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博 士 論 文

兒童與電腦間之社會互動–探討互動性、語音、與表情符號的影響

Social Interaction between Children and Computers- Effects of Interactivity, Speech, and the Emoticon

研 究 生：董 芳 武

指 導 教 授：鄧 怡 莘 博士

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國立交通大學應用藝術研究所

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摘要

許多研究證實將社會線索置入使用者介面可賦予電腦本身之社會臨場感，有助於提升人們對電腦的認同而產生滿意的互動經驗。電腦即社會成員典範指出人們會對電腦衍生社會性的回應，這在於增進人們對電腦的參與動機提出了具有潛力的應用性。然而這類研究大多以成人為研究對象，因此，本研究擬以兒童為研究對象，探討社會線索在數位學習環境的應用，檢視互動性、語音與臉部表情做為社會線索的應用，就兒童對電腦的態度與參與學習動機的影響。

本研究旨在探索如何善用人際溝通中互動性、語音、表情符號的社會特質作為社會線索應用在數位學習環境中，在兒童參與學習活動時對電腦的態度與學習動機之影響。主要的研究議題如下：1. 首先，在人機互動中，互動性、語音、和表情符號作為社會線索的應用是否足以提升兒童之社會臨場感受；2. 再者，透過這些社會線索的提供，是否能影響兒童對電腦衍生社會吸引；3. 最後，社會線索置入於數位學習環境中是否能提升兒童的學習動機。

本研究執行三個研究以檢視上述所提出之議題。首先進行研究(一)探討人際溝通中互動性和語音轉換於使用者介面之互動設計，是否能讓兒童體驗較強的社會臨場感與社會吸引感受，並提升他們參與學習的動機，研究結果顯示社會線索確實能提升兒童與電腦的互動經驗與參與數位學習之動機。基於研究(一)的成果，著手執行研究(二)比較語音和表情符號作為社會線索的應用，並預測兩者具有相當的影響力，但研究結果指出表情符號未能達到語音所產生的影響程度，此研究結果促使研究者進一步討論臉部表情在人際溝通中的本質。根據研究(二)的結果與討論，研究(三)的執行目的在於檢視語音和動態表情符號作為社會線索應用於數位學習環境中，就兒童對電腦的態度與學習動機之影響。研究結果證實語音和動態表情符號的影響程度並沒有顯著的差異，此外，結果分析中發現性別差異影響兒童對語音和動態

表情符號的接受與偏好。

經由本研究執行，可具體達成以下目的：1.獲知如何將人際溝通中的互動、語音、和臉部表情轉換為社會線索應用於介面設計；2.理解電腦即社會成員典範在以兒童為對象的應用性；3.了解互動性、語音、和表情符號之社會線索對兒童與電腦互動中社會臨場感與社會吸引的影響； 4.了解互動性、語音、和表情符號應用於數位學習環境中，對兒童參與學習動機的影響； 5. 以研究為基石，提出發展社會化與激勵性之介面設計策略。本研究模式不僅可應用於相關產業，同時提出一個以兒童為使用者的研究方法探討社會臨場感之互動設計對使用者的參與感受與學習動機之影響。

關鍵詞：互動設計、互動性、語音、表情符號、兒童、社會臨場感

Social Interaction between Children and Computers- Effects of Interactivity, Speech, and the Emoticon

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Abstract

Researchers have shown that incorporating social cues into a user-interface enables a computer to create a social presence, which helps people better identify with the computer and results in more sociable experiences. The CASA (Computers Are Social Actors) paradigm asserts that human to computer interactions are fundamentally social responses. It shows potential for improving engagement and motivation. Much of this research has been focused on adult subjects. This research discussed the effects of the management of social cues in children's e-learning environment development. Specifically, it examined the roles that interactivity, speech and the emoticon play in an e-learning environment in the development of children attitudes toward computers and their intrinsic motivation.

The research aimed at exploring how to utilize the social attributes of interactivity, speech, and the emoticon as social cues, as well as obtaining an insight in what effects these social cues have on children's attitudes toward computers and learning as employed in e-learning environments. It intended to focus on the following issues raised in the research. 1) The first issue of concern was whether the manipulation of such social cues as interactivity, speech, and the emoticon can be effective enough to generate strong feelings of social presence in child-computer interaction; 2) The second issue of concern was whether social cues provided by computers have an impact on children's perception of social attraction; 3) the third issue concerned whether computers with social interfaces could foster children's intrinsic motivation for learning.

Three studies were conducted to investigate the impact of interactivity, speech, and the emoticon on the issues addressed above. The first study tested whether modeling the computer to user interaction after the two factors in interpersonal communication could allow children to experience stronger feelings of social presence and social attraction, as well as sustain their intrinsic motivation with learning. The preliminary results gave us an idea that children's attitudes toward computers can be influenced significantly and positively by the social cues rendered by a computer interface. Based on the results obtained from study I, the research then conducted the second study to compare the effects of using speech and the emoticon as social cues in e-learning environments on children. The results of study II showed that the effects of emoticon do not reach the same level as the effects of speech, and as such were not consistent with the predictions. As a result, the nature of facial expressions in interpersonal communication was reviewed further. According to the results and discussion of study II, the study III was conducted to test the effects of the use of speech and dynamic emoticons as social cues on children's attitudes toward computers, as well as their motivation within learning. Similar effects of the two social cues on children's attitudes and motivation were observed. It was found that gender differences influence children's perception and preference of speech and dynamic emoticon.

The following goals were attained through the research: 1) to acquire the knowledge of how to employ interactivity, speech, and facial expressions of interpersonal communication as social cues in application to interface design; 2) to comprehend the implementation of the CASA paradigm to target children; 3) to understand effects of social cues of interactivity, speech and the emoticon on children's feelings of social presence and social attraction; 4) to comprehend the impacts of interactivity, speech and the emoticon in e-learning environments on children's motivation for learning; 5) to propose a set of principles for the design of more sociable and motivating interfaces. The results of the research are useful not only to relevant industries, but also to those interested in exploring how children react to the feelings of social presence and motivation created by an interactive system.

Keywords: Interaction design, Interactivity, Speech, Emoticon, Children, Social presence

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1. Introduction

1-1 Background

1-1.1 The coming trend in Human-Computer Interaction and social interfaces

Norman (2004) has suggested that people are emotional and social creatures and has mentioned the role of human emotions as an influencing factor in the way people deal with and relate to objects and artifacts. Thus, in addition to usability issues, design of products has to take human emotional needs and social desires into consideration. A similar trend appears in the field of Human-Computer Interaction. Many researchers have revealed that human-computer interaction is on both a social and emotional level. In light of their findings, researchers have started to explore new theories that enable or augment socio-emotional interaction between people and computers (Picard, Wexelblat, & Nass, 2002; Muller, 2004). "The coming revolution in computing is social" Microsoft chairman Bill Gates declared in a speech at the Consumer Electronics Show in Las Vegas. He pointed out social interface as something that has immense depth, and can be used to make the machine fun and more predictable (Harmon, 1995).

Indeed, technologists have aspired to make computer interfaces more human-like and sociable since it was suggested that more humanized interfaces convey a sense of comfort and ease to the user. (Laurel, 1990; Sproull et al, 1996). Shneiderman (1998) suggested that people seem to have a primitive urge to anthropomorphize objects. According to familiarity and comfort theses (Guthrie, 1997), it may come from human beings' primarily cognitive motivation to understand the world in the way people are most familiar with or from an emotional motivation to reduce the discomfort of relating to that which is different by making things be more human. It could be said that the interaction between people and the objects in their surroundings is filled with complicated feelings.

The demand for more human computer features reflects the aspiration for social interactivity as derived from the features of interpersonal social activities, together with the dependent attachment to familiar feelings and intimate relations. As mentioned by Norman (2004), people have evolved to interpret even the most subtle of indicators and are predisposed to anthropomorphize, and so to project human emotions into everything. From the perspective of the human tendency to interpret and anthropomorphize things, anthropomorphic responses can bring great delight and pleasure to the user of a product.

Besides the use of sophisticated computing technology or artificial intelligence, utilizing social cues in user interface may offer an uncomplicated and inexpensive way to achieve a humanized interface. Moving beyond theory, several experimental studies have demonstrated that people do not respond to a computer merely as a tool. Instead, individuals bring to bear a wide range of social rules and learned behaviors that guide their interactions with and attitudes toward computers (Picard, 1997; Picard, Wexelblat, & Nass, 2002; Reeves & Nass, 1996). The finding that people appear to have social relationships with computers raised attention for its potential to promote the interaction between humans and computers. Computers could act as social partners of humans. From this perspective, Nass et al. (Nass, Steuer, & Tauber, 1994)have empirically proven that people socially interact with computers and claim that "Computers are social actors (CASA)", which is widely regarded as one of the foremost developments in the theory of socio-emotional interaction with computer interfaces. CASA claims that computers that exhibit social cues can convey a sense of sociability and intimacy and thereby induce social responses from people, which leads people to treat computers in the way as they treat other people. Research on the CASA paradigm has received a great deal of attention in the recent past and has been recognized as a direction for interface design in the future (Picard, et al., 2002). IT-related businesses, such as web design, application design, and software design, have managed to explore the potential application of CASA. This effort has been devoted to creating sociability in human-computer interaction to increase the use and acceptance of computers.

The CASA paradigm is based on a concept of social presence, and involves the social responses of people not to other entities within a medium, but to cues provided by the medium itself (Lombard & Ditton, 1997). This paradigm has been shown to have a significant affect on human to computer interactions. It shows a potential strategy for interface design which uses interaction to improve engagement and motivation in a computer-mediated learning environment. CASA studies suggest that if a computer exhibits even minimal social cues it can induce people to treat the computer as a social actor rather than as an inanimate tool. This social response from the user can facilitate a more intimate human-computer interaction. This in turn improves user attitudes toward computers and fosters a more beneficial relationship between users and computers.

One conclusion that can be drawn from these studies is that people tend to feel that computers are friendlier, more attractive, and more helpful if they exhibit social cues. These studies of the user's social interaction with computers have come to be noticed in the field of human-computer interaction. In addition to triggering the interest of numerous scholars, there have also been several business organizations which have adopted the research on the subject of "Computers Are Social Actors" to create many successful business applications. These include Bob, the product made through the collaborating effort of Microsoft and Nass et al. Their effort attempted to make computers that featured much more humanity and also numerous applications in websites, service systems and education media. Both education-related departments from University of Florida and Michigan State University collaborated to research different ways of applying the concept of "Computers Are Social Actors". Through this effort, learning media was allowed to demonstrate the presence of sociability (Ferdig & Mishra, 2004). They suggested that designers of education technology should emphasize the possibility of social interactivity among interpersonal relations. From the view of creating social interactivity between learners and learning media, an inactive design attracting people's learning motives can be created.

1.1-2 Extending the employment of CASA to children's e-learning environments

The CASA paradigm is an important issue and should compel more interface designers to consider its employment to improve human-computer relationships. Numerous experiments have been conducted with adults and considerable evidence has been delivered. Few experiments however have focused on children or tested whether children respond similarly to computer social cues (Bracken & Lombard, 2004). Thus, this study tries to extend the concepts of CASA to the e-learning environment for children. Turkle (1984) has conducted a long-term observation of juvenile computer users, considering their interrelationship from the discipline of psychoanalysis. She has found that the boundary between computer interactions and live interactions is blurred in children. Children tend to anthropomorphize computers and endow them with human intelligence. This notable finding may provide powerful evidence to support the idea that children respond socially to computers in ways similar to adults, and may in fact respond to an even greater degree. This finding also raises the question of whether children are fundamentally social with computers regardless of social cues. This area should be explored in more detail as the authors hope to extend the employment of CASA to children.

Computers have expanded the available learning channels for children and provided them with a potential way to learn by themselves. The focus on design of computers for children's learning is different from those for task-oriented purposes. In addition to the issue of usability, the design of computers needs to improve engagement and motivation for younger users (Chiasson & Gutwin, 2005; Druin & Inkpen, 2001). Admittedly, computer-mediated learning initially appeals to many learners because of the novelty of the experience, the variety of features offered, and the cumulative effects that graphics and animation have on the learning experience (Brown, 1986). However, Keller (1997) pointed out that the component of motivation which is attributed to novelty tends to wane as computers become more widely used in the student's environment. As the excitement associated with these novel features diminishes, it becomes more challenging to stimulate and sustain learners' motivation while they engage in computer learning activities. One common strategy is to offer an entertainment-oriented interactive experience with the goal of enhancing a learner's motivation by making learning fun (Malone, 1981; Malouf, 1988). While this is a valid approach, entertainment is not appropriate for all learning modes and applications. It is, therefore, important to explore other possibilities and methods by which to increase and sustain learners' motivation and involvement in the e-learning environment. Another approach that may be effective would be the "computers are social actors (CASA)" paradigm (Nass, Steuer, &, Tauber, 1994). With this as background, the research attempts to extend the concepts of CASA to e-learning environments for children.

1.1-3 Study effects of interactivity, speech, and the emoticon

The research aims to extend the employment of the CASA concepts to children and to study their attitudes toward computers and motivation with learning within e-learning environments augmented with social cues. Specifically, it attempts to investigate the effects of such social cues as interactivity, speech, and emoticons on children by understanding the nature of the way people communicate and how the roles of speech and facial expressions in interpersonal communication function as social cues in human-computer interaction.

As long as social groups continue to be an integral part of human life, human sensitivity to voice and language cues has a critical role to play in the interactions among people. That is to say speech is social and plays a dominant role in interpersonal communication; and interactivity is an inherent property of the communication process. Interactivity does not mean verbal and nonverbal codes per se but offers potentially valuable insights into their interrelationships. Comparing speech with interactivity during interchange, the former is sensible and explicit while the latter is latent and implicit. Hence, it is interesting to explore how to utilize those features as cues being incorporated into interface design to enhance the social attributes of computers, as well as to investigate whether social cues could positively impact on the social interaction between children and computers.

Facial expression in addition to speech plays a crucial role in interpersonal communication. It can nonverbally express emotions to others and serves as the most powerful external representation of emotion. Besides this, people process faces differently than all other objects just as they process voices differently than all other sounds. If we compare speech with facial expression, the former is a channel of verbal communication and an audio modality while the latter is one of nonverbal communication and a visual modality. The emoticon, a blend of "emotion" and "icon", is intended to represent a human facial expression and convey an emotion. Thus, the comparison of speech and the emoticon relates to a further issue, that of verbal communication versus nonverbal communication as well as audio modality versus visual modality. The study also attempts to better understand the management of emotion via the use of speech and the presentation of emoticons in interface design.

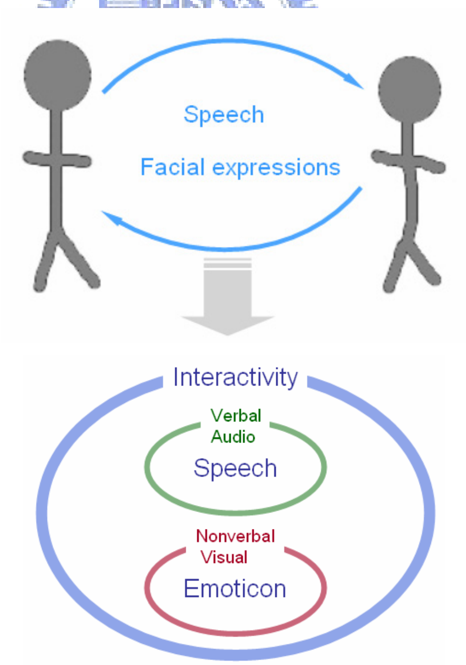


Figure 1-1 Employing Interactivity, speech and facial expressions in interpersonal communication as social cues

In sum, the research explores whether modeling the human-computer interaction after interpersonal communication can indeed endow a computer with the attribute of social presence and thereby become socially attractive to children. It goes further to test how this treatment would affect children's intrinsic motivation. Results of the research could provide designers with evidence-based design principles founded on research when they are developing relevant products targeting children and considering interactivity, speech and the emoticon.

1-2 Objectives

This research attempted to use social cues of interactivity, speech, and the emoticon in e-learning environments and test whether children respond socially to computers providing social cues. It aimed at investigating whether social interaction exists between children and computers and testing if the social interaction contributes to e-learning. The objectives of the research are as follows:

1. **To explore how to employ interactivity, speech, and facial expressions of interpersonal communication as social cues and to apply them to interface design.**

   Interactivity, speech, and facial expressions play important roles in communication, human-to-human interaction and perception. The research intends to study the nature of the aforementioned three elements of interpersonal communication and how they function as social cues in computer interfaces.

2. **To extend the implementation of the CASA paradigm to target children**

   The CASA paradigm suggests that people respond to computers and other forms of media in the same way that they respond to real people. One benefit of this work is that computers exhibiting sociability make users' experiences more positive during interaction, leading to increasing the use and acceptance of computers. However very little CASA-related research has been done with children to examine the effects of social cues provided by computers on children's attitudes toward computers and on the way they interact with computers. This study therefore manages to extend the employment of the CASA concept to children and to more clearly understand their attitudes toward a computer's social attributes.

3 To compare the effect of the social cues of interactivity and speech on children's feelings of social presence and social attraction as well as the comparison between the effect of the social cues of speech and the emoticon.

Interactivity, speech, and the emoticon (representation of facial expression) are essential elements in communication. Each one entails various aspects of social attributes. To obtain an insight of how the three elements function as social cues to make computers more humanized and sociable, the research first compares the effects of interactivity and speech on children's feelings of social presence and social attraction toward computers, and then the effects of speech and the emoticon were compared as well.

4. To investigate the effect of interactivity and speech in e-learning environments on children's motivation with learning, and the effect of speech and the emoticon is investigated as well.

The research also explores the effects of social cues of interactivity, speech, and the emoticon used in e-learning environments on children's motivation for learning. Numerous studies claim that social presence within e-learning environments serves as a positive factor in motivating learners. The social presence in the said studies involves learners and instructors in an online environment. The research focuses on the possibility that the social presence of the computer itself can play an effective role in engaging an individual in learning, especially in the form of individual self-paced learning. Computers may be perceived as learning partners to improve motivation while a single learner participates in computer learning activity with no instructor involved.

5. To propose a set of principles for the design of more sociable and motivating interfaces

The research manages to leverage the social attributes of interactivity, speech, and the emoticon for interface design to make computers more humanized and sociable and then investigate the possibility of social interaction and relationships between children and computers. This effort aims at supporting children's social needs and sustaining their motivation in learning during interaction with computers. Results of the research can be used for the practical development of learning software, educational products and systems, or interactive toys which target children.

1-3 Framework of dissertation

In the following chapter outlines the literature relevant to social presence, Computers are Social Actors, social presence and e-learning environments, and children's reactions to computers. In the chapter 3 interactivity, speech, and the emoticon will be defined and the way they function as social cues will be detailed. The research issues and the methodology adopted will be described in chapter 4. The method and the results of study I, study II, and study III will be discussed in detailed in chapter 5, 6, and 7, respectively. The three studies were linked by the theme of exploring how interactivity, speech, and facial expressions function as social cues and what effects these social cues employed in e-learning environments have on children. Finally, chapter 8 will provide the general conclusion and future research.

