness perceptions. Moreover, Wang et al. (2007) showed a significant relationship between socialness perceptions and flow experience. Csikszentmihalyi (1990) indicated that, in a human-computer environment, customers have a positive socialness perceptions and a higher level concentration, which facilitates a high-flow state. Based on the discussed studies, we infer that incorporating social cues into an e-learning curriculum can improve the socialness perceptions of students by facilitating their flow experience. Therefore, we propose the following hypothesis:

H1. Socialness perceptions have a positive effect on flow experience.

3.2. Relationship among socialness perceptions, arousal, and pleasure

According to the M–R model (Mehrabian & Russell, 1974), the stimulation in the environment affects users' arousal and pleasure in both physical retail shops and retail websites. Wang et al. (2007) showed that social cues cause socialness perceptions to improve arousal and pleasure states in retail websites. Furthermore, many studies have indicated that a positive association exists between social elements (e.g., service workers) and the arousal and pleasure of customers. Reeves and Nass (1996) indicated that adding the contents of social cues can improve the degree of users' social intercourse and socialness perceptions toward a website, thereby enhancing the state of customers' arousal. Lombard and Ditton (1997) indicated that computer-based social presentations could increase users' pleasure. The discussed studies have all investigated retail websites as a common theme, which clearly differs from the research topic of e-learning. However, we assert that when students are participating in an e-learning curriculum, social cues such as language, human voice, and animated characters that are presented using a computer can induce socialness perceptions that allow students to learn, understand, and judge the course content. Consequently, this generates arousal (stimulation, excitement, or tension) and pleasure (joy, relaxation, or satisfaction). Therefore, we assume that embedding social cues into an e-learning curriculum increases the socialness perceptions of students, thereby increasing their arousal and pleasure. Accordingly, we propose the following hypotheses:

H2. Socialness perceptions have a positive effect on arousal.

H3. Socialness perceptions have a positive effect on pleasure.

3.3. Relationship between arousal and flow experience

Social psychologists believe that a state of boredom is caused by a lack of external stimuli, which results in distraction from an activity (Conrad, 1997). This implies that external stimuli can increase a user's energy and attention. Previous studies have shown that both positive and negative arousal (affective experience) have a significant effect on flow experience (Quinn, 2003). Novak et al. (2000) and Wang et al. (2007) have also shown that arousal has a positive effect on flow experience.

In this study, we assert that stimuli, such as computers, that use social cues (e.g., language, human voice, and animated characters) can arouse the socialness perceptions of students who participate in an e-learning curriculum. Because their feelings of excitement or nervousness about the MIM arouse their interest and curiosity, their concentration on the course content improves. Moreover, excitement, curiosity, and concentration are key elements for entering a flow experience. Therefore, we infer that students who are aroused by an MIM have a high flow experience. Hence, we propose the following hypothesis:

H4. Arousal has a positive effect on flow experience.

3.4. Relationship between arousal and pleasure

Russell and Pratt (1980) proposed that emotion comprises two independent dimensions (arousal and pleasure). Chebat and Michon (2003), Wang et al. (2007), and Bigne, Andreu, and Gnoth (2005) have shown that arousal affects pleasure. Berlyne (1971) assumed that arousal affects pleasure, and this effect has been con-

firmed by numerous marketing studies (Babin & Attaway, 2000; Chebat & Michon, 2003; Wakefield & Baker, 1998).

We assumed that, after students experience an e-learning curriculum, their socialness perceptions is aroused by the stimulus of social cues in the software or website such as language, human voice, and animated characters. They feel excited or nervous about the e-learning curriculum content, thereby arousing pleasure (e.g., joy, appropriate expectation, relaxation, and satisfaction). Therefore, we argue that, when users have a high arousal toward MIMs, they have a highly pleasurable experience. Hence, the following hypothesis was proposed:

H5. Arousal has a positive effect on pleasure.

3.5. Relationship between flow experience and pleasure

Csikszentmihalyi (1990) asserted that pleasure is related to flow experience. Numerous studies have defined flow experience as an internal pleasure state that can induce feelings of pleasure (Hedman & Sharafi, 2004; Hoffman & Novak, 1996). Moreover, in an online shopping survey, Wang et al. (2007) confirmed that a relationship exists between pleasure and flow experience. We argue that, after students have participated in an e-learning curriculum, their interest and curiosity are aroused and they find it easier to concentrate on the courses and enter a flow experience state, at which point they experience joy, relaxation, and satisfaction. Thus, we assert that a positive association exists between a student's flow experience and their pleasure toward the MIMs, and propose the following hypothesis:

H6. Flow experience has a positive effect on pleasure.