2. Interactions and Relationships between Humans and Computers

Technology drives social change. Mcluhan (1964) proposed that the main technology and medium used in a society has a determining effect on culture. The introduction of new technology will make an impact on society and culture. The dominant medium will influence the way human experiences are interpreted. Generally, a technology determines or dictates how individuals in a society will react to and with different media and the world (Bracken, 2000). Mcluhan (1964) argued that media and technologies affect the human mind and senses, and proposed that media and technologies are extensions of man. Any extension, whether of skin, hand or foot, affects the whole psychic and social complex. The personal and social consequences of any medium–that is, of any extension of ourselves–result from the new scale that is introduced into our affairs by each extension of ourselves, or by any new technology (p.7). Any medium or technology is seen in terms of the change of scales pace or pattern that it introduces into human affairs. Thus, computers, being the dominant technology and medium of the age, play an influential role in reshaping the interplay between media, people, and their surroundings. As asserted by Bolter (1984), the computer is the latest and most radical defining technology as it has become the dominant metaphor for the human mind in popular culture. Bolter argues that throughout history, technology has transformed human thought on two levels: self-conception and relation to nature. Bolter uses the term ‘defining technologies’ to describe technical innovations which have defined or redefined humanity and its relationship to the natural world.

Society is more than just people; it includes the interrelationships among them. Likewise, computing technology is not just about computers and processing of data but it is also worthy to note the relationships among its use and its users (Marakas, et al., 2000). Obviously, the computer appears to have made a remarkable impact on the experiences of humans and their relationship to their surroundings since it came into the world. Being extensions of the human body and senses, the computer insinuates itself into people's lives in various ways. The way the computer affects how people interpret and think about themselves has manifested itself in language. It is common that CPU or RAM specification could be used to describe human capabilities or a metaphor of the computer could be used to symbolize the human brain as a computer. Turkle (1984) said that language like this carries an implicit psychology that equates the processes that take place in people to those that take place in machines. Besides this, the computer also brings unprecedented experiences to people, such as social presence, in various ways.

2-1 Social presence

The term, presence, was coined by Minsky (1980) who used "telepresence" to refer to teleoperation systems for remote manipulation of physical objects and a physical sense of "being there" in a remote, mediated location. Since then, media scholars use the term "presence" to refer to the generic perception of being in an artificial or remote environment and are interested in how people are influenced by media presentations (Sheridan, 1992). Lombard and Ditton (1997) have defined presence as "illusion of nonmediation". It is available to create the connection between consciousness and experience only when people's perception towards external experience can be operated by mediation. Mediation acts as the communication mechanism. When mediation and personal perception are combined, the feeling of presence to materialize objective knowledge or the external world immediately occurs (Tung, 2006).

The dimensions of presence are generally categorized into two types: physical and social of presence. Physical presence refers to the sense of physically being in or near a mediated environment. This can be achieved by providing people with, for example, virtual reality systems . Social presence is defined as the degree of awareness of another person in an interaction and the consequent appreciation of an interpersonal relationship (Walther, 1992). Biocca (1997) declared that social presence occurs when users feel that a form, behavior, or sensory experience indicates the presence of. Social presence in a computer-mediated communication environment refers to the user's degree of feeling, perception, or reaction being connected to another intellectual entity, which involves a subjective quality of the communication medium related to the psychological concepts of social intimacy and immediacy (Short, Williams, & Christie, 1976; Tu & McIsasc, 2002). In other words, intimate or immediate responses provided by a medium contribute an appreciable degree of social presence. Lombard and Ditton (1997) outlined six conceptualizations of presence, among which four refer to social presence.

1. Presence as social richness- It occurs that medium is perceived as sociable, warm and personal when it is used to interact with other people. A medium high in presence of social richness allows interactants to adjust more of voice quality, facial expressions, gestures, and so on.
2. Presence as Transportation- This involves the idea of transportation consisting of three different types:: "You are here", in which the user is transported to another place; "It is here", in which another place and objects within it are transported to the user; and "We are together", in which two (or more) communicators are transported together to a place that they share.
3. Presence as Social Actors within Medium- This may be called para-social interaction which refers to the relationship between a television personality and a television viewer. In a parasocial interaction media users respond to social cues presented by persons they encounter within in a medium.
4. Presence as Medium as Social Actor- It involves social responses of media users not to

entities (people or computer characters) within a medium, but to cues provided by the medium itself.

From the four conceptualizations of presence mentioned above, people could discern different amounts of social presence in various types of media. Studies of social presence not only focus on the feeling of being together (and communicating) with a mediated person, but also explore the perceived social presence created by the medium itself. The "Presence as medium as social actor" occurs when an individual feels a sense of social presence from the medium itself and then perceives it or interacts with it as if it is a veritable social actor. It involves social responses of people not to other entities within a medium, but to cues provided by the medium itself. Studies claim that if computers exhibit social cues, people will treat the computers as social actors rather than as inanimate tools. Several empirical studies have demonstrated that people do not respond to a computer merely as a tool. Instead, individuals bring to bear a wide range of social rules and behaviors that change their interactions with and attitudes towards computers. The most studied type of social presence is represented by CASA research. The concept of CASA (Nass, et al., 1994) points that social cues exhibited by the computer lead users to treat the computer as a social entity.

2-2 Computers Are Social Actors

2-2.1 Social responses to computers

Reeves and Nass (1996) have gathered their empirical evidence into the book, "The *Media Equation: Media equate real life to argue that people tend to equate media and real life*." The book claims that people treat media socially as they treat other people in real world experience. People unconsciously apply social behaviors such as politeness and reciprocity to media. Based on the surprising findings, Nass et al (1994) have proposed the "Computers are Social Actors" paradigm to highlight the way in which people attribute social or human characteristics to computers when those computers demonstrate sufficient social cues.

Several studies provided evidence that people are influenced by a computer's social attributes and subsequently treat the computer the way they would treat humans. The findings reveal the phenomenon that the way people interact with computers is potentially social; moreover, they provide a new perspective on social psychology to fulfill the goal of humanizing interfaces. Employing social cues derived from social psychology and sociology to interface design can enable users to sense a high degree of social presence from the medium itself and a sense of intimacy accordingly. Such perceptions may elevate the human-to-computer relationship to the level similar to human-to-human relationship. The CASA paradigm seeks to incorporate a set of contextual cues into user interface design by replicating human-human interaction in the context of human-computer interaction. The general structure of CASA paradigm begins with picking a social science finding (usually social psychology or sociology) concerning behavior or attitude toward humans, and then substituting 'computer' for 'human' in the statement of the theory and replicating the methodology of the social science study but replacing humans with computers, and finally determining whether or not social rules still apply. CASA-related research draws on literature which can be grouped into the following four categories:

(1) Exploring human attitudes toward computers exhibiting human traits: Research conducted by Nass et al. (Moon, 1996; Nass, & Lee, 2001) supported the existence of similarity attraction between humans and computers. The Computer can exhibit either extroverted or introverted traits by manipulating its voice, or presenting either submissive or dominant personalities by manipulating its text feedback. Isbister and Nass (2000) demonstrated that people sense and interact with a character's personalities via verbal and non-verbal cues and prefer a character that is complementary to them. The results described above suggest that humans are influenced by the traits of the computer that are exhibited during interaction, and the computer's personality can be created by using minimal psychological cues (e.g., verbal style, voice, and postures).

(2) Exploring whether people apply social rules and norms to computers: It is found that humans react to praise or flattery from a computer in the same way as they react to these messages from humans. Studies also showed that people will act according to the norm of reciprocity or apply politeness norms when interacting with computers (Fogg, & Nass, 1997; Morkes, Kernal, & Nass, 1999).Tzeng's (2004) study suggests that a computer offered apologetic feedback triggered people's social schema and made them behave in a civilized way.

(3) Exploring whether and under what conditions people would affiliate with a computer: Nass and his associates have demonstrated that people affiliate with computers in a team relationships via minimal cues of social identity in a controlled interaction (Nass, Fogg, & Moon, 1996) The ethnicity of a computer agent will affect the attitudes and behaviors of a user in line with social identity theory.

(4) Investigating the effect of the way computers interact with users: The study conducted by Klein, Moon, and Picard (1999) revealed that social-affective feedback with text-only interaction was able to alleviate users' feeling of frustration. They then suggested that designers should consider the user's emotional state as an interactive factor during design processes. In view that people tend to like and be more willing to cooperate with a humorous person, Morkes et al. (1999) studied effects of humor in human-computer interaction and computer mediated communication. It was found that people respond to humans and computers in identical ways; participants responded to computers that provided humorous comments in a more social manner, joke back more often, and reported greater cooperation. Brave et al., (2005) demonstrated that computers which are programmed with the capacity for empathic emotion have major positive effects on both liking and trust, as well as on perceived caring and felt support.

Clearly, computer embedded social cues could act more sociable and humanlike and change people's attitudes and behaviors. These findings show an insight into users' social interaction with a single computer. It implies that designers could create a more sociable and intimate user-interface by utilizing social cues properly. The developers need not rely on sophisticated computing technology or artificial intelligence to achieve a humanized interface.

2-2.2 Explanations for social responses to computers

The CASA paradigm states that the interaction between people and computers is social. The phenomenon of social interaction does not derive from a mistaken belief that computers are human, but from a natural human psychological tendency. Nass and Moon (2000) argued that mindlessness is the main cause of humans unconsciously applying social rules and expectations to computers. As stated by Langer (1989), mindlessness is likely to go along with behavior that is influenced primarily by routines and rules regardless of the particulars of current circumstances. That is, when acting in a mindless manner, one is relying on distinctions and categories drawn from past experiences. Langer (1992) indicated the cause of mindlessness is conscious attention to a subset of contextual cues. The cues trigger expectations that focus attention towards certain information and away from other information. Computers nowadays offer a variety of cues that suggest 'humanness'; they use words for output, they offer interactivity (responses based on multiple prior inputs), and they fill roles traditionally filled by humans (Nass & Moon, 2000; Nass, Steuer, Henriksen et al., 1994). From the perspective of mindlessness, these cues are enough to trigger categorization of computers as social actors. This categorization, in turn, often leads people to respond to computers in a social and natural way.

Nass and Moon (2000) outlined the following three human tendencies that cause people to treat computers as social actors. First, people tend to overuse human social categories. People would carry over uniquely human social categories to the computer realm, such as gender and ethnicity, by applying them to computers. Second, people engage in overlearned social behaviors, such as politeness and reciprocity, toward computers. Third, people easily exhibit premature cognitive commitments with respect to computers.

Turkle (1980) described the computer as Rorschach to present the computer as a relatively neutral screen onto which people were able to project their thoughts and feelings. Nevertheless, Turkle (2003) has pointed out that the computational object is no longer affectively neutral. People may perceive computers on a social dimension and attribute personality, intelligence, and emotion to them. She argues that sociable technology can encourage humans to view the computer as a companion not a tool, and further can enhance human performance. Marakas et al. (Marakas, Johnson, & Palmer, 2000), shared a similar view, which they suggested that sociable technology may provide opportunities to enhance human-computer interaction, to improve training and educational activities, and to improve satisfaction with the system. Marakas et al. have extended the CASA paradigm and proposed that four elements serve as inputs to an attribution process which results in an attribution of the computing technology as a social actor. The four elements that influence the attribution toward computing technology are: the social character of the computing technology; the individual's core self-evaluations; the nature of the interaction with the technology; and the presence or absence of certain attributions which relate to the characteristics of the technology, an individual difference, individual experience, and the relationship between an individual and the technology with the social context. Given this, the social characteristics of the technology are regarded as an important input to the attribution process.

2-3 Social presence and e-learning environments

Learning is a social activity that requires a close connection to achieve better quality. Thus, the e-learning environments should take into consideration the learner's desire for social interaction while participating in learning activities. Gunawardena (1995) agues that social presence is necessary to enhance and improve effective instruction in both traditional and technology-based classroom. A lack of social presence may lead to a high level of frustration and a lower level of effective learning (Rifkind, 1992). Aragon (2003) also pointed social presence is important in an online environment due to the isolated nature of the instructional settings. Studies have suggested that enhancing social presence in an e-learning environment can instill the learner with an impression of a quality learning experience. One benefit is to induce and sustain the learners' motivation (Newberry, 2001; Tu, 2001;Walther,1992).

As stated above, a high degree of social presence could create a learning environment that is perceived as warm and approachable for all involved (Rourke et al., 1999), which benefits supporting and sustaining learning objectives by making group interactions engaging, appealing and rewarding. The research, however, mainly focuses on the enhancement of the computer's social presence necessary to create a successful learning experience involving learners and instructors in an online environment. By comparison, the possibility that a learner perceives the social presence created by the computer itself via the interaction and the interface design is seldom explored. In addition to supporting collaborative learning environments, computers used as learning technology can function as tutor, tool, and tutee (Bruckman, & Bandlow, 2003; Taylor, 1980). The latter three genres can be widely seen in a variety of instructional media and educational tools which deliver the ways of individual self-paced learning. When learning in this way the sense of social presence is required even more because the learner is cut off from other peers and tutors. This kind of perception may reduce the learner's feeling of isolation and achieve the instructional goal despite the absence of a human instructor (Tung, & Deng, 2006). Social presence in a computer-mediated communication environment refers to the user's degree of feeling, perception, or reaction being connected to another intellectual entity. Such experiences could enable an individual to perceive that another social being exists and is interacting with them. Thus, computers may be perceived as a social actor to improve motivation while a single learner participates in a computer learning activity with no instructor involved. This research focuses on the social presence and specifically the dimension of presence in which people perceive media technology as social actors.

As stated previously, the CASA paradigm, a concept of social presence, involves social responses by people not to other entities through a medium, but to cues provided by the medium itself (Lombard, & Ditton, 1997). The paradigm suggests that if a computer can be perceived as a social entity that this may improve user's motivation when a child participates in a computerized learning activity with no instructor involved. Thus, a computer mediated learning experience especially designed for individual self-paced learning should afford the learner the feeling of social presence of a partner to facilitate learning. Mishra (2006) also argues that the findings of the CASA approach have the potential to reconfigure the domain of educational technology by forcing designers to evaluate the conception of computer and the other forms of media as being mere tools. Mishra's research (2006) demonstrated that failure to recognize the existence of people's social responses towards media can thwart the pedagogical goals of educational technology and emphasize the importance of the social relationship that can develop between a computer and the learner. As suggested by Fogg (2002), the author of Persuasive Technology, the fact that people respond socially to computer products has significant implications for persuasion. When perceived as social actors, computer products can leverage these principles of social influence to motivate and persuade. The CASA paradigm shows a potential strategy to provide social support and model a target behavior or attitude just right for creating a sociable and motivating e-learning environment (Tung & Deng, 2006a; 2006b).

2-4 Children's attitudes toward objects and computers

2-4.1 Childhood animism

Piaget (1929) contended children's knowledge about world was based on the interaction between them and surroundings. To make sense of the world around them children apply strict rules to new objects (Turkle, 1984). To understand children's attitude toward general objects should be helpful to understand their conception about computers. Accordingly, it is required for us to understand the way children treat and perceive objects. Furthermore, we must understand their perception about computers.

As the research concerns children's attitudes toward computers, the phenomenon of childhood animism should also be considered. Animism was first used by Piaget (1929) to describe children's tendency to endow inanimate things with life and consciousness. He outlined four stages of animism through which children normally go. In the first stage (age of 4-6): a child attributes consciousness and life to anything that is in any way active, undamaged, or useful. A whole dish is alive; a broken dish is not alive. In stage two (6—7) only things that move are given life-like qualities. A ball is alive when it is rolling; otherwise it is not alive. In the third stage (8—10) consciousness is attributed only to things that move spontaneously. The sun and river are alive; a bike is not alive, even when moving. In the final stage (older than age of 11) restricts consciousness and life to plants and animals only. Humans and animals are alive, and many children in this stage state that plants are alive. Piaget (1962) especially pointed out that self-moving is an important criterion used by children to judge the aliveness of objects. Children attribute life to objects which appear to move by themselves,

Inspired by Piaget's finding on childhood animism, Dolgin and Behrend (1984) expanded on the research to test children across a wide age range from age 3 to 9. The children were asked twenty questions about stimuli reflecting the basic differences between animates and inanimates, and comparing their answers with those of adults. These stimuli were presented as photographs including animate beings and inanimate objects: human adults, preschool-age children, infants, mammals, birds, fish, insects, cooked, obviously dead animals, plants, dead plants, naturally occurring immobile objects, man-made immobile objects, naturally occurring mobile objects, objects commonly made by young children, and dolls. The questions were as follows: Which of these grow? Can die? Have a brain? Eat? Get thirsty? Are sometimes happy? Can hurt and feel pain? Can drink? Have dreams? Sleep? Might want to do something or to have something? Have a mom and dad? Might understand you if you talk to it? Can move all by itself? Are sometimes naughty? Can do things on purpose? Might be a boy or a girl? Can see? Might like you? Are alive? It was found that apparently self-moving or animate-appearing objects yielded more errors in children, especially in 5-year-old children. 3- and 4-year-olds were less likely to respond animistically than 5-year-olds. Interestingly, the finding revealed that animism does not appear to be the most primitive mode of conceptualization. Animism probably demonstrates incomplete knowledge and understanding of the world, but it is also a reflection of children's rich imagination (Bullock, 1985). Dolgin and Behrend argued that certain properties associated with animates (e.g. physical appearance, self-moving) are so potent to 5-year-olds that they presume other animistic properties must be present as well.

2-4.2 Children's concepts of objects change with the coming digital objects

When Piaget proposed the phenomenon of childhood animism, most objects on the world could be easily understood. According to the research conducted by Piaget and Dolgin, attributes like inanimates linking motion or physical appearance association in mind, could be recognized. This recognition would make children view them as living individuals. All the said attributes were all visible and tangible in physic nature. However, since the late 70s' we have seen the continuous occurrence of electronic games and toys,. These digital products could actually affect children's knowledge about the natures of objects and the ways to understand them. In Turkle (1984) study children were asked to sort pictures of objects into "alive" and "not alive" categories and explain choices. The stimuli include natural entities (like the sun, a cloud), animals (like a dog, an insect), plants (like a tree), products (like an alarm clock, an airplane, a telephone) as well as computer toys (like Merlin, speak and spell). It was observed that objects which manifest human qualities like intelligence and speaking as well as motion lead children at age 4-6 to conclude that those objects are alive. With the capabilities of speaking and thinking, the computer seems to act more human than other objects. As a result of this, the way children categorize humans, machines, and animals may change further. Turkle (1984) also argued that children view traditional objects as living/dead individuals in physical terms. As for digital objects, the physical characteristics are opaque or even dismissed. Children turn to a psychological way to understand them because of their human behaviors, such as talking or thinking.

Scaife and Duuren (1995, 1996) compared children's and adults' judgments of brain and brain-related behavior of entities with differential anthropomorphic similarity (person, robot, computer, doll and book-objects). Subjects were asked questions of whether each of the entities had a brain and heart, where the brain was located and what the brain was made of. It was found that 5-year-olds tended to attribute a brain to the person only, while older children and adults commonly attributed a brain to the person, robot and computer. Compared with young children, older children's conception of the brain seems to be more flexible in that they appeared to indicate that there are different types of brains. Older children were found to associate cognitive and mental acts with the brain, whereas younger children were found to be limited in their brain understanding and brain-related attributions. The finding reveals that children's conceptualization of the brain or intelligence evolves with age. The criteria children used to attribute intelligence to inanimate objects vary from being based on perceptual cues (i.e., physical similarity to humans) to being based on cognitive capabilities (i.e., apparent intelligence of the artifact).

2-4.3 Granting psychological status to computational objects

Brown's (1988) study investigated how children distinguish between humans and machines and explored how children make sense of advanced mechanical media in the form of life-like, programmable talking toys. The results showed that children's perceptions of media toys are influenced both by motion and speech characteristics of the toys. Children tend to develop parasocial relationships with those toys which have human qualities like motion or speech.

Turkle (1984) used an ethnographical approach to study how children believe and feel about computers and their experiences with computers as well. Turkle stated children's relationships with computers go through three stages. In the first stage, metaphysical, very young children are concerned with whether the computers think, feel, and are alive. The more contact children have with computational objects, the more they tend to believe those objects are alive. The reasons children think computers are alive involve the ability of computers to provide speech feedback and present emotion. For example, a four-year-old child explained why she thinks the computer is alive because it has a talking voice in it (p. 48). Another eight-year-old stated "Things that talk are alive" (p. 48). Children also believe computers in possession of emotions and used the showing of emotion as a justification for counting a computer as alive. A seven-year-old child, for example, said "You see; it is happy now. It made a happy sound (p. 50)." In the second stage, mastery, children are all involved with the question of their own competence and effectiveness. They do not want to philosophize, but want to win while working with computers. In the third stage, identity, children are interested in what they can do with computers. By using computers, they can keep a diary, program computers, and do other self reflexive activities. The activities of children working with computers express something of who they are, giving them a chance to understand themselves. In this way, the computer functions as a constructive as well as a projective medium.

Turkle's research revealed that the evolution of children's relationship with computers was a process of natural development and the development could keep pace with children's recognition growth equally. The younger children could much easier hold opinions that computers were featured with real life than older children. In keeping with the study of children and computers, Turkle (1995) has indicated today's children know the computer is not alive and the issue of aliveness has moved into the background. The notion of the computer has been expanded to include having a psychology. Children are willing to grant psychological status to computational objects, and endow them with properties, such as having intentions and personalities, previously reversed for living beings. It means that computational objects in the category "machine", like objects in the categories "pets" and "people", can play the role of partners to humans. Children are increasingly likely to project human qualities on computational objects, which are blurring the people/machine distinction. Turkle (1995) concluded two reasons lead children to attribute psychological properties to the computer. First, the computer is responsive; it acts like it had a mind. Second, the machine's opacity keeps children from explaining its behavior by referring to physical or mechanical properties. Being responsive and opaque, the computer is associated by children with other objects with the same properties: the human mind.

Interestingly, the tendency to connect the computer with human qualities does not fade with age, so that the CASA paradigm suggests that adults socially respond to computers and treat them not simply as tools but as a social actors, too.

2-5 Summary

The computer, being a dominant medium of the age, has not only made an impact on society and culture, but also influenced how people interpret and think about themselves. Moreover, the computer also brings unprecedented experiences to people such as social presence in various new ways. "Presence as Medium as Social Actor" reveals that the interaction between people and computers could be social. The CASA paradigm has empirically proved that people treat computers exhibiting social cues as social actors. Such perception does not derive from a mistaken belief that computers are human, but from a natural human psychological tendency. Humans mindlessly apply social rules and expectation to computers. These responses are mainly as a result of those individuals' previous social experiences and the accumulation of learned social behaviors toward computers. The fact that social responses to computers are easy to be induced by minimal social cues provides a means to empower computers to be more friendly, human, and sociable.

Numerous experiments have been conducted with adults and considerable evidence has been delivered. Few experiments have paid the same attention to children or tested whether children similarly respond to computer's social cues. The research intends to extend the research focus and application of the CASA paradigm to children. When approaching this issue, the possibility that childhood animism may lead children to unconditionally endow computers with mental and human qualities should not be ignored. The features that computers have of responsiveness and opacity lead children to intuitively associate the computer with human brain. Children's tendency to animate objects may provide powerful evidence to support the idea that children respond socially to computers in similar ways as adults or even to a greater degree. At the same time the tendency may raise the question of whether children are fundamentally social with computers regardless of social cues. Moreover, if children can perceive the sense of social presence via social cues of a computer itself and generate social attraction toward the computer, it may provide a strategy where interaction is specifically designed to engage children within the e-learning environment. This question warrants further exploration in more detail as the authors seek to extend the employment of CASA to children. The research tries to leverage the attributes of interactivity, speech, and the emoticon to empower computers to be more humanized and sociable, which will be discussed in the next chapter.

3. Interactivity, Speech, and the Emoticon

Literature regarding interactivity, speech, and the facial emoticon and how they function in the social context are reviewed in this chapter.

3-1 Interactivity

When people say that humans are social beings, they are speaking of the human tendency to conduct social activities and associate with others. Human communication is a universal and essential feature of an individual's social life. The processes and outcomes of human communication vary systematically with the degrees of interactivity afforded or experienced. Interactivity is not about nonverbal and verbal codes per se; rather, it offers potentially valuable insights into the interrelationship of humans and computers (Burgoon et al, 2002). Rafaeli (1988) argued that interactivity is one of the properties of the communication process, and he maintained that interactivity is variable given the way preceding messages are related to even earlier ones. That argument means that interactivity is a condition of communication in which participants are mutually engaging and taking turns as sender and receiver (Hanssen, Jankowski, & Etienne, 1996; Rogers, 1995). Interactivity can be viewed as a mutual process where message exchange and role exchange are two essential elements for maintaining the process and taking it forward. These two features derived from interpersonal communication can be developed into a set of social cues to evoke a sense of social presence.

Marakas et al (2000) suggested that the social character of computer technology serves as an important element enabling people to view the computer as a social actor. In regard to the social character of technology, Marakas et al noted that promoting the sense of interactivity is one way to encourage the desire to incorporate social characteristics into the computer, and that perceptions of control have been proposed as a main category of social characteristics, which occur when the user's interaction with the computer is such that the individual is being directed in a proactive manner by the technology. Interactivity here is referred to as a means of developing sociable technology, and it involves a perception of control. Relevant educational literature shows that perceptions of control are critical to a computer-mediated learning environment. Popular arguments state that placing the learner in control can increase motivation (Schnackenberg & Sullivan, 2000; Yeh & Lehman, 2001), while some researches indicate that user control offers no benefits over program control (McNeil & Nelson, 1991). According to the aforementioned reviews, learner-control interactivity indicates that instructional media interact with an individual in a passive manner in which the individual primarily plays the role of sender with the computer as receiver. Passive interactivity may lower the quality of the communication experience, leading the computer to act more like a tool and fail to satisfy the learner's desire for a social relationship during the interaction. These studies suggest that instructional media that interact with the learner in an active manner enable learners to feel a stronger sense of social presence from a computer. Such awareness allows children to treat the computer as a companion, and as such the learning experience can be enhanced by their intrinsic motivation. Therefore, it is argued that both learner-control and learner-controlled communication in an e-learning environment can persuade children to treat a computer as a social actor.

3-2 Speech

Language is a fundamental medium for interpersonal communication. People convey their ideas, emotions, and desires by means of language. Language can be regarded as a social product of the faculty of speech, that is to say it is a human communication system based on speech sound (De Saussure, 1959; Pearson, 1997). In general, language competence is an inherent human ability and speech performance is the externalization of communication. Indeed, humans have developed language skills out of the need to communicate. As long as social groups continue to be an integral part of human life, human sensitivity to voice and language cues has a critical role to play in the interactions among people. That is, voice plays a dominant role in interpersonal communication. As said by Nass and Brave (2005) “that humans have become voice-activated, with brains built to rapidly equate voices and people and quickly act on the identification” (p. 3). Speech is more than merely the speaker sending messages to the listener. In the case of a computer user, speech conveys a social presence resembling human-to-human relationship. Jensen et al. (2000) also concluded that the voice has special properties that evoke a sense of social presence and proclivity to collaborate.

Chalfonte et al (1991) has empirically demonstrated that speech is a more expressive medium compared to text because the features of the voice as a means of expression allow communicators to devote more attention to the content and keep their audience’s attention during its creation. Moreover, speech modality appears to support or encourages the social process of collaboration to form social bonds. It has also been found in other studies that speech in computer-mediated communication has the unique feature to create social presence (Keil & Johnson, 2002).

Humans are good at extracting the social aspects of speech as a result of human evolution. Numerous studies related to the CASA paradigm suggest that the human-computer relationship could be leveraged by activating the social aspects of speech (Nass, & Brave, 2005). The social attributes of speech could induce people to associate computers with humans, which is of benefit in increasing the identification and preference toward computers. Through an interactive way of guidance and feedback of speech, the perceptions of human to human communication could be reached.

Inspired by the CASA paradigm, Strommen and Alexander(1998) created two character-based interactive learning toys with audio interface. The toys with audio interface could ask questions, offer opinions, share jokes, and give compliments. They observed that children smiled and nodded in response to the character's praise, and several even responded verbally. For example, Children said "I know" as they heard "You're good at this" from the character. Speech not only can draw children's attention to its content, but can also induce social responses. Brown's (1988) study showed that speech, being more of a human quality, appears to exert a stronger influence on children to create a parasocial interaction with talking toys. The phenomenon that talking toys elicit social responses from children can be seen in Turkle's (1984) study on how children interact with the computer toy, Speak and Spell. It was found that children are sure that Speak and Spell is alive because it talks. Turkle stated that talking is a part of a large set of attributes used to construct the notion of alive/dead when the child confronts a computer toy. Children try to make sense of the computational objects with lifelike properties by way of developing psychological reasoning.

Thus, the study believes that using speech in computers can not only enable audio output interface or complement visual interface, but can provide an individual with a sense of social presence via its social attributes. Hence, speech applied in an e-learning environment can allow a child to feel like he or she is learning with a social partner, enhancing the child's social or intellectual attraction toward the computer and improving intrinsic motivation.

3-3 Facial expressions and emoticons

3-3.1 Facial expressions

In addition to verbal cues, nonverbal cues play essential roles within interpersonal communication, among which facial expressions are the most common signal. Ekman (1993) stated that humans have particularly well-developed abilities to accurately recognize emotional facial expressions. It has been argued that non-verbal cues can exert an equal or greater influence on the understanding of emotions in conversations than verbal messages alone; visual cues involving faces are considered to be the most influential (Burgoon et al., 1996). People regard facial expressions of emotion as more trustworthy than words (Ekman, & Frieser,1975).

Ekman and Frieser (1975) proved that some facial expressions of emotion are the same for people everywhere, no matter what their background. There are six universal facial expressions of emotion involving happiness, surprise, fear, anger, sadness, disgust, together with the neutral. People can tell the facial expressions of emotions by visible changes in the appearance of the face, such as the changes in the location or shape of the eyebrows, eyes, nostrils, lips, cheeks, and chin. As stated, people have particularly well-developed abilities to perceive emotions in facial expressions, even in low quality photos or line drawings. The study of Etcoff and Magee (1992) used drawings of the human face in the form of by the computer-generated line-drawings. The drawings consisted of only 37 lines, but the participants were still able to perceive the emotions accurately. Research conducted by Katsikitis (1997) and Bartneck (2001) demonstrated that emotional expressions by synthetic faces are recognized as well as emotions on natural faces. Bartneck and Reichenbach (2005) further examined the influence of the geometrical intensity of an emotional expression by synthetic faces on the perceived intensity and recognition accuracy. They reproduced six well-known universal emotional synthetic faces, and then manipulated the components of eyes, eyebrows, and a month. The spatial difference of each component between the neutral and the maximum expression was divided into equal parts in order to express different degrees of emotion (e.g., 30% happiness).

These results indicated that the perceived intensity increased with higher geometric intensity. Emotional expressions by synthetic faces can convey different levels of intensity for each emotion between the neutral face and the most intense face. In other words, it is possible to communicate emotions at varied levels of intensity and thereby enable synthetic faces or emoticons to act more subtly. It may be concluded from what has been mentioned above, that the basic facial expressions are universal and can be accurately perceived by humans just from a simple representation of facial expression, not needing a high quality photo or photo-realistic computer rendering. Besides this, emotional expressions by synthetic faces can convey emotion in a subtle way by manipulating the components of eyes, eyebrows, and a month.

3-3.2 Emoticons

The face, being the most important channel of emotional expression, does indeed play a significant role in social communication. The symbols of facial expressions have been applied in human-computer interfaces as a means of communication. Earlier versions of the Mackintosh operating system had used the anthropomorphic icons of happy Mac and sad Mac, representing the need for the computer to alter the state of its use. The icons prompt computers to be user-friendly and accessible.

An emoticon, a blend of "emotion" and "icon", is intended to represent a human facial expression and convey an emotion. It appears that the emoticon was invented by Fahlman who used text-based smiley face on the CMU bulletin board around 1981. Emoticons were defined by Extejt(1998) as symbols composed of punctuation marks designed to express some form of emotion in the form of a human face (see picture 3.1). The use of emoticons in computer mediated communication is popular to enhance the message content by conveying nonverbal information. With the increasing frequency of emoticon usage, recent developments in computer mediated communication make emoticons graphic based, going far beyond the composition of punctuation marks.

:-) :-] %-(:-C :-|

:'-> :-x :-O :'-(:-J

:-D [] >:-| :-{} :-@

:'-) :-(>:-< :-\ :-$

:-} :-P :-< :-/ '-)

Figure 3-1 Emoticons composed of punctuation marks

Although the emoticon occurred later, its development was very successful regardless. Emoticons used as non-verbal symbols of communication within the application computer-mediated communication were immediately accepted and adopted by people after being introduced. They created a concrete visual pictorial expression, and this phenomenon already exceeded the definition made by Extejt in 1998. The emoticon was no longer a combination of punctuation marks only, but featured a more concrete image (shown in Figure 3.2). The latest animation applications have also created more vivid emotional facial expressions. Numerous animation fans have been creating various facial expression symbols available for free download. People's preference and potential demand for using facial expression symbols in intermediate computer communication could be clearly seen.

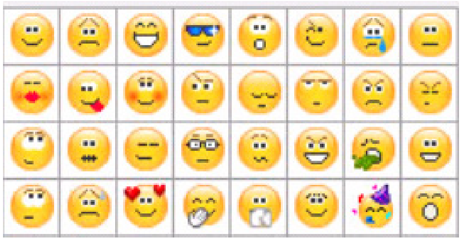


Figure 3-2 Concrete images of Emoticons

According to Takeuchi and Nagao (1993), presenting a human face in a system is of benefit to increase successful human-computer communication. Thompson and Foulger (1996) suggest that emoticons can reduce perceptions of flaming in electronic mail by leading a receiver to view the message as less threatening. As indicated by Rezabek and Cochenour, CMC users often use emoticons as visual cues to expand the meaning of textual electronic messages. Tzeng's (2004) study proposed that computers offered apologetic feedback by using a frown face emoticon that triggered people's social schema and made them behave in a civilized way. Concluded from those studies, emoticons can provide additional social cues beyond what is found in the text, which may enhance the exchange of social information and prompt people to experience a pleasant and affable human-computer interaction.

Rivera et al (1996) found that communicators were more satisfied with a system employing emoticons than those in which emoticons were not present. Walker et al (2001) used a human face in a computer interface and investigated people's responses to it in a context of a questionnaire. They found performance of people in the face conditions was better than in the text condition as they measured and reported that face icons and faces used in computer-mediated communication supplement the verbal cues.

Tzeng had high school students in Taiwan act as the experimental subjects and found it could form a polite interactivity whenever the  facial expression was a feedback responded to students' wrong answers during the operation of computer learning software. This suggested that the computer offered an apologetic feedback, which triggered people's social schema and made them behave in a civilized way. Tzeng's research was mainly focused on interface design embedded with apologizing social modes within interpersonal interactivity. Despite the contents with the adoption of facial expression symbols, there was still no further research on the expression and selection of facial emoticons. As such there is doubt if the symbolic expression  could properly be extended as an apology or if it could properly satisfy the anticipation or preference of learners. The author has made studies within this research focusing on the facial expression symbols preferred or anticipated by people within various interactivity settings.

Dirkin et al. (2005) created a human-like pedagogical agent through 3D software and investigated the effect of the agent in a multimedia-learning module on students' perception of their experience and learning. The results indicated that unnatural behaviors exhibited by a human-like pedagogical agent may detract from the learning experience. They suggested designers of educational technology should pay attention to factor in the social and psychological aspects of character design. Indeed, the more concrete a visual symbol of human appearance was shown, the more natural the expression and behavior would be anticipated by users. Interface designers should very careful that the human-like appearance used to act as a social cue to improve sociability has to be consistent with its performance (Tung, 2006). Whenever the social cue is inconsistent with the anticipation of user, the user experience would be reduced. Therefore, to adopt facial expressions as social cues, it was required to have a sophisticated understanding of people's expectations in the application of facial expressions and properly embed this understanding in the design of human-machine interactivity.

3-4 Speech and the emoticon

Just as the brain processes voices differently than all other sounds, it processes faces differently than all other objects (Allison, et. al., 1994; Nass & Brave, 2005). To compare the emoticon with speech involves further issues of nonverbal communication versus verbal communication as well as visual modality versus audio modality. Posner et al. (Posner, Nissen, Klein, 1976) argued that visual stimuli are less likely to automatically engage attention than auditory stimuli, and people have to learn to direct their attention to visual information. Compared with texts and symbols in the visual channel, speech in the auditory channel is less cognitively demanding (Kroll, 1978). Moreover, speech is a dynamic process which can trigger people to focus on the content and keep the audience in awareness during its creation (Chalfonte et al, 1991), leading to exerting a high degree of social presence.

Judging from above, speech seems to be superior to emoticons. The sound of speech is effective in gaining users' attention; nevertheless, Zaidel and Mehrabian (1969) claimed that faces are more important than voices in interpersonal interaction. As mentioned above, emoticons being visual cues may not draw as much attention as speech in terms of sensory aspects. However, the emoticon as a representation of the facial expression which is most powerful channel of nonverbal communication and expresses more explicit emotions fitting in the situation than speech does. Speech may transmit emotional messages by changing pitch, tempo as well as loudness, but research revealed information about emotions transmitted by the facial expression is more precise than speech (Ekman, 1975). Burns and Beier (1973) also pointed out that visual cues are also more influential and accurate than vocal cues in the designation of a mood state.

Moreover, emotions have influence on perceptual processing. Ekman (1994) indicated that happiness is an easily recognizable facial expression, while it is more difficult to identify in the voice. Also, children demonstrated a preference for visual over auditory expressions of happiness (Scherer et al, 1991, Scherer, Banse, & Wallbott, 2001). These strengths may enable the emoticon to receive more attention and as such yield higher social presence. Thus, it is interesting to investigate whether the emoticon used in computer interfaces has the same effect on children's feeling of social presence as speech does.

In short, both speech and the emoticon have their own unique characteristics in interpersonal communication, so it is difficult to debate which one is superior. The research further compares the effects of speech and the emoticon on children's experiences and attitudes while interacting with the computer. The former is through the auditory channel using verbal communication, while the latter is through the visual channel and using nonverbal communication. The results may provide designers with research based guidelines to flexibly use speech or emoticon techniques to design a sociable interaction.