3.6. Relationship between pleasure and learning motivation

Deci and Ryan (1985) stated that internal motivation is produced by participating in an interesting or pleasurable activity. Moreover, Vansteenkiste, Simons, Lens, Sheldon, and Deci (2004) asserted that if teachers arrange learning activities based on the intrinsic objectives of students, then the students experience an increased level of pleasure while participating in learning activities. Sobral (2004) conducted a study on medical college students' learning quest and determined that when students were more motivated, they were better able to learn and accept new knowledge, thereby improving their learning outcome (Sobral, 2004). We assert that an e-learning curriculum can arouse the student's pleasure (joy, expectation, relaxation, and satisfaction) and increase their learning motivation, thereby providing the initiative to learn and achieve both intrinsic and extrinsic goals. Therefore, we argue that a positive association exists between the pleasure students experience while participating in an e-learning curriculum and their learning motivation. Accordingly, we propose the following hypothesis:

H7. Pleasure has a positive effect on learning motivation.

3.7. Relationship between flow experience and learning motivation

Several studies have employed flow theory to assess learning in higher education, verify learning outcomes, and improve the quality of learning activities (Guo & Ro, 2008). Ishimura and Kodama (2009) stated a positive relationship exists between flow and pleasure, and it could motivate students to learn. Rathunde (2003) proposed that flow could improve the learning motivation of teenagers and young adults, and increase their willingness to participate in e-learning activities. We assert that social cues (language, human

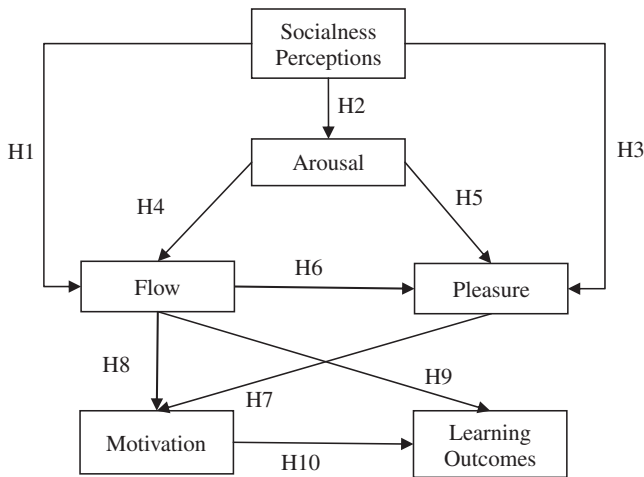


Fig. 1. Research model and hypotheses.

voice, and animated characters) stimulate students who are participating in an e-learning curriculum. Consequently, they become curious, which makes them focus on the MIM, thereby increasing their learning motivation and enabling them to achieve intrinsic and extrinsic goals. Thus, curiosity and concentration are both factors that facilitate entering the flow experience. Accordingly, we argue that a positive association exists between flow experience and the learning motivation of students participating in an e-learning curriculum, and propose the following hypothesis:

H8. Flow experience has a positive effect on learning motivation.

3.8. Relationship between flow experience and learning outcome

Flow experience facilitates students' concentration, control, and enjoyment, which can improve learning outcomes (Guo & Ro, 2008). Ho and Kuo (2010) showed that the flow experience of students has a direct effect on their learning outcomes in an e-learning environment, which supports the findings of numerous previous studies (Brady, 2004; Chen et al., 1999; Guo, Klein, Ro, & Rossin, 2007; Guo & Ro, 2008; Pearce, Ainley, & Howard, 2005; Skadberg & Kimmel, 2004; Webster et al., 1993; Woszczynski, Roth, & Segars, 2002). In an e-learning environment, interacting with computers can directly affect students' satisfaction, flow experience, and the length of time they concentrate, all of which enhance their learning outcomes (Brady, 2004; Woszczynski

et al., 2002). In addition, several scholars have supported the assertion that the flow experience has a direct effect on the learning outcomes and satisfaction of students (Guo et al., 2007; Pearce et al., 2005). Based on these studies, we argue that a positive association exists between the flow experience of students participating in an e-learning curriculum and their learning outcomes. Thus, we propose the following hypothesis:

H9. Flow experience has a positive effect on learning outcomes.

3.9. Relationship between learning motivation and learning outcome

Motivation has been regarded as a critical psychological factor that relates directly to learning outcome (Lee, Wong, & Fung, 2010). The findings of numerous studies have shown that the learning motivation of students affects their learning outcomes at school (Benbunan-Fich & Hiltz, 2003; Hardré & Sullivan, 2008; Linnenbrink & Pintrich, 2002; Salzman, Dede, Loftin, & Chen, 1999). Moreover, research on educational psychology holds that intrinsic motivation has a positive influence on academic achievements (Wilbourne, 2006). For example, Lloyd and Barenblatt (1984) and Haywood and Burke (1977) have shown that a relationship exists between intrinsic motivation and learning outcomes. Rezabek (1995) and Virvou et al. (2005) have reported that motivation could affect the learning outcomes and performance of students. Furthermore, Gottfried (1985) measured the intrinsic motivation of students enrolled in specific subjects (e.g., mathematics), and showed that a positive relationship exists between intrinsic motivation and learning achievement. Based on these studies, we propose that a positive association exists between learning motivation in e-learning curriculums and learning outcome. Therefore, we propose the following hypothesis:

H10. Learning motivation has a positive effect on learning outcome.