3-5 Gender differences in perception of facial expressions

Speech is a channel of verbal communication while the emoticon is a channel of nonverbal communication. According to the dual-coding theory developed by Paivio (1971), we can assume that there are two cognitive subsystems, one specialized for the representation and processing of nonverbal objects or vents, and the other specialized for dealing with language. The former involves facial expressions and the latter refers to speech. Paivio (1986) stated that human cognition is unique in that it has become specialized for dealing simultaneously with language and with nonverbal objects and events. Moreover, the language system is peculiar in that it deals directly with linguistic input and output (in the form of speech or writing) while at the same time serving as a symbolic function with respect to nonverbal objects, events, and behaviors (p 53). Also, studies reveal that male and female participants showed differences in perceiving nonverbal cues. Women generally pay more attention to and better remember nonverbal cues than men do. Decoding abilities are dependent upon the degree of attention given to nonverbal cues (Buck, 1984). Thus, it is found that females are also clearly superior to males in decoding the meaning of nonverbal cues (Kirouac & Dore, 1985;Thayer & Johnsen, 2000).

The tendency for females to be better than males in detecting and decoding faces and other nonverbal indicators is culturally universal. Moreover, these gender differences are noticeable very early in development, and girls are more accurate in identifying emotional facial expression than boys. The study conducted by Boyatzis et al (1993) indicated that girls were significantly better than boys at identifying emotional facial expressions; in fact, 3.5-year-old girls were as accurate as 5-year-old boys. This suggests that the gender difference may mediate the way girls and boys respond to computers with speech or emoticon feedback.

3-6 Summary

Briefly summarizing the literature drawn on in this chapter includes 1) "message exchange" and "role exchange" are essential in the nature of interactivity in communication, 2) Speech plays a dominant role in interpersonal communication since humans are voice-activated and more sensitive to verbal sounds, and 3) Facial expressions are an important channel of nonverbal communication, which are regarded more trustworthy than words. Humans can accurately perceive emotions just from a simple representation of facial expression. Thus, emoticons could have social attributes similar to those of facial expressions.

The research focused on three social cues, namely interactivity, speech and the facial expression within interpersonal communication, to compare the possible influence exerted on children within the e-learning environments. Results of the research will provide designers with evidence-based design principles founded on research when they are developing relevant products targeting children as users in consideration of interactivity, speech and the emoticon. However, the development of sociable interface has never meant the direct embedding of social attributes without prudential consideration, but it is required for more insightful knowledge about users' attitude and perceptions. Otherwise, it is probably impossible to transfer the initial attempt of the designer and would eventually cause a negative effect. The research used experimental methodology to insightfully understand the influence on children's perception and learning motives on computers with the application of interactivity, speech and the emoticon.

4. Research Issues and Method

4-1 Research issues

The research aims at exploring how to utilize the social attributes of interactivity, speech, and facial expressions in human-to-human interaction as social cues, as well as obtaining an insight in what effects these social cues have on children's attitudes toward computers and learning as employed in e-learning environments (see Figure 4-1). It specifically intends to focus on the following issues raised in this research.

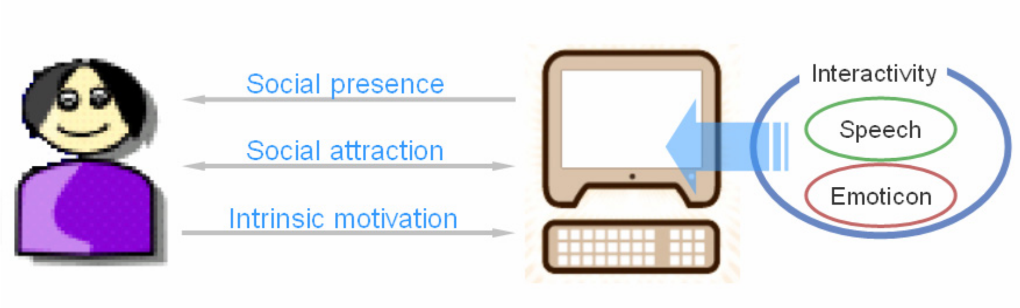


Figure 4-1 Children's attitudes and motivation to e-learning environments with social cues

1. **The first issue of concern is whether the manipulation of such social cues as interactivity, speech, and the emoticon can be effective enough to generate strong feelings of social presence in child-computer interaction.** It has been theoretically and practically proven that social presence can also be created through a computer when the computer manifests human-like characteristics. Hence, it suggests that children could feel social presence during interacting with a computer which provides social cues. At the same time, the childhood animism may raise the question of whether children see computers as a social entity regardless of the presence or absence of social cues. The question deserves to be tested further.

Based on the literature review in chapter three, the social attributes of active interactivity and speech could act as social cues to allow people to experience feelings of social presence when they interact with a computer individually. It is therefore expected that computers providing either of the two social cues can convey stronger social presence than those lacking them. Besides this, the emoticon could have the same impact on social presence as speech does. Thus, it is predicted that children feel similar levels of social presence when they interact with a computer providing emoticons or with a computer providing speech.

2. **The second issue of concern is whether social cues offered by computers have an impact on children's perception of social attraction.** If it is true that children have a tendency to respond socially to computers, then this may lead to the rise of various types of social relationships such as social attraction. Social attraction has been considered an important part of social judgments of others (McCroskey & McCain, 1974). It is a key determinant of the development of interpersonal relationships (Nowak, 2004). Social attraction does not only exist in interpersonal relationships, but also can be found between humans and computers or robots (Lee, et al., 2005). As the CASA paradigm claims that if a computer exhibits enough social cues to children during interaction, the computer may be more like a partner than a tool to them. Thus, it is predicted that computers that manifest social characteristics can exert greater social attraction.

3. **The third issue concerns whether the computer with social interfaces could foster children's intrinsic motivation for learning.** Concluded from section 2-4, social presence plays a mediating role in shaping learners' attitudes toward e-learning environments, which is conducive to enhance effective instruction and improve learners' motivation. Most research concerns the feeling of social presence which is created by the instructor and the online community. According to Issue 1 mentioned above, if it is true that computers with social cues have strong social presence and yield more social responses

from children than computers without the social cues, then this research argues that social presence created by the computer interface can act as a factor to enhance children's intrinsic motivation while participating in an environment without any instructor or mate involved.

4-2 Experimental method

The research employs an experimental method to investigate the impact of interactivity, speech, and the emoticon on the issues addressed above. The social cues derived from interpersonal communication will be explored in human-computer interaction. This research adopted experimental method is based on the following two reasons: First, many research has been conducted to study the nature of relationship between and computers, in which the most notably study is Turkle's (1984, 1995) long-term observation has shown that children respond socially to computers, however, these observations have not been tested further. As mentioned above, the possibility that children may tend to anthropomorphize computers regardless of the availability of any social cues should not be ignored. Thus, an experimental method helps us clarify the effects of social cues of interactivity, speech, and the emoticon on children. Second, the general structure of CASA paradigm begins with picking a social science finding and then substituting 'computer' for 'human' in the statement of the theory and replicating the methodology of the social science study but replacing humans with computers. An experimental method is then used to examine whether social rules still apply in the context of Human-Computer interaction.

The use of a computer allows for a controlled manipulation of social cues by the experimental design. Quiz-based learning environments were developed for the research. Interactivity, speech, and the emoticon will be manipulated in various situations during interaction with the e-learning environments. To obtain the effects of social cues manipulated in this research, the quiz-based learning environments did not contain music or graphics as would normally be found in e-learning environments.

The research presents three studies linked by the theme of exploring how interactivity, speech, and facial expressions function as social cues and what effects these social cues employed in e-learning environments have on children.

1. **Study I was conducted to investigate the effects of speech and interactivity.** This research first tests whether modeling the computer to user interaction after the two factors in interpersonal communication could allow children to experience stronger feelings of social presence and social attraction, as well as sustain their intrinsic motivation with learning. The preliminary results give us an idea that children's attitudes toward computers can be influenced significantly and positively by the social cues rendered by a computer interface. The results further offer an understanding of the effects of interactivity and speech on children and suggest a suitable level of interactivity for e-learning environments. Based on the interactivity, this research moved on to investigating the effects of speech and the emoticon on children.

2. **Study II was conducted to compare the effects of using speech and the emoticon as social cues in e-learning environments on children.** The results of this study show that the effects of the emoticon do not reach the same levels of the effects of speech; which is not consistent with the predictions. This led we to further review the nature of facial expressions in interpersonal communication. Just as speech proceeds continuously and has inherent dynamics, facial expression is dynamic which increases sensitivity to changes of facial feature compositions. Furthermore, the dynamics can enrich emotional expression and thus plays an important role in recognition of its intensity (Ambadar, et al., 2005; Biele, et al., 2006). Given that another study was carried out to compare the effects of speech and dynamic emoticons.

3. **Study III was conducted to further study the effects of the use of speech and dynamic emoticons as social cues on children's attitudes toward computers, as well as their motivation within learning.** Similar effects of dynamic emoticons and

speech on children's attitudes and motivation were observed. Gender differences in children's perception and preference of speech and dynamic emoticon were also found.

5. Study I: Effects of Interactivity and Speech

This study, in summary, aims to examine what effects speech and interactivity in the learning environment have on a child's attitude toward computers and learning.

5-1 Hypotheses and research questions

The first two issues concerned where the manipulation of interactivity and speech could influence children's feeling of social presence and social attraction during their interaction with a computer. Based on the literature review in the chapter three, the social attributes of active interactivity and speech could act as social cues to yield more social responses from computer users. It is therefore expected that computers with either of the social cues will have stronger social presence than those without it. Moreover, if it is true that children have a tendency to respond socially to computers, then this may lead to the rise of various types of social relationships such as social attraction. This leads to the following hypotheses:

H_{1a}. Children perceive stronger social presence in a speech-output environment than in a nonspeech-output environment.

H_{1b}. Children perceive stronger social presence in an active-interactivity environment than in a passive-interactivity environment.

H_{2a}. Children will be more socially attracted to a speech-output computer than to a nonspeech-output computer.

H_{2b}. Children are more socially attracted to an active-interactivity computer than to a passive-interactivity computer.

The third issue concerns whether the computer with social interfaces could foster children's intrinsic motivation for learning. Learning is a social activity. A learning environment provides a child with social presence that may satisfy his or her social desire and enhance intrinsic motivation while participating in environment without any instructor or mate involved. This leads to the following hypotheses:

H_{3a}. Children participating in a learning activity with a speech-output environment will be more intrinsically motivated than with a nonspeech-output environment.

H_{3b}. Children participating in a learning activity with an active-interactivity environment will be more intrinsically motivated than those with a passive-interactivity environment.

Besides, Social presence is defined as a sense of engagement or connection with a social entity and linked presence with involvement (Lombard, & Ditton, 1997; Witmer & Singer, 1998). This study therefore attempted to investigate whether the degree of social presence children perceived influences their intrinsic motivation within e-learning environments. And if a computer is a social actor, what is its role and do the two independent variables (interactivity and speech) affect the role a computer plays? This leads to the following questions:

RQ_1. Is there a correlation between the distinguished social presence and children's motivation with learning?

RQ_2. Do the independent variables of interactivity and speech affect children to perceive a computer as a social role like as a friend, or a teacher, or a competitor?

5-2 Participants

Subjects were seventy-four children (40 boys and 34 girls) at one elementary school in Hsinchu. The subjects were from two fifth-grade classes. The average age was 10.8 years. All subjects have experienced using computers and have received computer instruction at least once a week since third grade. A total of 81 percent of the subjects reported that they often use computers at home for game play and web browsing. These figures suggest that the subjects are familiar with computers and could sense the different levels of interactivity provided by the study. Each participant was presented a toy after completing the experiment.

5-3 Experiment design

In this study, a mixed factorial design of experiment was employed to investigate the effect of two factors. The first factor, speech, is a between-subject factor of the presence or absence of speech-output. The second factor, interactivity, is a within-subject factor of active interactivity or passive interactivity. So it is a two by two mixed factorial design (see table 5-1). The dependent variables were the perceived social presence, children's social attraction towards computers as well as their intrinsic motivation.

Table 5-1 A two by two mixed factorial design

speech(between) / interactivity(within)	present	absent
active	1. speech / active	2. nospeech / active
passive	3. speech / passive	4. nospeech / passive

5-4 Materials

The instructional materials were designed as a math problem-solving practice program. The program designed in Macromedia Flash was developed in four versions to represent speech (speech, nonspeech output) x interactivity (active, passive interactivity) conditions. Each version had seven math problems which were at moderate 5th grade level and involved the four fundamental operations of arithmetic. Each subject had to participate in active-interactivity and passive-interactivity conditions due to interactivity as the within-subject factor. Thus, two sets of math problems were developed for the two conditions. The two sets of questions were different but had the same degree of difficulty. This had been tested and confirmed with students from another class. The two sets of questions were equally used in the two conditions and the order of the questions was randomized to reduce the effect of practice.

5-5 Four experimental conditions

The first factor, speech, had two levels: speech and nonspeech output. The speech-output environment provides subjects with human-voiced guidance or feedback while the nonspeech-output environment did not. Speech for the experiment was created from recordings made by a young female and the content was interrelated to the two levels of the second factor, interactivity, including active and passive interactivity. In the active interactivity environment the instructional program actively communicated with subjects in a manner which exhibited message-exchange and role-exchange features. This means that the computer followed a preprogrammed interaction which would provide messages based on earlier inputs and could play the role of sender and receiver with subjects. In the passive interactivity environment the instructional program interacted with a subject in a learner-control manner and does not actively provide any further messages. Thus, a passive-interactivity subject controls all steps by using the keyboard. Subsequently the program would respond to the command. The program does not take any action unless the subject presses a function key. The two levels of interactive manner and matching speech output are summarized as follows.

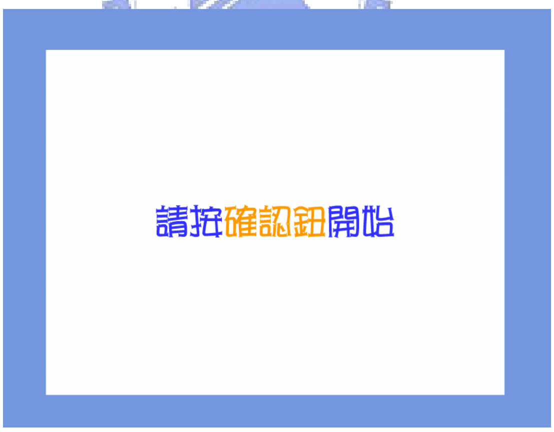


Figure 5.1 The start screen

1. The screen first shown written words “Please press the Start Key” (shown in Figure 5.1). When a subject presses the “start” key, the active-interactivity program will present a written greeting “Hi, Welcome!” and then automatically guide the subject to the first question (shown in figure 5.2a, 5.2b). The matching speech output reads “Hi, welcome!” But the passive-interactivity program immediately shows the first math problem without any greeting

or matching speech output (shown in figure 5.2b).

Figure 5.2a Feedback with greeting

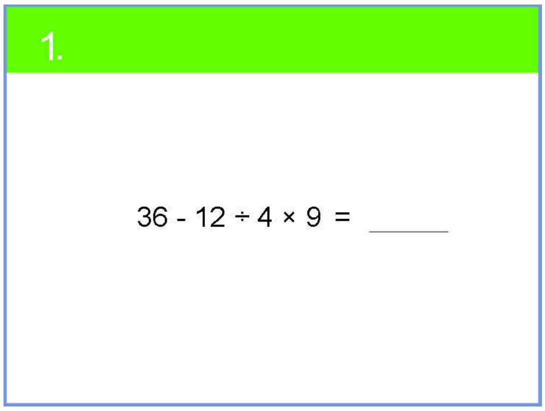


Figure 5.2b A math problem presented on screen

2. When a subject answers correctly, the active-interactivity program will show the "right" symbol as feedback and automatically guide the participant to the next question. The matching speech output reads "Right! Please be proceeding" (see figure 5.3a). In the same situation, the passive-interactivity one will show a "answer right" symbol (see figure 5.3b). The subject is then required to press "next" key to go to the next question. The matching speech output reads "Right!"

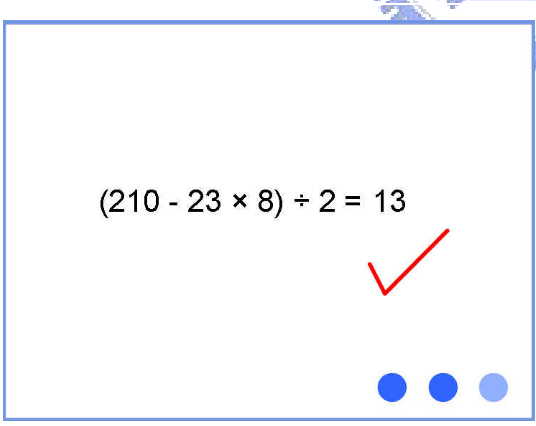


Figure 5.3a Feedback to a correct answer in the active-interactivity condition

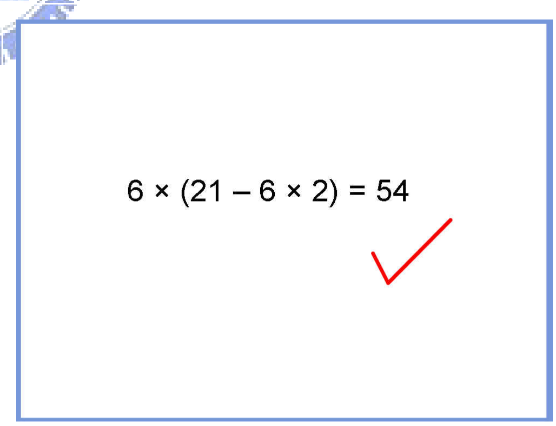


Figure 5.3b Feedback to a correct answer in the passive-interactivity condition

3. When a subject fails to answer correctly, the active-interactivity program will display a screen which showed the "wrong" symbol and politely suggested the subject to press "again" or "next" key for proceeding (see figure 5.4a). The matching speech output reads "Wrong! Would you like to try again or go on the next one?" If the subject decides to go to the next

question, the program will show the correct answer and advance the next one. The matching speech output, for instance, for subject A reads "The answer is 15! Please be proceeding."

In the answer-wrong situation, the passive-interactivity one will display a "wrong" symbol without any introduction for the next step (see figure 5.4b). The matching speech-out reads "answer wrong!" The subject can try again; check the answer, or move on to the next question by pressing "again", "next", or "answer" keys respectively.