The research model and hypotheses is shown in Fig. 1.

4. Research methodology

In this study, we applied an experimental design to groups of students enrolled in the five e-learning courses at a private university in Taiwan, taught by the same faculty. The independent variables were the following three types of e-learning instructional materials: (a) a PowerPoint presentation guided by a human-like animated character; (b) a PowerPoint presentation guided by a

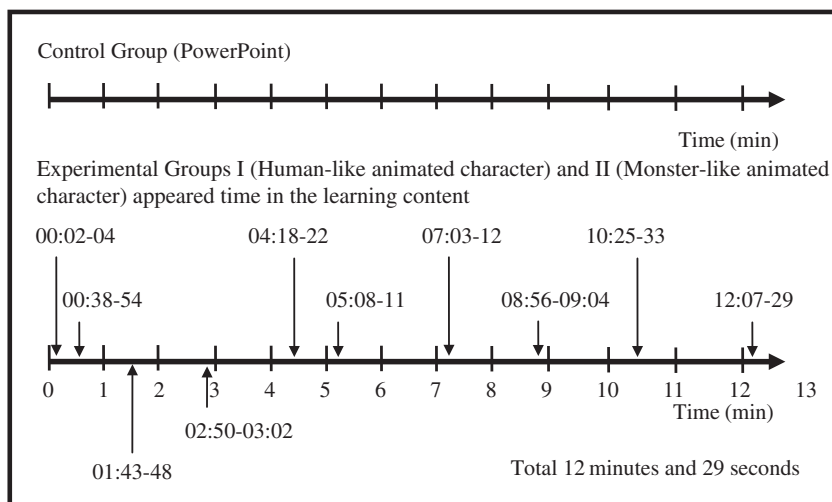


Fig. 2. Time Series of the three MIMs.



Fig. 3. Control group interface.



Fig. 4. Experimental Group I interface (human-like animated character).

monster-like animated character; and (c) a PowerPoint presentation only. The dependent variables were the participants' socialness perceptions, arousal, pleasure, flow, motivation, and learning outcomes. We applied a path analysis to test the proposed research model, and used a multivariate analysis of variance (MANOVA) to compare the differences among the independent variables for two experimental groups and one control group.

4.1. Research participants

The research sample comprised 176 undergraduate students enrolled in the following five classes at a private university in Taiwan: (a) Physics and Life; (b) Love, Sex, and Law; (c) Programming; (d) Introduction to e-Learning (A); and (e) Introduction to e-Learning (B). The five classes were randomly assigned into two experi-

mental groups and one control group, detailed as follows. Group I comprised 87 students from the Physics and Life and Introduction of e-Learning (A) classes, and they were assigned the MIMs that contained a human-like animated character as a guide for the PowerPoint presentation. Group II comprised 58 students from the Love, Sex, and Law class, as well as the Programming class, and they were assigned the MIMs that featured a monster-like animated character as a guide for the PowerPoint presentation. The control group comprised 53 students from the Introduction to e-Learning (B) class, and they were assigned a PowerPoint presentation as their MIM.

4.2. Procedure

First, we informed the participants that we were testing their recall of the course information, and that they should pay close



Fig. 5. Experimental Group I interface (monster-like animated character).

attention to the presented information. The five classes were randomly assigned to one of the three groups. The learning content (“Introduction to Cloud Computing”) was identical for each group. We delivered the presentation by using an e-learning platform (Interactive Course Assisting Net Version XP, ICan XP) and we embedded the e-learning material guided by the human-like animated character and the monster-like animated character. For Groups I and II, the animated character appeared 10 times throughout the entire lesson. The timeline in Fig. 2 shows the timing of when animated character appeared. All of the participants explored the content individually throughout the entire lesson. At the end of the lesson, we distributed questionnaires to the participants. The entire experiment, including administering the questionnaires, took approximately 22 min. The three interfaces of the MIMs are shown in Figs. 3 (control), 4 (Group I), and 5 (Group II).

4.3. Research measurements

The research measurements comprised the following six sets of items: (a) socialness perceptions; (b) arousal; (c) pleasure; (d) flow; (e) motivation; and (f) learning outcomes. We employed pen-and-paper questionnaires to assess the students at the end of the lesson. All were ranked using a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*), and the indices for all items were reliable (detailed as follows).

For the first set of items, we adopted and modified the three items proposed by Wang et al. (2007) to measure socialness perceptions (e.g., *The course was helpful for me*; Cronbach’s $\alpha = 0.79$). The second set comprised four items that were adapted from Mehrabian and Russell (1974) to assess the students’ perception of arousal (e.g., *I felt that the course with the avatar/PowerPoint was stimulating*; *The course with the avatar/PowerPoint made me mentally alert*; Cronbach’s $\alpha = 0.87$). The third set of items were adapted from Mehrabian and Russell (1974) to measure the extent to which the presentation contents induced feelings of pleasure regarding the course presented (e.g., *The course with the avatar/PowerPoint made me happy, pleased, joyful, delighted, and entertained*; Cronbach’s $\alpha = 0.91$). The fourth set of items were from Wang et al. (2007) to measure the students’ perception of flow (e.g., *The course with the avatar/PowerPoint was interesting for me*; *The course with the avatar/PowerPoint enhanced my curiosity*; Cronbach’s $\alpha = 0.85$). The fifth set comprised four questions that were

adapted from McAuley, Duncan, and Tammen (1989) to measure students’ motivation to participate in the presented course (e.g., *I enjoyed the course with the avatar/PowerPoint very much*; *I was very relaxed in the course with the avatar/PowerPoint*; Cronbach’s $\alpha = 0.75$). Finally, the sixth set comprised nine items proposed by Maor and Fraser (2005), Benbunan-Fich and Hiltz (2003), Marks, Sibley, and Arbaugh (2005), Martens, Bastiaens, and Kirschner (2007), and Chou and Liu (2005) for assessing students’ learning outcomes (e.g., *I was able to apply what I learned in the courses with the avatar/PowerPoint to my studies*; *I now have a much better understanding of the course content than I did before*; *I was able to adapt what I learned in the course with the avatar/PowerPoint to improve my learning effectiveness and efficiency*; Cronbach’s $\alpha = 0.95$).

4.4. Data analysis

Group I (experimental), which viewed the presentation featuring the human-like animated character, comprised students from Physics and Life and Introduction to e-Learning (A), Group II, which viewed the presentation featuring the monster-like animated character, comprised students from Programming and Love, Sex, and Law. To compare the two classes within each group, we conducted a MANOVA as the preliminary analysis. The analysis results show that the difference between these the two classes was non-significant. Subsequently, the two classes in each group were combined to form a sample set. We calculated the descriptive statistics and conducted path analyses (Jöreskog & Sörbom, 2007) to test the proposed research model. We performed a MANOVA to investigate the mean differences among the variables for the three groups.

5. Results

Table 1 shows the mean and standard deviation of the variable scores for the three groups. To test the research model, a path analysis (Arbuckle, 2007) and the maximum-likelihood (ML) estimation method were conducted for each of the three groups. Figs. 6–8 show the hypothesized model and parameter values for the three groups.

The analysis results show that the fit of our hypothesized model was excellent for the control group ($\chi^2/df = 3.353/5$; GFI = .978, NFI = .985, RFI = .954, CFI = 1.000; RMSEA = .000), Group I ($\chi^2/$

Table 1
Means and standard deviations for each item according to three groups.

Variables	Items	Human-like animated character		Monster-like animated character		PowerPoint	
		Mean	SD	Mean	SD	Mean	SD
Socialness perceptions	1	3.68	.668	3.28	.779	4.00	.577
	2	3.80	.749	3.33	.732	4.14	.736
	3	3.67	.742	3.28	.779	4.02	.595
Arousal	1	3.72	.675	3.33	.790	3.98	.661
	2	3.54	.725	3.35	.822	3.63	.809
	3	3.43	.724	3.09	.915	3.43	.913
	4	3.67	.742	3.28	.807	3.69	.742
Pleasure	1	3.73	.689	3.26	.773	3.76	.723
	2	3.74	.755	3.35	.766	3.73	.811
	3	3.86	.666	3.57	.720	4.04	.576
	4	3.70	.715	3.24	.794	3.82	.601
	5	3.68	.686	3.22	.786	3.80	.645
Flow	1	3.85	.776	3.46	.836	3.69	.769
	2	3.77	.746	3.09	.661	3.53	.793
	3	3.81	.743	3.70	.785	3.57	.736
	4	3.65	.744	3.48	.809	3.65	.805
	5	3.65	.761	3.43	.860	3.65	.723
	6	3.43	.741	3.24	.673	3.45	.914
Motivation	1	3.63	.782	3.22	.814	3.69	.796
	2	3.74	.587	3.76	.639	3.96	.735
	3	3.75	.643	3.48	.586	3.98	.595
	4	3.49	.793	3.22	.964	3.41	1.039
Learning outcomes	1	3.69	.584	3.41	.805	3.84	.800
	2	3.68	.629	3.54	.690	3.76	.751
	3	3.75	.603	3.52	.722	3.90	.714
	4	3.84	.580	3.70	.662	4.14	.736
	5	3.69	.683	3.33	.668	3.73	.785
	6	3.47	.614	3.26	.648	3.55	.843
	7	3.60	.665	3.30	.756	3.84	.688
	8	3.79	.541	3.67	.598	3.86	.677
	9	3.84	.535	3.52	.691	3.96	.735