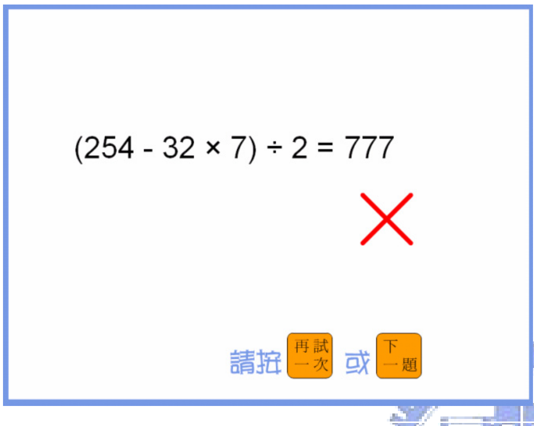


Figure 5.4a Feedback to a wrong answer in the active-interactivity condition

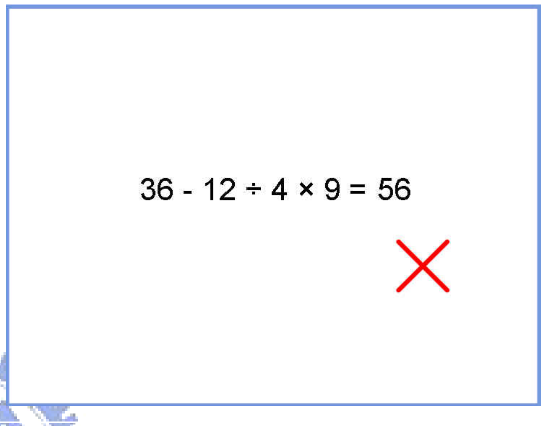


Figure 5.4b Feedback to a wrong answer in the passive-interactivity condition

4. After all questions having been attempted, the active-interactivity program will inform the subject the score, the counts of correct and wrong answers, and positive comments. The matching speech output, for instance, for subject B reads "Your score is 90. You are great (see figure 5.5a)!" The passive-interactive model will present the score without further information. The matching speech output, for instance, for subject C reads "Your score is 90 (see figure 5.5b)."

5. Peripheral：The programs was controlled by a keyboard on which the number keys and predetermined function keys were labeled with the number or the function such as "start", "erase", "next", "again", "confirm", "answer", and "exit". The computers for speech condition provided a subject with earphones.

Figure 5.5a A comment to on performance in the active-interactivity condition

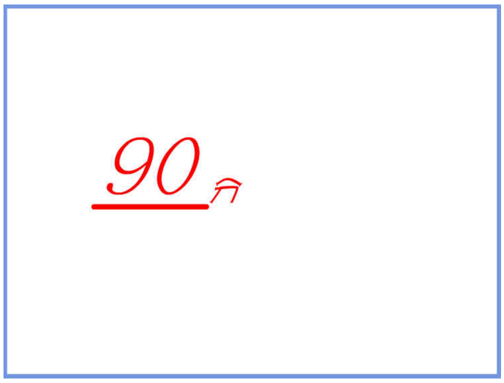


Figure 5.5b A comment to on performance in the passive-interactivity condition

5-6 Measurement tools

The dependent variables of social presence, social attraction, and intrinsic motivation were measured using a set of paper-and-pencil questionnaires, each item had 9-point Likert scale that ranged from 1(very strongly disagree) to 9(very strongly agree). The wording used in questionnaires had been discussed with teachers and the children to prevent any misunderstanding.

1. The first set questions adopted the four items proposed by Short, Williams, and Christie (1976), which is commonly used to measure social presence in mediated environments (Dirkin et al., 2005; Lombard et al., 2000). The scale consists of four items: sociable, personal, sensitive, and cold (reverse).

2. The second set of questions was modified version of McCroskey and McCain's (1974) social attraction scale, as well as referred to relevant studies which adapted the same scale to measure users' social attraction toward computers, robots, or media (Lee, et al., 2005; Moon, 1996; Nowak, 2004). The scale consists of four items: 1) I think this computer is friendly; 2) I like this computer; 3) I enjoy play math quiz game with this computer; 4) I am willing to play the quiz game with this computer again.

3. The third set of questions was adapted from the Activity-Feeling Scales (AFS) developed by

Reeve and Sickenius (1994) and used to measure the subjects' intrinsic motivation. The 12-item measure made up of separate 3-item scales to assess self-determination, competence, relatedness, and tension. The name and individual items for each index are as follows: self-determination-- offered choice what to do, I want to answer the questions, and I my participation is voluntary; competence-- capable, competent, and achieving; relatedness-- imitate, involved with friends, part of a team; Tension-- pressured, uptight, and easy (reverse).

5-7 Procedure

This experiment consisted of two stages. The purpose of the first stage was to allow the subjects to be familiar with the instructional program used in study. A demonstration was developed to show the subjects how to manage the four version programs. This effort facilitated the subjects understanding of the program mechanism within the four interfaces. The goal of the demonstration was to avoid having the subjects' unfamiliarity with the interface affect the results.

The experiment was carried out in the second stage. Four identical computers, two computers for speech condition and two ones for nonspeech, were set in a discussion room at the library of the elementary school. Four subjects took part in the experiment for each session. Each subject was asked to complete the instructional program of two conditions. The conditions were counterbalanced. After a subject finishing a single program, an experimenter asked the one to fill out a questionnaire. Then the subject took a 5-minute break before starting the next program. The experiment took approximately 40 minutes per round. Upon completing the experiment the subjects were debriefed, thanked with a toy, and asked not to discuss the experiment with other classmates.

5-8 Results

5-8.1 Validity and reliability

The measurement scales were designed on the base of related literature and confirmed through interviews with an HCI expert to assure content validity. Internal consistency (Cronbach's α) was calculated to assess the reliability of these scales. The Cronbach's α for the perceived social presence, social attraction, and intrinsic motivation are 0.89, 0.88, and 0.77, respectively. And the Cronbach's α for the four indices of intrinsic motivation including self-determination, competence, relatedness, and tension were 0.70, 0.77, 0.80, and 0.79, respectively. According to Nunnally (1967), Cronbach's α value of 0.7 is adequate for internal consistency reliability. The measures used in the study demonstrated adequate reliability.

5-8.2 Social presence

In Study I, the factors of speech and interactivity were evaluated. A mixed factorial design of experiment is used, where the presence or absence of speech-output is a between-subject factor, and active or passive interactivity is a within-subject factor. Table 5.2 shows the descriptive statistics of the social presence children perceived. From Table 5.2, it is found that children rated social presence to speech-output computers higher than nonspeech-output ones, and they graded social presence to active-interactivity computers higher than passive-interactivity ones.

Table 5.2 Descriptive statistics of social presence

Interactivity	speech	mean	sd	N
active	presence	7.52	1.46	37
	absence	6.69	1.72	37
	total	7.11	1.64	74
passive	presence	6.32	1.79	37
	absence	5.22	1.92	37
	total	5.77	1.92	74

The analysis of variance of within-subject effects indicated that the effect of interactivity on perceived social presence is significant ($F_{1,72}$=54.31, p<0.001). No significant interaction effect was found. The analysis of variance of subject-subject effects indicated that the effect of speech on perceived social presence is significant ($F_{1,72}$ =7.26, p<0.001). The hypothesis H_{1a} and H_{1b} are supported (see Table 5.3).

Table 5.3 Summarized results of the analysis of variance

Source	SS	df	MS	F value
Within-subject				
Interactivity	65.72	1	65.72	54.31***
interactivity * speech	0.69	1	0.69	0.57
Error	87.12	72	1.21	
Between-subjects				
Speech (between)	34.66	1	34.66	7.26**
Error	343.75	72	4.77	

* p< 0.05, ** p< 0.01, *** p< 0.001

5-8.3 Social attraction

Table 5.4 shows the descriptive statistics of children's social attraction towards computers. From Table 5.4, it is found that children rated social attraction towards speech-output computers higher than nonspeech-output ones, and they graded social attraction towards active-interactivity computers higher than passive-interactivity ones.

Table 5.4 Descriptive statistics of social attraction

Interactivity	speech	mean	sd	N
active	presence	7.58	1.26	37
	absence	6.83	1.57	37
	total	7.20	1.46	74
passive	presence	6.55	1.72	37
	absence	5.25	1.88	37
	total	5.90	1.90	74

The analysis of variance of within-subject effects indicated that the effect of interactivity on social presence is significant ($F_{(1,72)}$=50.48, p< 0.001). No significant interaction effect was found $F_{(1, 72)}$=2.21, p=0.14. The analysis of variance of subject-subject effects indicated that the effect of speech on perceived social presence is significant ($F_{(1,72)}$=38.82, p< 0.01). The hypothesis H_{2a} and H_{2b} are supported (see Table 5.5).

Table 5.5 summarized results of the analysis of variance

Source	SS	df	MS	F value
Within-subject				
Interactivity	63.05	1	63.05	50.48***
interactivity * speech	2.76	1	2.75	2.21
Error	89.932	72	1.25	
Between-subjects				
Speech (between)	38.82	1	38.82	9.66**
Error	289.43	72	4.02	

* p< 0.05, ** p< 0.01, *** p< 0.001

5-8.4 Intrinsic motivation

Table 5.6 shows the descriptive statistics of children's intrinsic motivation in learning with computers. From Table 6, it is found that children's intrinsic motivation in the speech-output condition were higher than those in nonspeech-output condition, and in the active-interactivity condition reported greater than those in the passive-interactivity condition.

The analysis of variance of within-subject effects indicated that the effect of interactivity on perceived social presence is significant ($F_{(1,72)}$=23.77, p< 0.001). No significant interaction effect was found ($F_{(1, 72)}$=0.01, p=0.90). The analysis of variance of subject-subject effects indicated that the effect of speech on perceived social presence is significant ($F_{(1,72)}$=6.17, p< 0.05). The hypothesis H_{3a} and H_{3b} are supported (see Table 5.7).

Table 5.6 Descriptive statistics of intrinsic motivation

Interactivity	speech	mean	sd	N
active	presence	7.04	1.18	37
	absence	6.44	1.26	37
	total	6.74	1.25	74
passive	presence	6.32	1.10	37
	absence	5.69	1.40	37
	total	6.01	1.97	74

Table 5.7 Summarized results of the analysis of variance

Source	SS	df	MS	F value
Within-subject				
Interactivity	19.77	1	19.77	23.77***
interactivity * speech	1.084E-02	1	1.084E-02	.013
Error	59.89	72	0.83	
Between-subjects				
Speech (between)	13.91	1	13.91	6.17*
Error	162.22	72	2.25	

* p< 0.05, ** p< 0.01, *** p< 0.001

To better understand what effects the speech and interactivity have on children's intrinsic motivation, figure 4 illustrates the effects of the two independent variables on their feeling of self-determination, competence, relatedness, and tension. The analysis revealed speech exhibited significant main effect on relatedness, $F_{(1,39)}$ =17.87, p<0.001, and competence, $F_{(1,39)}$ =8.59, p<0.01, while no significant effect on self-determination and tension. The effect of interactivity was significant on all four scales: relatedness, $F_{(1,39)}$ =27.65, p<0.001, competence, $F_{(1,39)}$ =8.92, p<0.01, self-determination , $F_{(1,39)}$ =7.85, p<0.01, and tension, $F_{(1,39)}$ =6.35, p<0.05 (see Table 5.8).

5-8.5 Correlation between social presence and intrinsic motivation

The total mean of social presence and intrinsic motivation in the two conditions is 6.44(SD. 1.90) and 6.38(SD. 1.32), respectively. A correlation analysis with the Pearson correlation coefficient (r) was employed to establish relationships between the two variables. The result (Pearson r =0.75, p<0.001) indicates that there exists a statistically significant positive correlation between the two variables (shown in Figure 5.6), that is, the feelings of social presence even from the computer itself can mediate children's intrinsic motivation.

Table 5.8 Effects of interactivity ad speech on self-determination, competence, relatedness, and tension

	Source	SS	df	MS	F value
	Within-subject				
	Interactivity	10.41	1	10.41	5.60*
	interactivity x speech	5.59	1	5.59	3.00
	Between-subjects				
Self-determination	Speech	11.22	1	11.22	2.43
	Within-subjects				
	Interactivity	23.36	1	23.36	12.86**
	interactivity x speech	2.39	1	2.39	1.31
competence	*Between-subjects*				
	Speech	25.64	1	25.64	4.07*
	Within-subjects				
	Interactivity	26.64	1	26.64	21.98***
	interactivity x speech	5.3E-02	1	5.3E-02	.044
relatedness	*Between-subjects*				
	Speech	17.44	1	17.44	5.18*
	Within-subjects				
	Interactivity	6.24	1	6.24	4.71*
	interactivity x speech	2.7E-02	1	2.7E-02	.02
Tension(reverse)	*Between-subjects*				
	Speech	6.9E-02	1	6.9E-02	0.11

* p< 0.05, ** p< 0.01, *** p< 0.001

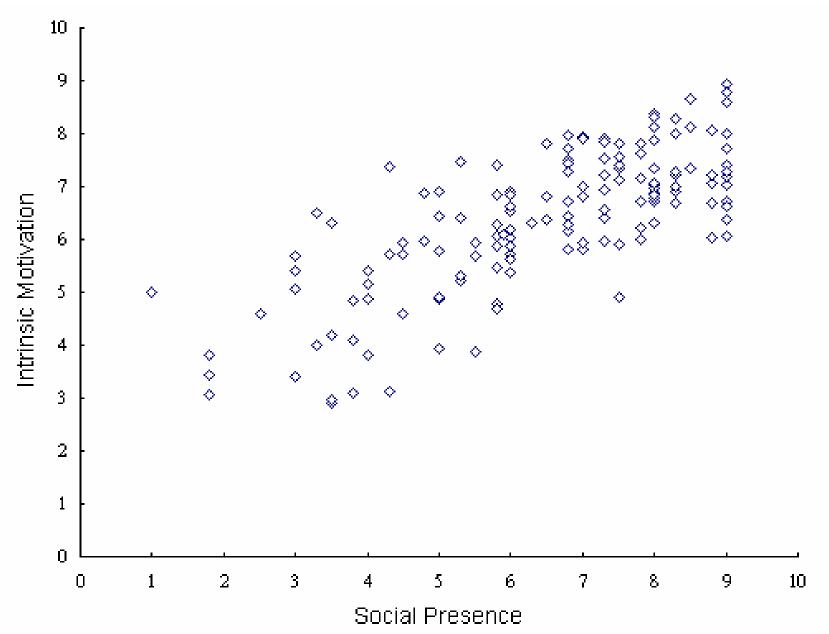


Figure 5.6 A significant positive correlation between social presence and intrinsic motivation

5-8.6 Children's views of computers as social actors

As regards the question about what social roles the computer is and the how effects of interactivity and speech have on children's perception of computer as a social role, Table 5.9 shows the descriptive statistics of children's views of computer as a friend, teacher, and competitor. From Table 5.9, it is found that computers either in the speech condition or in the active-interactivity condition act more like friends or teachers to children.

Table 5.9 Descriptive statistics of computers as friends, teachers, and competitors

		friend		teacher		competitor		N
interactivity	speech	mean	sd	mean	sd	mean	sd	
active	presence	7.1	(2.2)	6.5	2.7	4.7	2.9	37
	absence	6.1	(2.2)	6.1	2.6	5.2	2.9	37
	total	6.6	(2.2)	6.3	2.6	4.9	2.9	74
passive	presence	6.0	2.4	6.1	2.4	5.1	2.7	37
	absence	5.1	2.5	5.3	2.6	4.9	2.8	37
	total	5.5	2.4	5.7	2.5	5.0	2.7	74

The analysis of variance of within-subject effects revealed speech exhibited significant main effect on computer as a friend ($F_{(1, 72)}$=4.17, $p< 0.05$), while no significant effect on computer as a teacher or a competitor. The effect of interactivity was significant on computer as a friend ($F_{(1, 72)}$=17.93, $p< 0.001$)and a teacher ($F_{(1, 72)}$=5.13, $p< 0.05$), while no significant effect on computer as a competitor (see Table 5.10). The results indicated that the speech output interface can promote the computer as a friend, and the active interactivity can promote the computer as a friend or as a teacher to children.

Table 5.10 Effects of speech and interactivity on Children's perception of computer as a social role

Dependent variables		Effects	S S	df	f
	between	speech	5460.8	1	4.17 *
friend	*within*	interactivity	46.5	1	17.93 ***
		Interactivity x speech	6.1E-02	1	0.87
	between	speech	14.3	1	1.33
teacher	*within*	interactivity	13.1	1	5.13*
		Interactivity x speech	1.3	1	0.52
	between	speech	1.1	1	0.10
competitor	*within*	interactivity	0.2	1	0.03
		Interactivity x speech	5.7	1	1.13

$p< 0.05$, ** $p< 0.01$, *** $p< 0.001$

5-8.7 Summary of results for hypotheses

As described above, a summary of the results of this study are given in Table 5.11.

Table 5.11 Summary of results for hypotheses

Hypotheses	Results
H_{1a}. Children perceive a higher degree of social presence in a speech-output environment than in a nonspeech-output environment.	supported
H_{1b}. Children perceive a higher degree of social presence in an active-interactivity environment than in a passive-interactivity environment.	supported

H_{2a}. Children will be more socially attracted to a speech-output computer than to a nonspeech-output computer.	supported
H_{2b}. Children are more socially attracted to an active-interactivity computer than to a passive-interactivity computer.	supported
H_{3a}. Children participating in a learning activity with a speech-output environment will be more intrinsically motivated than with a nonspeech-output environment.	supported
H_{3b}. Children participating in a learning activity with an active-interactivity environment will be more intrinsically motivated than those with a passive-interactivity environment.	supported

5-9 Discussion

This study investigates the effects of speech and interactivity in the e-learning environment on children attitudes toward computers and learning activity. According to the aforementioned studies, speech can be associated with human-to-human relationship while active interactivity bears features of message exchange and role exchange resembling to the nature of interpersonal communication. This study tries to utilize these features as social cues incorporated into the e-learning environment to enhance the social attributes of the computer. The results show that speech and active interactivity can empower a computer to produce strong feelings of social presence and trigger children's social attraction. Moreover, they could be manipulated in an e-learning environment to foster a child's intrinsic motivation.

As for whether it is true that children tend to anthropomorphize computers regardless of the availability of any social cue, the results reveal that children can perceive the social attractiveness of a computer and therefore view the computer more as a social entity than a tool. The findings further indicate that such awareness can be influenced significantly and positively by the social cues rendered by a computer interface. Such a social interface enables a computer to establish a close relationship with children and enhance their recognition of the computer, which may in turn motivate children to learn and engage them in the interaction.

Added to this, a major finding of the study is that feelings of social presence play a major role in mediating children's intrinsic motivation. There was a positive correlation between children's intrinsic motivation and social presence. Studies suggest that high levels of social presence create an environment that is felt as being accepting and will produce positive results on student learning. The social presence addressed in those studies involved the degree of interpersonal contact with the instructor and other participants in an online learning environment. The present study further suggests that the perceived social presence provided by a computer can function as a way to reduce a child's feeling of isolation, and lead to enhance his or her motivation while interacting with an e-learning environment with no instructor or other peers involved.

The analysis of the results of the present study comes to the following conclusions to be discussed as follows: 1) Speech intensifies the sense of social presence in an e-learning environment 2) Interactivity entails rich social traits, and 3) Effects of Interactivity and Speech in Social Roles of Computers.