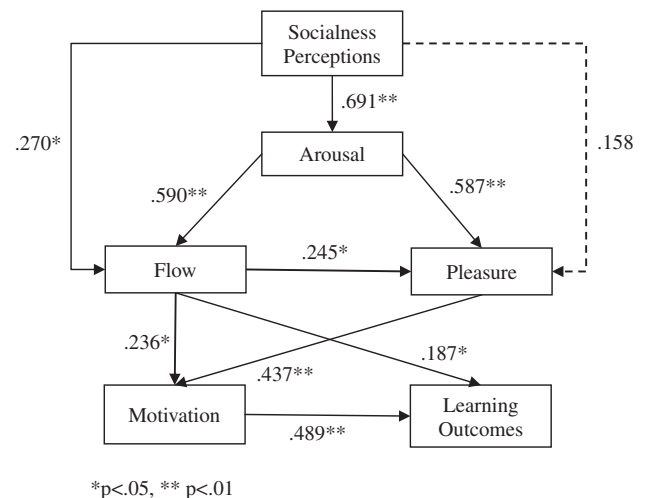
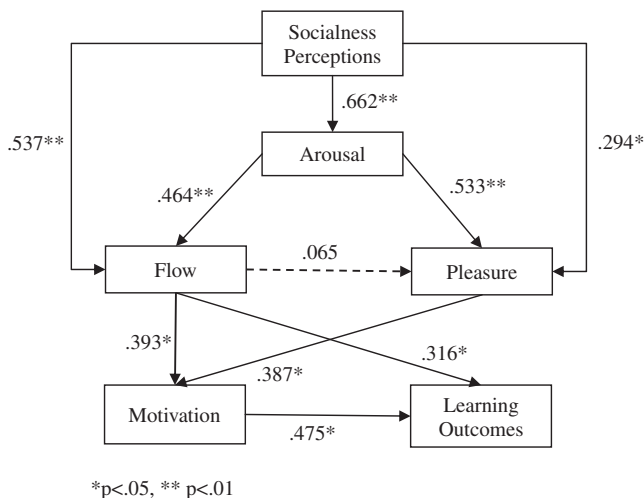


Fig. 6. Path analysis model with standardize estimates for control group (PowerPoint).

Fig. 7. Path analysis model with standardize estimates for experimental Group I (Human-like Animated Character).

$df = 2.164/5$; $GFI = .991$, $NFI = .995$, $RFI = .984$, $CFI = 1.000$; $RMSEA = .000$), and Group II ($\chi^2/df = 3.987/5$; $GFI = .972$, $NFI = .980$, $RFI = .940$, $CFI = 1.000$; $RMSEA = .000$). For the control group model, only one path (flow–pleasure) in the hypothesized model was statistically non-significant. Similarly, only one path (socialness perceptions–pleasure) in the hypothesized model for Group I was non-significant. However, for the model of Group II, three paths (i.e., flow–pleasure, flow–motivation, and pleasure–motivation) were non-significant. Table 2 shows the hypotheses test results for the three groups.

We conducted a one-way MANOVA with univariate follow-up to determine any differences among the three groups regarding the set of the measurement variables (socialness perceptions, arousal, pleasure, flow, motivation, and learning outcomes). The multivariate test results were statistically significant (Wilks $\chi = .688$, $F[12, 336] = 5.765$, $p < .001$, partial $\eta^2 = .171$). An examination of the univariate ANOVA tests showed six statistically significant differences regarding the following dependent variables: (a) socialness perceptions ($F[2, 173] = 18.853$, $p < .000$, partial

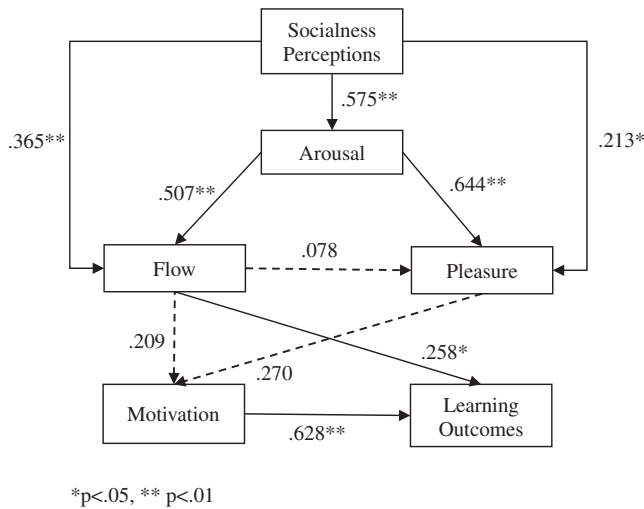


Fig. 8. Path analysis model with standardize estimates for experimental Group II (Monster-like Animated Character).

$\eta^2 = .179$), arousal ($F[2, 173] = 5.471, p < .01$, partial $\eta^2 = .062$), flow ($F[2, 173] = 3.615, p < .05$, partial $\eta^2 = .040$), pleasure ($F[2, 173] = 9.087, p < .001$, partial $\eta^2 = .095$), motivation ($F[2, 173] = 5.18, p < .01$, partial $\eta^2 = .056$), and learning outcomes ($F[2, 173] = 5.958, p < .01$, partial $\eta^2 = .064$).

The Scheffe’s post hoc test results for the control group had higher means than those for Groups I and II did on socialness perceptions, whereas the results for Group I had higher means than those of Group II did. The control group and Group I had higher means than Group II on arousal, pleasure, and motivation, and Group I had higher means than Group II on flow. Finally, the control group had higher means than Group II on learning outcomes.

6. Discussion and conclusion

We examined whether an e-learning curriculum involving various multimedia instructional materials (MIMs) can stimulate learners’ socialness perceptions, and whether the difference in style has a specific effect on the students’ emotional feelings (arousal, pleasure, and flow experience) that consequently affect the students’ learning motivations and learning outcomes. We integrated research on multimedia, social response theory, flow theory, and educational theory into an innovative model, which fills a research gap in extant literature by providing a systematic study on how students make sense of the presentation of virtual others

(Lee & Nass, 2003). We provide the following contributions. First, regarding the effects of the various MIMs, the results show that various MIMs might affect the perceptions of learners and elicit positive or negative emotional responses. This finding is in agreement with prior findings, which have shown that socialness perceptions significantly associated with arousal (Paulhus & Lim, 1994; Wang et al., 2007). The analysis results show that, through the presentations of various types of MIMs, the students reported active feeling during the learning process. In other words, the presentations of various MIMs would probably decrease their passion and willingness to participate in the e-learning course if the MIMs were unable to elicit positive emotions.

Second, regarding the learning process, we integrated relevant research and developed an innovative and novel model to explain the effect of student perceptions of various MIMs on the extent of their arousal, which affects the students’ flow experience, pleasure, satisfaction, and motivation. The results of applying three MIMs in three groups are detailed as follows. First, expect for H2 in Experimental Group I (human-like animated character), socialness perceptions all had a significant and positive effect on flow experience (H1), arousal (H2), and pleasure (H3) (see Table 2), which is consistent with the findings of numerous previous studies (Csikszentmihalyi, 1990; Eroglu et al., 2003; Lombard & Ditton, 1997; Novak et al., 2000; Reeves & Nass, 1996; Wang et al., 2007). This shows that after the students experienced the e-learning curriculum and were stimulated by the application of language, human voice, and animated characters presented using a computer interface, the students had higher socialness perceptions to produce flow experience, arousal, and pleasure. Second, for Control group and experimental Group I (human-like animated character), arousal had a significant and positive effect on flow experience (H4), which supports the research results of Novak et al. (2000) and Wang et al. (2007). This shows that when the students exhibited arousal states such as excitement and tension, they invested more in the current activity and entered a flow experience state. Third, for the three groups, arousal had a significant and positive effect on pleasure (H5). Chebat and Michon (2003), Wang et al. (2007), and Bigne et al. (2005) have shown that pleasure has a direct and positive effect on arousal. These results were adapted to the e-learning curriculum; after learners experienced the e-learning curriculum and were stimulated by the application of language, human voice, and animated characters in the computer interface, they felt excited about the presentation content, thereby experiencing joy, satisfaction, and pleasure. The effect of flow experience on pleasure was non-significant (H6) in the group of Experimental Group II (Monster-like Animated Character). Csikszentmihalyi (1990), Hedman and Sharafi (2004) and Wang et al. (2007) have shown that pleasure has a direct and positive

Table 2 Hypotheses testing results for three groups.