5-9.1 Speech intensifies the sense of social presence in e-learning environments

The use of speech function in an e-learning environment does more than simply add an auditory channel. It helps intensify the sense of social presence. The social attribute of the speech function renders the computer with a social attraction-- a talking computer that directs children to intuitively associate the human-to-computer interaction with human-to-human relationships. Judging by the children's reactions, a talking computer seems to change their perception of a computer being an inanimate object and make children feel that they are interacting with a social entity. Experimenters have found that, upon hearing spoken words, children's facial expressions became livelier than they were when merely reading written words or symbols. It could be found that many children unintentionally grinned at or nodded to computers when given the spoken instruction of "answer right". Goffman (1959) contented that humans construct their self-presentations and carry them off in front of others either intentionally or unintentionally. Hence, social presence conveyed by speech such an explicit signal that the perceiver evokes of moved and expressive body.

In term of improving children's intrinsic motivation, the findings indicate speech is conducive to children's experiences of relatedness and competence. In addition, results show that using speech in e-learning environments can actively engage children so that they are willing to do the given math exercises again. This suggests that a computer with oral guidance and feedback can create a close bond between children and the computer, and this bond reinforces a confidence in their own competence. However, speech dose not influence the experiences of self-determination and tension. These findings show that a channel as sensible as speech does not easily affect a child's perception of self-determination. Interestingly, speech feedback can reinforce children's confidence in their own competence, but it can also cause anxiety for some children when they fail to give correct answers. This could be the reason why speech has no significant effect on tension. Klein et al. (2002) have pointed out that applying social-affective skills to enable a system to respond with emotion support can minimize user frustration. Thus, the role of emotions in speech output should be concerned.

5-9.2 Interactivity entails rich social traits

Compared with the explicitness and sensibility of the speech effect interactivity is implicit yet entails rich social traits. The concept of interactivity is regarded as a natural attribute of interpersonal communication (Morris & Christine 1996; Rafaeli, 1990). According to Goffman (1967), people tend to spontaneously involve themselves in a conversation and respond to participants during interpersonal communication. Goffman has also proposed that the elements of reciprocal responses and role exchange are important to maintain a smooth transfer of information. This study develops active interactivity by enhancing a computer's social attributes, which is achieved through closely imitating human-human communication by means of providing timely feedback and leading users at appropriate times. Results here show that such activity enables a computer to covey a higher degree of social presence and become more socially attractive. During debriefing at the completion of the experiment, many children reported that they liked the way that computers automatically guided them to the next question after they gave a correct answer. They considered the computer “kinder” and more “helpful” because it suggests the options when their answers were wrong.

It is easily observed that children enjoyed the interactive manner with the computer providing guidance and more social messages. The results also indicate that active interactivity can benefit children’s experiences of relatedness, competence, tension, and self-determination. This reassures the notion in the previous studies that message exchange and role exchange are two essential characteristics in interpersonal communication. Merely being automatically guided by a program does not deprive a learner of control. On the contrary, an individual who can play both sender and receiver roles would experience a greater sense of social presence during interaction. Thus, this paper suggests that an interface programmed with automatic guidance allows a learner to better perceive a sense of social presence, thereby motivating the leaner to engage more actively in the learning process. As for the divided views on the learner-control and program-control modes in computer-mediated learning environments, this paper intends to provide yet a different perspective on the social dimension of interface design.

5-9.3 Effects of interactivity and speech in social roles of computers

When considering effects of interactivity and speech on what social roles of computers, results indicated interactivity caused remarkable influence on children's views of computers as friends and teachers. As children mentioned, the active interactivity provided by computers made them feel computers were friendly and helpful. The said features would, indeed, trigger children to link computers with active interactivity to social roles like friends and teachers. On the other hand, children felt computers that provided passive interactivity showed few friendly and helpful features. In addition, passive interactivity also reduced the social attributes of computers and this phenomenon could not trigger children to link computers to opponents. This means that it was necessary to guide children's conception with computers projected as social roles. Computers, in themselves, should provide sufficient social features to evoke children's linking association in mind.

Speech exerted remarkable influence on children's views of computers as friends but showed no influence on children's views computers as teachers or opponents. As numerous researches proposed, speech was composed of abundant social presence. However, speech in itself and the context of communication actually featured unique social attributes. The speech sound adopted by this study was the voice of young female. Speech contents provided children with feedback and guidance within learning activities like "Hi!", "Right" , "Wrong", "Try again or go to the next question?" or " You are excellent". The speech contents showed similarity to children's dialogs with peers, which lead children to associate the computer with a friend. In order to have children identify computers as teachers or competitive opponents through speech, the accent and contents of speech were required to express the features of these social roles well. Children's identification of social roles of computers provided speech reflected from the methods of communication within their real lives. When computers showed special social features, children also showed that they projected perception on the same said social roles.

The application of speech combined with active interactivity could amplify the social attributes of computers and enhance children's perception of computers as social roles. Figure 5.7 indicated that children viewed computers separately as friends, teachers and opponents within the four experimental conditions. It could be seen that children rated the computers in the 1st condition (speech /active interactivity) as friends and teachers remarkably higher than that in other conditions. In addition, the view that the computer in the 4th experimental condition (non-speech /passive interactivity) is a friend and a teacher was lower than those in other experimental conditions. It indicated it could cause mutually positive effects for interface design with the application of speech combined with active interactivity to enhance children's views of computers as social actors.

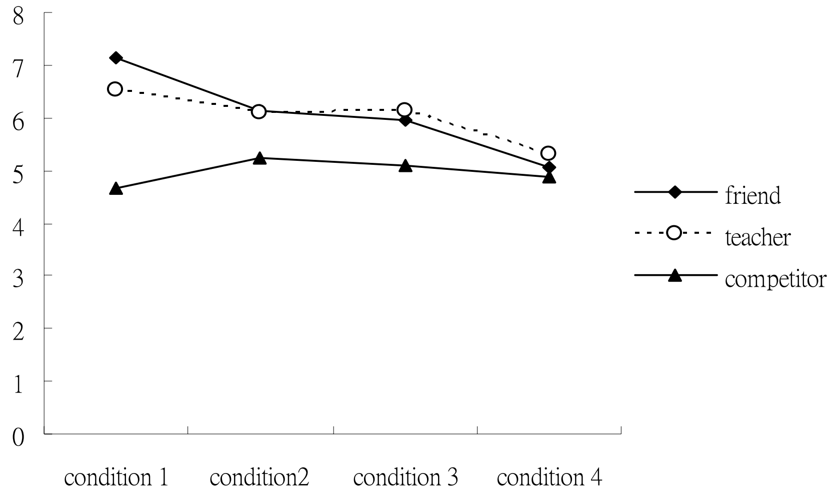


Figure 5.7 Children’s perceptions of computers as social roles in the four conditions

Humanized interfaces afford a sense of comfort and ease to the user that has always been the goal aspired to by technologists and researchers (Laurel, 1990; Sproull et al, 1996). In addition to realizing the goals by using complicated computing and artificial intelligence, the social cues derived from interpersonal interaction should be applied to computer interface design to trigger children's social identification toward computers, in view of the possibility for social interaction between children and computers. But there is in fact an easier way available to reach this goal. The results can not only be directly applied to the development of relevant e-learning environments. With increasing growth of educational products and interactive toys, the speech and active interactivity could be integrated into the interface development of those products to convey social presence. In other words, the said products providing speech feedback or reacting to children in an active manner could lead children to conceive of them as social actors. By means of this, it is possible to enhance children's social preferences and participating motives.

6. Study II: Speech versus the Emoticon

The results of study I indicated that speech could intensify the sense of social presence in an e-learning environment, as well as interactivity entails rich social traits. This study further explored the effects of using speech and the facial expression as social cues in e-learning environments on children. As stated in chapter three, speech and the facial expression are two essential components in interpersonal communication. Hence, this study was conducted to compare the effects of speech and emoticon on children's attitude toward computers, as well as their motivation and performance with learning. According to section 3-5, females generally pay more attention to and better in detecting and decoding facial expressions. It may result in differences in the way girls and boys respond to computers with speech feedbacks or emoticon feedbacks. Thus, data from boys and girls would be analyzed separately in an attempt to see whether gender influences subjects' reaction to the two social cues.

6-1 Hypotheses

First, the study examined whether the effects of speech and emoticon are equal on children's feelings of social presence and social attraction when they interact with computer. This leads to the following hypotheses:

H1a. There is no difference on social presence perceived by boys between in the speech condition and in the emoticon condition.

H1b. There is no difference on social presence perceived by girls between in the speech condition and in the emoticon condition.

H2a. There is no difference on boys' social attraction to computers providing speech and to those providing emoticon.

H2b. There is no difference on girls' social attraction to the computers providing speech and to those providing emoticon.

Secondly, the study compared the effects of speech and emoticon used in e-learning environments on children's intrinsic motivation. Furthermore, children's performance of the task in speech and emoticon conditions would be examined. This leads to the following hypotheses:

H3a. There is no difference on boys' intrinsic motivation between participating in the e-learning environment providing speech and participating in the one providing emoticon.

H3b. There is no difference on girls' intrinsic motivation between participating in the e-learning environment providing speech and participating in the one providing emoticon.

H4a. There is no difference on the performance boys achieve between in the speech condition and in the emoticon condition.

H4b. There is no difference on the performance girls achieve between in the speech condition and in the emoticon condition.

6-2 Participants

Eighty-six sixth graders (40 girls and 46 boys) from three classes of two elementary schools in Hsinchu participated. The average age was 11.4 years. All subjects have experienced using computers and have received computer instruction at least once a week since third grade. A total of 83 percent of the subjects reported that they often used computers at home for playing games and web browsing. These figures suggest that the subjects are familiar with computers.

6-3 Experiment design

The design was within-subjects with one factor with two levels (speech and the emoticon). The dependent variables were the perceived social presence, children's social attraction towards computers, intrinsic motivation, as well as performance.

6-4 Materials

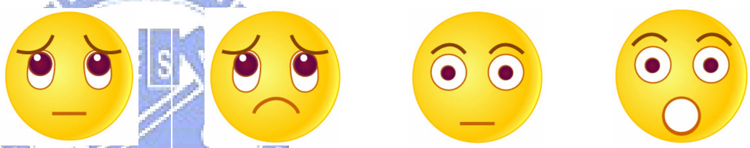
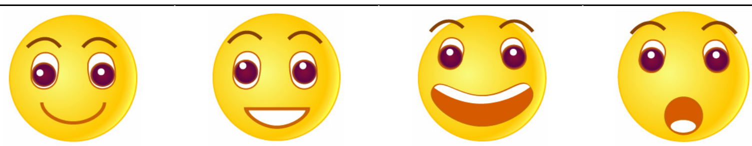
This instructional program adopted the active-interactivity one used in the study 1 and was modified so that can be used in this study. The instructional program had ten math problems at moderate 6th grade level. The degree of difficulty of the questions was discussed with teachers of the selected schools. The instructional program was controlled by using a mouse and the answer was inputted by key in number keys of the keyboard. The feedbacks provided by the program including presenting a text-based greeting at the beginning, showing the “right” symbol as feedback and automatically guide the participant to the next question when a subject answers correctly, or showing the “wrong” symbol and test-based message which suggested the subject to press “again” or “next” icon for proceeding when a subject fails to answer correctly, presenting the counts of correct and positive comments after all questions have been attempted. The program then developed into two versions to present speech and emoticon conditions by providing speech output and emoticon in the above-mentioned feedbacks.

Table 6.1 Voice settings of emotion for each speech output

Speech contents	Speech rate	Pitch average	intense	Emotion
Hi, welcome	Slightly faster	Slightly higher	Slightly higher	Slightly happy
Answer right	normal	Slightly higher	Slightly higher	happy
Answer wrong	Slightly lower	normal	lower	Neutral
Would you like to try again or go on the next one	Slightly lower	normal	normal	Neutral
you are great	normal	higher	higher	Very happy
You are excellent	normal	Slightly higher	Slightly higher	happy
Not bad this time	normal	normal	normal	Slightly happy
You will be better in the next time	Slightly lower	normal	lower	Neutral

There are two processes in choosing emotion of speech outputs and emoticons. First, researchers created each speech output with two different emotion and several emoticons. Speech for the study was created from recordings made by a young female. Emoticons were created into six basic emotions based on Ekman and Friesen (1975), and were then developed into different intensity levels for each emotion by manipulating the components of eyes, eyebrows, and a month. Those emoticons were depicted in small yellow faces with different emotions based on the most basic graphic emoticons used in computer-mediated communication. Then, the said instructional program was demonstrated to a focus group including two teachers and two students. The emotion of speech and facial expression suitable for each feedback were determined by the focus group. According to the results of the focus group discussion, the voice settings of emotion for each speech output are listed as Table 6.1. And there are several emoticons suitable to show emotional states for each feedback, which are summarized in Table 6.2.

Table 6.2 Selected emoticons for each feedback

Hi, welcome	
Answer right	
Answer wrong	
Would you like to try again or go on the next one	
You are great!	
You are excellent!	
Not bad this time!	
You will be better in the next time!	

According to the result of focus group that there are several emoticons suitable for each feedback, a class of sixth-year elementary school children was given questionnaires. The instructional program with speech feedback was demonstrated to them. They were subsequently asked to complete a questionnaire in which they chose an emoticon from options that best suited each feedback of the program. The emoticons with the highest frequency in feedbacks of the instructional program are presented in 6-5.

6-5 Experimental conditions

The differences between speech and emoticon conditions are social cues provided for the following interaction situations. The former provides speech output while the latter provides emoticons.

(1) Greeting

As a subject presses the "start" key, the instructional program will present a written greeting "Hi, Welcome!" and then automatically guide the subject to the first question. The computer reads "Hi, welcome!" in the speech condition (see Figure 6.1a), while showing an emoticon in the emoticon condition (see Figure 6.1b).

Figure 6.1a Greeting in the speech condition

Figure 6.1b Greeting in the emoticon condition

(2) Feedback to a correct answer

When a subject answers correctly, the instructional program will show the “right” symbol as feedback and automatically guide the participant to the next question. The computer reads “Right!” in the speech condition (see Figure 6.2a), while showing an emoticon in the emoticon condition (see Figure 6.2b).

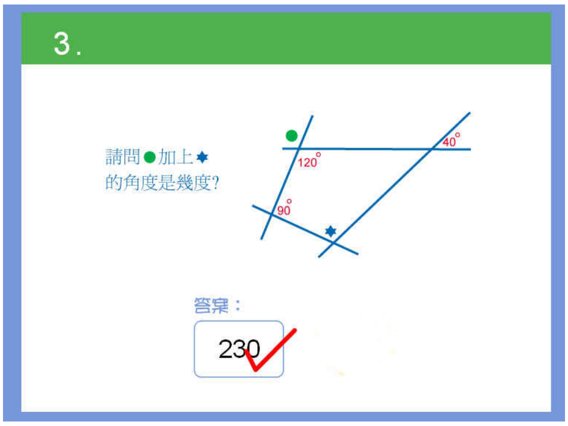


Figure 6.2a Feedback to a correct answer in the speech condition

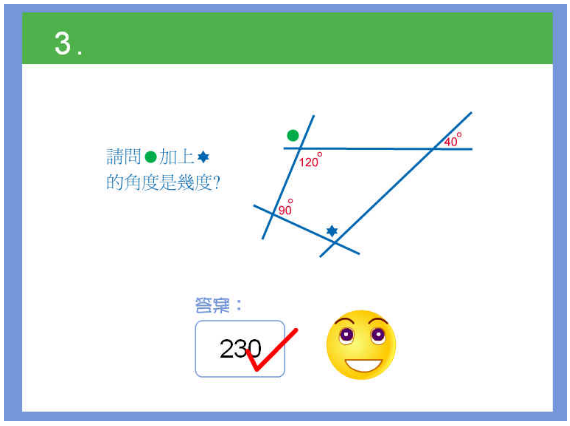


Figure 6.2b Feedback to a correct answer in the emoticon condition

(3) Feedback to a wrong answer

When a subject fails to answer correctly, the instructional program will display a “wrong” symbol on the screen. The computer reads “answer wrong!” in the speech condition (see Figure 6.3a), while showing an emoticon in the emoticon condition (see Figure 6.3b).

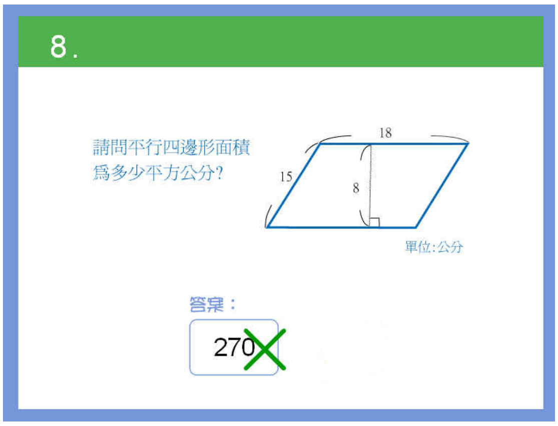


Figure 6.3a Feedback to a wrong answer in the speech condition

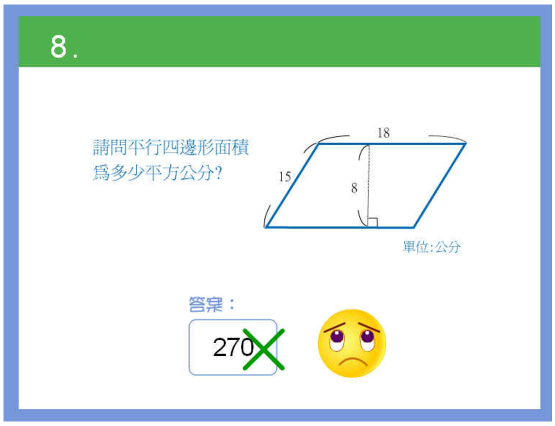


Figure 6.3b Feedback to a wrong answer in the emoticon condition

(4) Prompt of the next step

After offering feedback to a wrong answer, the program then presents written words, “Would you want to try again or go on the next one", on screen to prompt subjects for the next step. The computer reads the written words in the speech condition (see Figure 6.4a), while showing an emoticon in the emoticon condition (see Figure 6.4b).

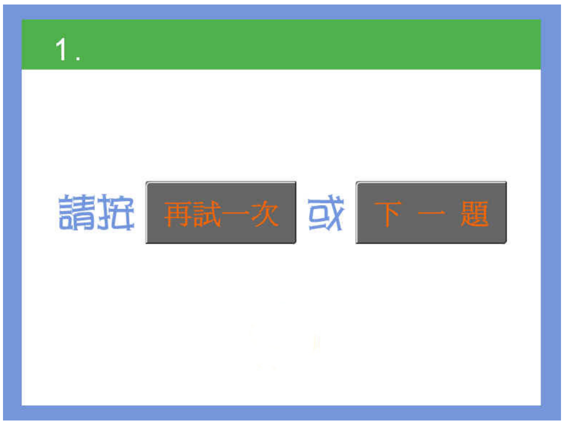


Figure 6.4a Prompt in the speech condition

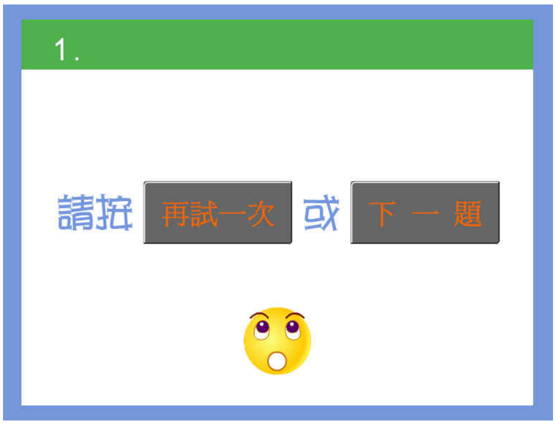


Figure 6.4b Prompt in the emoticon condition

(5) Comments

After all questions have been attempted, the instructional program will inform the subject the counts of correct and positive comments by showing the text feedback on the screen. For instance, for subject B the screen shows "The number of correct answers is 10. You are great!" The computer reads the text displayed on the screen in the speech condition while showing an emoticon in the emoticon condition (see Figure 6.5a and 6.5b).