Hypotheses	Path	Control group (PowerPoint)		Experimental Group I (human-like animated character)		Experimental Group II (monster-like animated character)	
		Path coefficient	Results	Path coefficient	Results	Path coefficient	Results
H1	Socialness perceptions → Flow	.537**	Supported	.270*	Supported	.365**	Supported
H2	Socialness perceptions → arousal	.662**	Supported	.691**	Supported	.575**	Supported
H3	Socialness perceptions → pleasure	.294*	Supported	.158	Not Supported	.213*	Supported
H4	Arousal → flow	.464**	Supported	.590**	Not supported	.507**	Supported
H5	Arousal → pleasure	.533**	Supported	.587**	Supported	.644**	Supported
H6	Flow → pleasure	.065	Not supported	.245*	Supported	.078	Not supported
H7	Pleasure → motivation	.387*	Supported	.437**	Supported	.270	Not supported
H8	Flow → motivation	.393*	Supported	.236*	Supported	.209	Not supported
H9	Flow → learning outcomes	.316*	Supported	.187*	Supported	.258*	Supported
H10	Motivation → learning outcomes	.475*	Supported	.489**	Supported	.628**	Supported

* p < .05.
** p < .01.

effect on flow experience. However, these results are inconsistent with those obtained in this study. This could be related to the duration of the designed e-learning curriculum (12 min 48 s). In such a short time, students can neither focus nor feel curious about and interested in the curriculum. Moreover, because the entire class participated simultaneously in the experiment on the e-learning curriculum, they might have distracted each other. Therefore, they could not enter the flow experience state or experience pleasure.

Third, regarding the learning outcomes, the results of the three groups are detailed as follows: (a) In both control group and experimental Group 1 (human-like animated character), pleasure had a significant and positive effect on learning motivation (H7), which is consistent with the results reported by Deci and Ryan (1985) and Su (2007). This shows that learning motivation is produced by the students' participation in an activity. This result is adaptive to the e-learning curriculum because, after learners experienced the e-learning curriculum or when they were affected by the interface design or curriculum contents, joyful, expected relaxed, and satisfied pleasure were elicited, thereby increasing students' learning motivation and initiative to learn. (b) In three groups, flow experience had a significant influence on learning motivation (H8). This finding is consistent with the results of Rathunde (2003), who proposed that flow could foster students' motivations to learn. (c) In three groups, flow experience had a significant and positive influence on learning outcomes (H9). This is supported by research of Brady (2004), Guo et al. (2007), Guo and Ro (2008), Ho and Kuo (2010) and Pearce et al. (2005), which has shown that flow experience has a direct effect on learning outcomes because flow experience typically involves concentration, control, and enjoyment; thus, it can improve learning outcomes. This finding is also adaptive to the e-learning curriculum. A possible reason is that, when students participate in e-learning courses, they become curious and interested in the curriculum, and their elevated concentration causes them to lose awareness of the passage of time. During that period, they can improve their learning outcome. (d) In three groups, learning motivation had a significant and positive influence on learning outcomes (H10), which is inconsistent with the research results obtained by, indicating that learning motivation has a positive effect on learning outcome. This result is also adaptive to the e-learning curriculum (Lee et al., 2010; Linnenbrink & Pintrich, 2002; Virvou et al., 2005; Wilbourne, 2006). This is possibly because, when learners experience the e-learning curriculum, they are stimulated and affected by the interface design or curriculum content and exhibit intrinsic learning motivation, making them work to their maximum potential to achieve the extrinsic and intrinsic goals. Thus, their learning outcomes are improved.

According to social response theory, social cues that are embedded in the user interface design in human-computer learning environments cause students to perceive computers as having a sense of social presence and interpersonal behaviors and attitudes that are similar to people. Based on related studies on social response theory, Steuer and Nass (1993) indicated that language, human voice, interaction, and social characters create social cues. Wang et al. (2007) showed that the socialness perceptions of websites that contain strong social cues is higher than that of websites with poor social cues. However, this finding differs from the research results in this study. The possible explanation is detailed as follows. Regarding the variables (i.e., socialness perceptions, arousal, flow experience, pleasure, and learning motivation), the slide presentation method is significantly higher than the application of human-like animated character and the method that applied the monster-like animated character. The possible reason for this is previous learning habits. In a traditional instructional curriculum, a course is typically delivered using slide presentations. Students are familiar with method, which elicits emotional responses related to learning (e.g., concentration, caution, and listening);

consequently, it is easy for them to enter the flow experience of learning. Furthermore, the human-like animated character and the method that featuring the monster-like animated character were frequently problematic because the pictures changed throughout the lesson; consequently, the students thought that the slide presentation method was effective, and that it could provide additional assistance and more information than the human-like animated character and the application of monster-like animated character could. Therefore, the degree of emotional response and learning outcomes resulting from the slide presentation method were significantly higher than those resulting from the other two methods.