Figure 6.5a Comment on performance in the speech condition

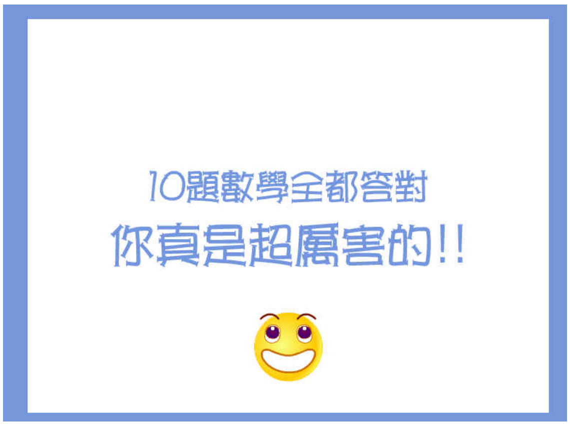


Figure 6.5b Comment on performance in the emoticon condition

6-6 Measurement tools

The dependent variables of social presence, social attraction, and intrinsic motivation were measured using a set of paper-and-pencil questionnaires.

The first set questions adopted the four items proposed by Short, Williams, and Christie (1976) to measure social presence, sociable/unsociable, personal/impersonal, sensitive/insensitive, and warm/cold, and applied a semantic differential technique. The semantic differential technique was used with bipolar five-point scales.

Same four questions used in Study 1 regarding social attraction of computers were asked.

Same ten questions used in Study 1 were used to measure children's intrinsic motivation.

The items for the performance measure were based the numbers of correct answers that each subject achieved after finishing the task.

6-7 Procedure

The study took place in the computer labs of the two selected schools during one of their computer class sessions. Each computer was separated by some distance from one another to prevent mutual interference. Each student was assigned to one computer in the lab. The speech and emoticon conditions are counterbalanced. All subjects were informed through the opening introduction which encouraged them to participate in the new designed math practice game and requested them to fill out the questionnaires according to their experience, and their evaluation of the game would be variable opinions to the design of the instructional media. The experiment took around 100 minutes. Upon completing the experiment, the subjects were debriefed and thanked with a toy.

6-8 Results

6-8.1 Validity and reliability

The measurement scales were designed on the base of related literature and confirmed through interviews with an HCI expert to assure content validity. Internal consistency (Cronbach's α) was calculated to assess the reliability of these scales. The reliability based on internal consistency was confirmed with a Cronbach's α coefficient. The Cronbach's α for the social presence perceived by boy and girl subjects are 0.90 and 0.83 respectively, for boy and girl subjects' social attraction to computers are 0.83 and 0.78 respectively, and for intrinsic motivation of boy and girl subjects are 0.83 and 0.87 respectively. According to Nunnally (1967), Cronbach's α value of 0.7 is adequate for internal consistency reliability. The measures used in the study demonstrated adequate reliability.

6-8.2 Social presence

Table 6.3 shows the descriptive statistics of the mean of social presence perceived by boy subjects in the speech condition is higher than those in emoticon condition. Similarly, results of girl subjects appear the same situation.

Table 6.3 Paired Samples Statistics of social presence

	Boy			Girl		
	Mean	SD	N	Mean	SD	N
Speech	6.8	2.9	46	7.1	2.0	40
emoticon	5.9	2.6	46	6.3	1.9	40

A Paired t-test was performed to compare the social presence the participants perceived between the two conditions. A statistically significant difference between the speech and emoticon conditions was observed in boy subjects ($t= 2.85$, $p < 0.001$) and girl subjects ($t= 2.35$, $p < 0.001$). The results indicated that both boys and girls perceived a higher degree of social presence from computers providing speech than from those providing emoticons. The hypothesis H_{1a} and H_{1b} are not supported (see Table 6.4).

Table 6.4 Paired Samples Test of social presence

Speech – emoticon	Paired Differences					df	t
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper		
boy	0.96	2.47	0.34	2.85	1.63	45	2.85***
girl	0.79	2.14	0.34	2.35	1.48	39	2.35***

* p< 0.05, ** p< 0.01, *** p< 0.001

6-8.3 Social attraction

Table 6.5 shows the descriptive statistics of the mean of children's social attraction to computers. It is found that boy subjects rated social attraction towards speech-output computers higher than nonspeech-output ones. A similar trend appears in the results of girl subjects.

Table 6.5 Paired Samples Statistics of social attraction

	Boy			Girl		
	Mean	N	SD	Mean	N	SD
Speech	6.5	46	2.0	6.6	40	1.7
emoticon	6.0	46	1.9	6.3	40	1.7

A Paired t-test was performed to compare the participants' social attraction toward the computer between the two conditions. A statistically significant difference between the speech and emoticon conditions was observed in boy subjects ($t= 2.24$, $p < 0.001$) while not observed in girl subjects ($t= 1.82$, $p =0.08$). The hypothesis H_{2b} is supported but hypothesis H_{2a} is not (see Table 6.6).

Table 6.6 Paired Samples Test of social attraction

Speech –emoticon	Paired Differences					df	t
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	Upper		
boy	0.53	1.62	0.24	0.05	1.01	45	2.24***
girl	0.39	1.35	0.21	-0.44	0.82	39	1.82

* p< 0.05, ** p< 0.01, *** p< 0.001

6-8.4 Intrinsic motivation

Table 6.7 shows the descriptive statistics of the mean of children's intrinsic motivation while participating in the learning task. It is found that boys and girls reported higher intrinsic motivation in the speech condition than in the emoticon condition.

A Paired t-test was performed to compare the participants' intrinsic motivation between the two conditions. A statistically significant difference between the speech and emoticon conditions was observed in both boy subjects ($t= 3.52$, $p < 0.001$) and girl subjects ($t= 2.14$, $p < 0.05$). This reveals that e-learning environments providing speech can motivate children more comparing to those providing emoticons. The hypothesis H_{3a} and H_{3b} are not supported (see Table 6.8).

Table 6.7 Paired Samples Statistics of intrinsic motivation

	Boy			Girl		
	Mean	N	SD	Mean	N	SD
Speech	6.1	46	1.3	6.4	40	1.3
emoticon	5.6	46	1.4	6.1	40	1.3

Table 6.8 Paired Samples Test of intrinsic motivation

Speech – emoticon	Paired Differences					df	t
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper		
boy	0.52	1.00	0.15	0.22	0.81	45	3.52***
girl	0.33	0.90	0.42	0.02	0.59	39	2.14*

* p< 0.05, ** p< 0.01, *** p< 0.001

6-8.5 Performance

Table 6.9 shows the descriptive statistics of the mean numbers of correct answers for boy subjects in speech and dynamic-emoticon conditions was 6.9 and 6.1 out of ten, and for girl subjects in speech and dynamic-emoticon conditions was 7.1 and 6.8 out of ten. It is found that subjects' performance of the learning task is higher in the speech condition than in the emoticon condition.

Table 6.9 Paired Samples Statistics of performance

	Boy			Girl		
	Mean	N	SD	Mean	N	SD
Speech	6.9	46	2.6	7.1	40	2.2
emoticon	6.1	46	2.8	6.8	40	2.7

A Paired t-test was performed to compare the number of correct answers between the two conditions. A statistically significant difference between the speech and emoticon conditions was observed in boy subjects ($t= 2.06$, $p < 0.05$) while not observed in girl subjects ($t= 1.83$, $p =0.07$). The hypothesis H_{4b} is supported but hypothesis H_{4a} is not (see Table 6.10).

Table 6.10 Paired Samples Test of performance

Speech – emoticon	Paired Differences					df	t
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
boy	0.78	2.57	2.06*	0.02	1.55	45	2.06*
girl	0.33	1.18	1.83	-0.03	0.68	39	1.83

* p< 0.05, ** p< 0.01, *** p< 0.001

6-8.6 Summary of results for hypotheses

As described above, a summary of the results of this study are given in Table 6.11.

Table 6.11 Summary of results for hypotheses

Hypotheses	Results
H1a.There is no difference in social presence perceived by boys between in the speech condition and in the emoticon condition.	not supported
H1b.There is no difference in social presence perceived by girls between in the speech condition and the in emoticon condition.	not supported
H2a.There is no difference in boy's social attraction to the computer providing speech outputs and to the one providing emoticons.	not supported
H2a.There is no difference in girls' social attraction to the computer providing speech outputs and to the one providing emoticons.	supported
H3a.There is no difference in boys' intrinsic motivation between participating in the e-learning environment with speech and participating in the one with emoticon.	not supported
H3b.There is no difference in girls' intrinsic motivation between participating in the e-learning environment with speech and participating in the one with emoticon.	not supported
H4a.There is no difference in the numbers of correct answers that boys achieve between in the speech condition and in the emoticon condition.	not supported
H4b.There is no difference in the numbers of correct answers that girls achieve between in the speech condition and in the emoticon condition.	supported

6.9 Discussion

6-9.1 Speech versus the emoticon

This study attempted to explore the application within e-learning environments with speech and the emoticon acting as social cues. It was expected that the effects of the two on children's attitudes toward computers and participating behaviors could be the same. However, results revealed that emoticons showed less influence than speech did.

Generally speaking, the results of this study demonstrated that children felt stronger social presence and social attraction in the speech condition than in the emoticon condition. Consistent with results of study 1, this study indicates that children's intrinsic motivation correlates closely with feelings of social presence; and it could be found that speech was more capable of triggering children's learning motives than emoticons, and children's learning achievement would be further influenced. Consequently, children reported higher intrinsic motivation and yielded better performance in the speech condition than in the emoticon condition. Results demonstrated that girl subjects' rating of social attraction and performance were not statistically significant, but were very close to statistically significant values. This indicates that speech still remains more effective in enhancing girls' feelings of social attraction and performance than emoticons.

Admittedly, speech has unique properties which can be associated with humans. It was not only true that speech in the auditory channel directly drew people's attention but it also originated from the evolution of human social interaction. Therefore, when people hear speech sounds, the social presence linking them to people should be achieved. Clearly, speech could create stronger gains in social presence and commands more attention in the process of interaction than text or symbols do (Chalfonte et al., 1991). Nevertheless, the emoticon is not only a symbol; it is a representation of a facial expression which is considered a primary source of information in interpersonal communication. Just as the brain processes voices differently than all other sounds, it processes faces differently than all other objects (Allison et. al., 1994; Nass & Brave, 2005).

Nass (1994) argued that human social responses to computers are unintentional. To elicit unconscious social responses, a computer still has to exhibit enough cues to lead people to categorize it as worthy of social responses (Nass, Moon, 2000). Given this, the features of facial expressions within interpersonal communication are reviewed closely in the following section.

6-9.2 Dynamic emoticons versus static emoticons

Humans depend highly on facial expression during communication which also means that it is an important piece of the communication message. Ekman and Friesen (1975) categorize three types of signals provided by the human face: static, slow, and rapid. They emphasize that emotion messages are transmitted by rapid facial signals, not by static facial signals which may affect the implication of an emotion message. Rapid facial signals mean facial muscles contract and there are visible changes in the appearance of the face when these feelings occur. Indeed, a person's smile and or expression of worry has never had a fixed pictorial image but featured as a singular, transient and alternating message. Under comparison, static facial expression symbols showed unnatural demonstration. Consequently, whenever designers used emotions as social cues for the application within human-machine interface, it was required to pay special attention to features in real life and insightfully observe the way that they could be demonstrated on people's faces. In view of this, a dynamic demonstration of the use of emoticons as social cues for the application of interface design should be represented instead of a static representation.

As stated above, facial displays of emotion are a dynamic phenomenon and a static emotion is an unnatural representation. The dynamic display of facial expressions provides unique temporal information about the expressions that is not available in static displays. Although most researches on people's responses to emoticons are conducted by using static facial icons as stimuli, the dynamic characteristics of facial expression have been mostly overlooked. A few studies have examined its effect on the intensity of emotional expressions and suggested that dynamic characteristics are necessary for full extraction of emotional information from faces (Ambadar, 2005; Biele, et al., 2006).

In view that dynamics is important in facilitating the perception of facial expressions, the study therefore assumes that the dynamic emoticon has the same effect on creating social human-computer interaction as speech does. This is worthwhile to be examined in more detail as the author hopes to employ emoticons as social cues to improve children's experiences and motivation with e-learning. As such, another study was conducted to make a comparison between the influence on children exerted by the application separately from speech and dynamic emoticons.

7. Study III: Speech versus the Dynamic Emoticon

7-1 Hypotheses and research questions

Based on the results of study 2, another experiment was conducted to study the effects of the use of speech and dynamic emoticon as social cues on children's attitudes toward computer as well as their motivation with learning. According to the discussion in chapter 6, it is predicted that there is not significant different between the two social cues. Data from boys and girls would be analyzed separately in an attempt to see whether gender influences subjects' reaction to the two social cues. The hypotheses and research questions are listed as below.

H1a. There is no difference on social presence perceived by boys between in the speech condition and in the dynamic-emoticon condition.

H1b. There is no difference on social presence perceived by girls between in the speech condition and in the dynamic-emoticon condition.

H2a. There is no difference on boys' social attraction to computers providing speech and to those providing the dynamic emoticon.

H2b. There is no difference on girls' social attraction to the computers providing speech and to those providing the dynamic emoticon.

H3a. There is no difference on boys' intrinsic motivation between participating in the e-learning environment providing speech and participating in the one providing the dynamic emoticon.

H3b. There is no difference on girls' intrinsic motivation between participating in the e-learning environment providing speech and participating in the one providing the dynamic emoticon.

H4a. There is no difference on the performance boys achieve between in the speech condition and in the dynamic-emoticon condition.

H4b. There is no difference on the performance girls achieve between in the speech condition and in the dynamic-emoticon condition.

Furthermore, two research questions were explored to gain an insight regarding how manage the speech and dynamic emoticon as social cues in e-learning environments to motivate children in learning.

RQ1. Is children's feeling of the four items of intrinsic motivation different between in the e speech condition and in the dynamic-emoticon condition?

RQ2. Is the effect of speech and dynamic emoticon on children's intrinsic motivation different between levels of performance?

7-2 Participants

Eighty-eight sixth graders (42 girls and 46 boys) from three classes of two elementary schools in Hsinchu participated. The average age was 11.9 years. All subjects have experienced using computers and have received computer instruction at least once a week since third grade. A total of 86 percent of the subjects reported that they often used computers at home for playing games and web browsing. These figures suggest that the subjects are familiar with computers.

7-3 Experiment design

The design was within-subjects with one factor with two levels (speech and dynamic emoticon). The dependent variables were the perceived social presence, children's social attraction towards computers, intrinsic motivation, as well as their performance.

Presence of dynamic emoticons

This study adopted the instructional program used by the study II and transformed the static emoticons into dynamic emoticons. Static emoticons are fully expressive during the whole presentation time, while dynamic emoticons start with a neutral face, which then continuously evolves into full expression. The speed of the dynamic display is 12 frames per second. Table 7.1-7.5 illustrate five sequential emoticons captured from a dynamic display that demonstrates the visible change of eyes, eyebrows, and mouth during the transition from the neutral emoticon to the intended emoticon for each interaction situation.

Table 7.1 The transition from the neutral emoticon to the intended emoticon for a greeting

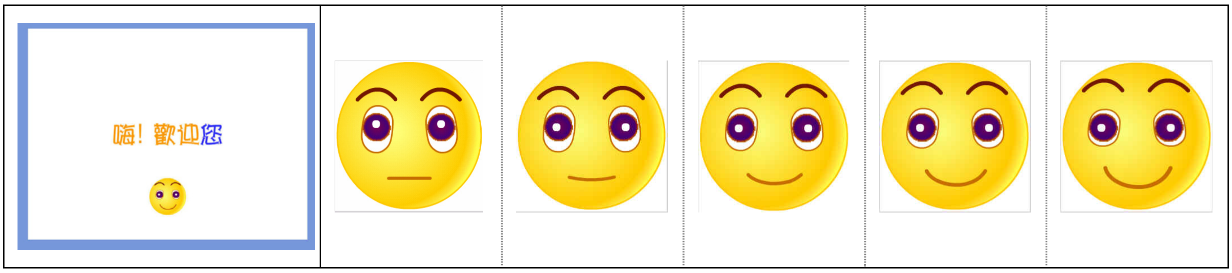


Table 7.2 The transition from the neutral emoticon to the intended emoticon for a correct-answer feedback

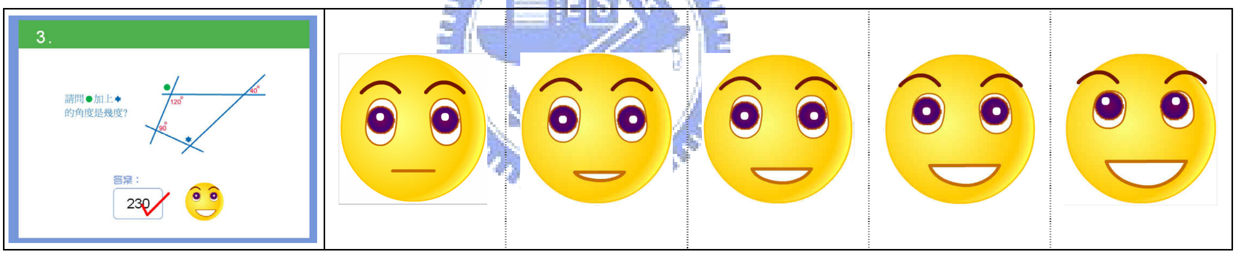


Table 7.3 The transition from the neutral emoticon to the intended emoticon for a wrong-answer feedback

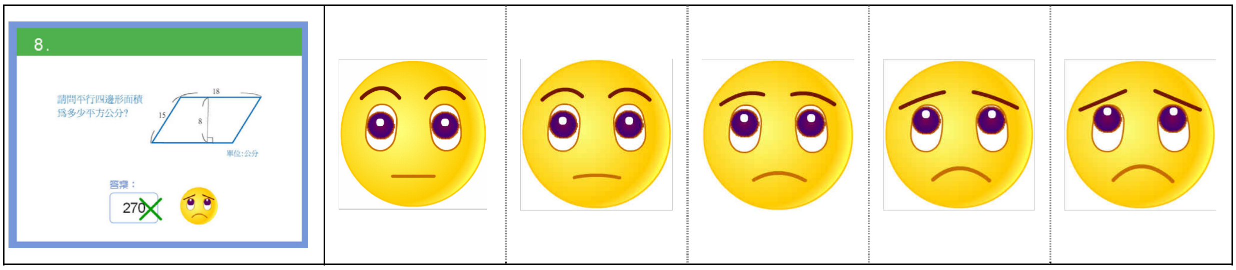


Table 7.4 The transition from the neutral emoticon to the intended emoticon for a prompt

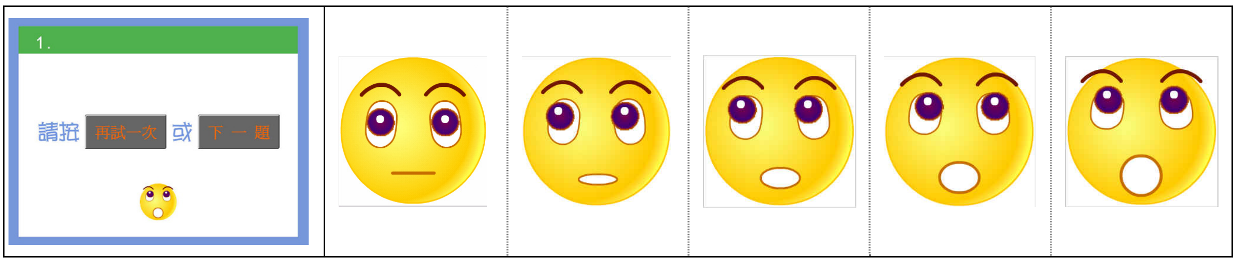


Table 7.5 The transition from the neutral emoticon to the intended emoticon for a comment on performance

7-4 Measurement tools

Same four questions used in Study 2 were used to measure the assessment of social presence.