The human-like animated character method produced a significantly higher degree of arousal, pleasure, and learning motivation than the monster-like animated character method did (see Table 3). This is attributable to the differences between the animated characters. Moreover, the images employed in the human-like animated character were designed to imitate a teacher. Consequently, this method aroused more interest and projected a stronger sense of professionalism than the monster-like animated character method did; thus, students could focus on the curriculum without being distracted. This could also be explained by the background images employed in the presentation. For example, the background used in the human-like animated character method was more colorful than that in the monster-like animated character method, and might have induced a sense of comfort, thereby making it easier for the students to concentrate on the curriculum. The monster-like animated character method might be considered unprofessional, which could induce feelings of discomfort or unease. In contrast, the background color of the human-like animated character method was relatively vivid. In summary, a human-like animated character method should offer stimulating social cues such as language, human voice, and animated characters. In addition, the socialness perceptions toward this method were significantly higher than that of the monster-like animated character. Moreover, the monster-like animated character method might also have been considered unprofessional, thereby eliciting negative emotional responses that impair discipline and cause boredom. This, in addition to other issues, such as the selected colors and the transition of images, could nullify emotional responses such as pleasure, joy, and expectation.

Based on the effect of the three curriculum interfaces on arousal, we conclude that the application of slides and human-like animated character methods is superior to the application of the monster-like animated character method regarding the emotional response of students, showing that all types of presentation methods are suitable for improving the emotional responses of students. According to the limited capacity hypothesis of the CTML, people can process a limited amount of information in the visual and auditory channels. In other words, students can maintain their concentration for only a portion of the information; this is similar to the concept of cognitive load theory proposed by Chandler and Sweller (1991). Therefore, if animated characters are incorporated into multimedia instructional materials, it is critical to select of the type of animated characters that elicit a positive emotional response, such as excitement. Moreover, it is also crucial to determine whether the animated characters elicit the students' intrinsic learning motivation and convey a sense of professionalism, thereby assuring the students that the curriculum is worthy of learning and encouraging them to invest time in learning. Using inappropriate animated characters reduces the students' emotional response, flow experience, and learning outcome.

In summary, this study shows that the variables of socialness perceptions, arousal, pleasure, flow experience, and learning motivation can all affect students' learning outcomes. Moreover, the slide method, human-like animated character, and the

Table 3
Univariate and Scheffe's post hoc tests results: differences in means for control group, experimental Groups I and II.

Variables	Mean (SD)			F	Scheffe's post hoc
	Control Group ① (PowerPoint)	Experimental Group I ② (human-like animated character)	Experimental Group II ③ (monster-like animated character)		
Socialness perceptions	4.05 (.537)	3.72 (.617)	3.30 (.637)	18.853***	① > ②; ① > ③; ② > ③
Arousal	3.68 (.667)	3.59 (.601)	3.26 (.691)	5.757**	① > ③; ② > ③
Flow	3.59 (.597)	3.70 (.596)	3.40 (.604)	3.615*	② > ③
Pleasure	3.83 (.577)	3.74 (.633)	3.33 (.656)	9.087***	① > ③; ② > ③
Motivation	3.76 (.610)	3.65 (.504)	3.42 (.500)	5.118**	① > ③; ② > ③
Learning outcomes	3.84 (.635)	3.71 (.443)	3.47 (.531)	5.958**	① > ③

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

monster-like animated character method present various social cues that have a significant effect on the students' socialness perceptions, arousal, pleasure, flow experience, learning motivation, and learning outcome. Therefore, when designing the e-learning curricula, we recommend that teachers consider their students' previous learning habits, emotional responses, learning motivation, interests, and curiosity. The curriculum interface design must integrate the students' requirements and the required learning content. If animated characters are necessary, teachers must design them to project a sense of professionalism to ensure that students can listen to the curriculum carefully and be willing to invest time into learning the subject. The discussed methods are useful for improving learning outcomes.

7. Limitations and suggestions

First, considering the limited research resources, we cooperated with the e-learning service center at a private university in Taiwan and recruited participants in the e-learning system. Because the research sample primarily comprised college students, we recommend that future studies broaden the scope of this research by recruiting postgraduate and doctoral students. Furthermore, we recommend that questionnaires be distributed to students in other universities and colleges, diverse sample data be established, and the relevant elements that affect learning outcomes be clarified. Second, because of the limited research resources and time, we collected data based on a one-off experimental teaching design, and applied them as the verification basis of the research model. Because the analysis did not involve a vertical section approach, it could not be used to elucidate changes in the participants' behavior, emotional responses, and development trends over a long period. Thus, we recommend that future studies extend the research period and collect sample data by applying a vertical section research methodology to examine the variable changes over time.

Third, quantitative 5-point Likert scales were used to measure the variables, limiting its capacity to elucidate the students' cognitive processes. Thus, we recommend that future studies include open participants or adopt an in-depth interview methodology, as well as quantitative and qualitative methods to examine other elements that influence learning outcome. Finally, we focused primarily on the curriculum interface by employing slides, a human-like animated character, and monster-like animated character to identify how they affect students' emotional responses toward learning, as well as their learning motivation and learning outcome. Thus, it is recommended that future studies examine gender, facial features, and the appearance of characters in human-like animated character, and employ various animals to obtain different results.

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