Same four questions used in Study 2 regarding social attraction of computers were asked.

Same ten questions used in Study 2 were used to measure children's intrinsic motivation.

Same way used in Study 2 concerning the evaluation of children's performance was used.

7-5 Procedure

The study took place in the computer labs of the two selected schools during one of their computer class sessions. Each computer was separated by some distance from one another to prevent mutual interference. Each student was assigned to one computer in the lab. The two conditions of speech and dynamic emoticon are counterbalance. All subjects were informed through the opening introduction which encouraged them to participate in the new designed math practice game and requested them to fill out the questionnaires according to their experience, and their evaluation of the game would be variable opinions to the design of the instructional media. The experiment took around 100 minutes. Upon completing the experiment, the subjects were debriefed and thanked with a toy.

7-6 Results

7-6.1 Reliability

Internal consistency (Cronbach's α) was calculated to assess the reliability of these scales. The reliability based on internal consistency was confirmed with a Cronbach's α coefficient. The Cronbach’s α for the social presence perceived by boy and girl subjects are 0.87 and 0.88 respectively, for boy and girl subjects’ social attraction to computers are 0.88 and 0.89 respectively, and for intrinsic motivation of boy and girl subjects are 0.77 and 0.80 respectively. According to Nunnally (1967), Cronbach’s α value of 0.7 is adequate for internal consistency reliability. The measures used in the study demonstrated adequate reliability.

7-6.2 Social presence

Table 7.6 shows the descriptive statistics of the mean of social presence boy subjects perceived in the speech condition is higher than those in emoticon condition, and the social presence girls perceived in the speech condition is almost as same as in the dynamic-emoticon conditions, as shown in Figure 7.1.

Table 7.6 Paired Samples Statistics of social presence

	Boy			Girl		
	Mean	N	SD	Mean	N	SD
speech	7.1	46	2.5	7.0	42	2.5
dynamic emoticon	6.4	46	2.1	6.9	42	2.0

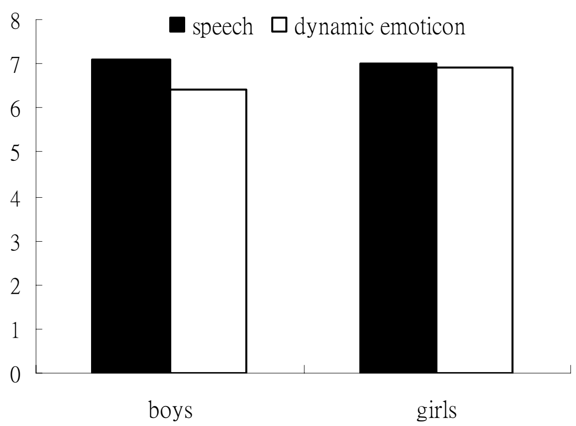


Figure 7.1 Results of boy and girl subjects’ feeling of social presence in the two conditions

A Paired t-test was performed to compare the subjects’ social attraction toward the computer between the two conditions. No statistically significant difference was found for the girl subjects (t= 0.27, p =0.79). The difference for the boy subjects was not, but close to, statistically significant (t= 1.90, p= 0.07). The hypothesis H_{1a} and H_{1b} are supported (see Table 7.7). The gender difference on feelings of social presence between speech and dynamic emoticon conditions is taken up in a later chapter.

Table 7.7 Paired Samples Test of social presence

Speech – Static emoticon	Paired Differences					df	t
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
boys	0.67	2.45	0.36	-0.05	1.40	45	1.90
girls	8.0E-0 2	1.90	0.29	-0.51	0.67	41	0.27

* p< 0.05, ** p< 0.01, *** p< 0.00

7-6.3 Social attraction

Table 7.8 shows the descriptive statistics of the mean of children's social attraction to computers. It was found that boy subjects rated social attraction to computers providing speech slightly higher than to those providing dynamic emoticons. A reverse result was observed in girl subjects, as shown in Figure 7.2.

Table 7.8 Paired Samples Statistics of social attraction

	Boy			Girl		
	Mean	N	SD	Mean	N	SD
speech	7.1	46	1.7	6.7	42	2.0
dynamic emoticon	6.8	46	1.6	6.9	42	1.5

A Paired t-test was performed to compare the social presence the participants perceived between the speech and emoticon conditions, no significant difference was found for the boy subjects (t= 1.52, p = 0.34) and the girl subjects (t= -1.14, p =0.19). The hypothesis H_{2a} and H_{2b} are supported (see Table 7.9).

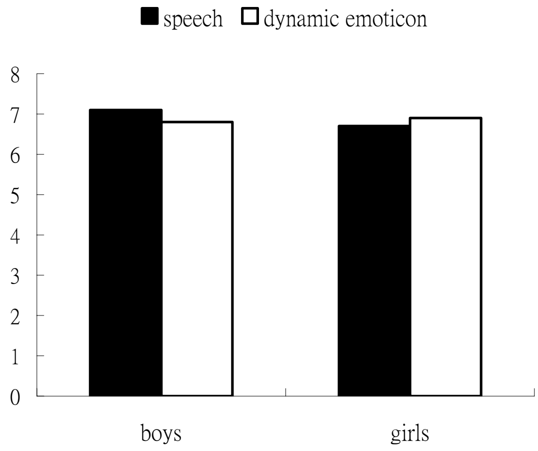


Figure 7.2 Results of boy and girl subjects' feeling of social attraction in the two conditions

Table 7.9 Paired Samples Test of social attraction

Speech – emoticon	Paired Differences					df	t
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
boys	0.26	1.16	0.17	-0.08	0.61	45	1.52
girls	-0.25	1.40	0.22	-0.68	0.19	41	-1.14

* p< 0.05, ** p< 0.01, *** p< 0.00

7-6.4 Intrinsic motivation

Table 7.10 shows the descriptive statistics of the mean of children's intrinsic motivation while participating in the learning task. It is found that boys reported slightly higher intrinsic motivation in the speech condition than in the emoticon condition. A reverse result is observed in girl subjects, as shown in Figure 7.3.

Table 7.10 Paired Samples Statistics of intrinsic motivation

	Boy			Girl		
	Mean	N	SD	Mean	N	SD
speech	6.5	46	1.2	6.1	42	1.5
dynamic emoticon	6.3	46	1.2	6.3	42	1.0

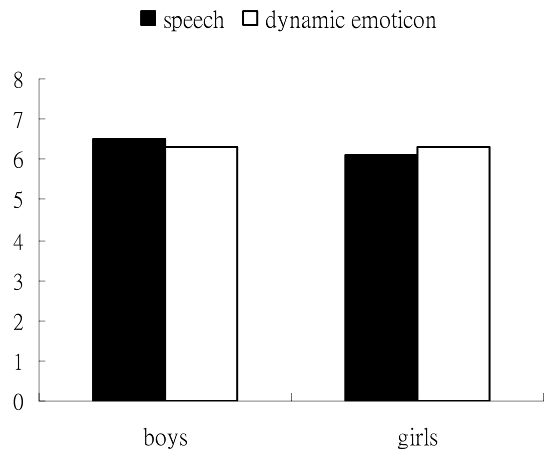


Figure 7.3 Results of boy and girl subjects' intrinsic motivation in the two conditions

A Paired t-test was performed to compare the participants' intrinsic motivation between the speech and emoticon conditions, no statistically significant difference was found for the boy subjects (t= 0.95, p =0.37) and the girl subjects (t= -1.32, p = 0.19). The hypothesis H3a and H3b are supported (see Table 7.11).

Table 7.11 Paired Samples Test of intrinsic motivation

Speech – Dynamic emoticon	Paired Differences					df	t
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
boys	0.13	1.00	0.15	-0.16	0.43	45	0.91
girls	-0.27	1.30	0.20	-0.67	0.14	41	-1.32

* p< 0.05, ** p< 0.01, *** p< 0.00

7-6.5 Performance

Table 7.12 shows the descriptive statistics of the mean numbers of correct answers for boy subjects in speech and dynamic-emoticon conditions was 6.5 and 6.3 out of ten, and for girl subjects in speech and dynamic-emoticon conditions was 6.8 and 7.5 out of ten, as shown in Figure 7.4.

Table 7.12 Paired Samples Statistics of performance

	Boy			Girl		
	Mean	N	SD	Mean	N	SD
speech	6.5	46	2.6	6.8	42	2.3
dynamic emoticon	6.3	46	2.6	7.5	42	2.2

Compare the number of correct answers between the two conditions by performing a paired t-test, a statistically significant difference was found for the girl subjects (t= -2.58, p < 0.05) but not for the boy subjects (t= 0.56, p =0.58). The hypothesis H4a is supported but hypothesis H4b is not (see Table 7.13).

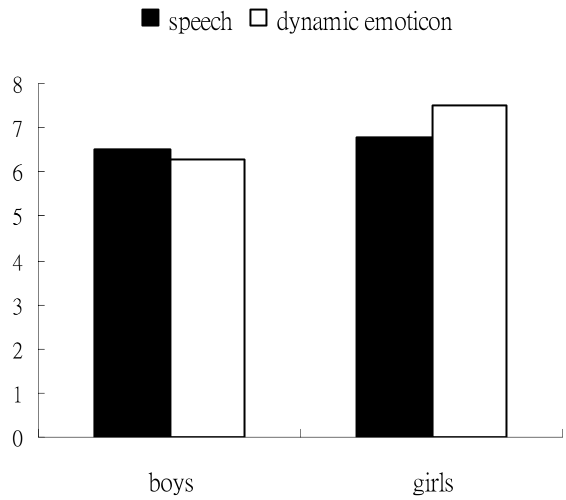


Figure 7.4 Results of boy and girl subjects' performance in the two conditions

Table 7.13 Paired Samples Test of performance

Speech – Dynamic emoticon	Paired Differences					df	t
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
boys	0.20	1.39	0.35	-0.51	0.91	45	0.56
girls	-0.67	1.68	0.26	-1.19	-0.14	41	-2.58*

* p< 0.05, ** p< 0.01, *** p< 0.00

7-6.6 Research questions

(1) Children's feeling of the four items of intrinsic motivation in the two conditions

Table 7.14 shows the analysis results of the boy subjects' feeling of self-determination, competence, relatedness, and tension between in the speech condition and in the dynamic-emoticon condition. No statistically significant difference was found in the four items, which indicates that the use of speech and dynamic emoticons in e-learning environments does not influence the boys' feeling of self-determination, competence, relatedness, and tension.

Table 7.15 shows the analysis results of the girl subjects' feeling of self-determination, competence, relatedness, and tension between in the speech condition and in the dynamic-emoticon condition. A statistically significant difference was found in the feeling of self-determination and competence but not in the feeling of relatedness and tension. The result indicates that the use of speech and dynamic emoticons in e-learning environments does not influence girls' feeling of relatedness and tension. However, the e-learning environment providing dynamic emoticon enable girls to feel a higher degree of self-determination and competence than do those providing speech.

Table 7.14 Results of boys' feeling of elf-determination, competence, relatedness, and tension

Speech – Dynamic emoticon		Paired Differences					df	t
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Self determination	7.2(1.6) 7.0(1.5)	0.12	1.13	0.17	0.21	0.45	45	0.72
Competence	6.9(1.9) 6.9(1.7)	-2.2E-02	1.38	0.20	-0.43	0.39	45	-0.11
relatedness	6.4(2.2) 6.4(1.9)	7.2E-02	2.13	0.31	-0.63	0.64	45	0.02
Tension (reverse)	5.3(2.0) 5.4(2.0)	-0.17	2.37	0.34	-0.87	0.54	45	-0.48

* p< 0.05, ** p< 0.01, *** p< 0.00

Table 7.15 Result of girls' feeling of elf-determination, competence, relatedness, and tension

Speech – Dynamic emoticon		Paired Differences					df	t
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Self determination	6.7(1.8) 7.1(1.3)	-0.38	1.22	0.19	-0.76	4.1E-02	41	-2.02*
Competence	6.3(2.2) 6.9(1.5)	-0.58	1.64	0.25	-1.09	-6.6E-02	41	-2.28*
relatedness	6.1(2.2) 6.3(1.7)	-0.18	1.99	0.31	-0.80	0.44	41	-0.60
Tension (reverse)	5.1(2.2) 5.1(2.1)	5.6E-02	2.25	0.34	-0.65	0.76	41	0.16

* p< 0.05, ** p< 0.01, *** p< 0.00

(2) Effects of speech and dynamic emoticons on intrinsic motivation of children at different levels of performance

To study whether the effect of speech and dynamic emoticons on children's intrinsic motivation is different between levels of performance, all subjects were divided into three levels according to mean numbers of correct answers that each subject achieved in the two conditions. The three levels are excellent (7.5~10), average (4.5~7.5), and below average (under 4.5) respectively. Table 7.16 shows the descriptive statistics of the means of intrinsic motivation of boy subjects at these three levels.

Table 7.16 Descriptive Statistics of intrinsic motivation of boy subjects at three levels of performance

Level \ condition	Speech		Dynamic emoticon		N
	mean	Std. Deviation	mean	Std. Deviation	
Excellent	6.7	0.8	6.5	1.0	16
Average	6.7	1.4	6.3	1.5	19
Below average	5.8	0.8	6.1	1.1	11
Total	6.5	1.2	6.3	1.2	46

The analysis of variance of between subjects indicated that the effect of speech on intrinsic motivation between different levels of performance is significant ($F_{2,45}$=2.86, p<0.0), but the effect of dynamic emoticons is not significant. It indicated that the speech feedback can be used to reinforce intrinsic motivation for boys at high levels of performance, as listed in Table 7.17.

Table 7.17 Tests of Between-Subjects effect

Condition	Dependent variable	source	SS	df	Ms	F
speech	Intrinsic motivation	Level of performance	7.02	2	3.51	2.86
emoticon			1.17	2	0.58	0.38

Table 7.18 shows the descriptive statistics of the mean of intrinsic motivation of boy subjects at the three levels of performance.

Table 7.18 Descriptive Statistics of intrinsic motivation of girls at three levels of performance

condition / Level	Speech		Dynamic emoticon		N
	mean	Std. Deviation	mean	Std. Deviation	
Excellent	6.5	1.6	6.6	1.0	16
Average	5.7	1.6	6.1	0.8	16
Below average	5.7	0.8	5.8	0.5	10
Total	6.1	1.5	6.3	0.9	12

The analysis of variance of between-subject effects indicated that the effect of dynamic emoticon on intrinsic motivation between different levels of performance is significant ($F_{2,45}$=2.86, p<0.0), but the effect of speech emoticon is not significant. Contrary to the result of boys, the dynamic-emoticon feedback can increase intrinsic motivation of those girls who are at high level of performance, as listed in Table 7.19.

Table 7.19 Tests of Between-Subjects effect

Condition	Dependent variable	source	SS	df	Ms	F
speech	Intrinsic motivation	Level of performance	6.24	2	3.12	1.34
emoticon			4.80	2	2.40	3.05

7-6.7 Summary of results for hypotheses

As described above, a summary of the results of this study are given in Table 7.20.

Table 7.20 Summary of results for hypotheses

Hypotheses	Results
H1a. There is no difference on social presence perceived by boys between in the speech condition and in the dynamic-emoticon condition.	supported
H1b. There is no difference on social presence perceived by girls between in the speech condition and in the dynamic-emoticon condition.	supported
H2a. There is no difference on boys' social attraction to computers providing speech and to those providing the dynamic emoticon.	supported
H2b. There is no difference on girls' social attraction to the computers providing speech and to those providing the dynamic emoticon.	supported
H3a. There is no difference on boys' intrinsic motivation between participating in the e-learning environment providing speech and participating in the one providing the dynamic emoticon.	supported
H3b. There is no difference on girls' intrinsic motivation between participating in the e-learning environment providing speech and participating in the one providing the dynamic emoticon.	supported
H4a. There is no difference on the performance boys achieve between in the speech condition and in the dynamic-emoticon condition.	supported
H4b. There is no difference on the performance girls achieve between in the speech condition and in the dynamic-emoticon condition.	not supported

7-7 Discussion

7-7.1 The dynamic emoticon as a social cue

Most of the results are consistent with the predictions. This demonstrates that dynamic emoticons as well as speech can function as social cues to allow computers to have strong social presence and yield social attraction for children. The empirical evidence supports the argument that dynamic presentation improves perceptions of emotional facial expressions and it also plays an important role in enriching the communication of emoticons, hence having a better social presence. The different results obtained from exp. 2 and exp. 3 reveal that dynamic emoticons were rated with a higher degree of social presence and obtained greater social attraction than static emoticons. One explanation could be that the static emoticon is unable to convey emotion as accurately as the dynamic emoticon. The dynamic nature of facial expression is important for recognition of emotions.

Besides the communication of emoticons, the different results of children's social awareness of static and dynamic emoticons could be related to the relative naturalness of the latter. The static emoticons presented the visual cues of emotional faces, but these were not the emotions expressed normally by people when they interact. Just as speech is dynamic, so facial expressions are a dynamic interaction in which the face moves and changes from one expression to another. People express different emotions when they interact with other people. They smile, laugh, frown and get serious. In comparison, dynamic emoticons express emotions of the face by the rapid facial signals which are more like the way people react.

Studies related to the CASA paradigm concerning human-to-human interaction can be replicated in the context of human-to-computer interaction. People are likely to see a computer not as a tool but as an independent social actor when the computer itself presents people with social cues normally reserved for human-human interaction. Consequently, we should pay close attention to the characteristics of emotional facial expressions in the context of human-to-human interaction for utilizing emoticons as social cues in e-learning environments. Dynamic expressions are more natural, more realistic and as thus are stronger signals of intentions and actions of others. Leveraging features could enrich the social presence in e-learning environments and create a more sociable learning experience. The results evidenced that the effect of dynamic emoticons could reach the effect of speech; and that both of them can be used for interface design to increase children's perception social presence from the computer, and in turn elicit their social attraction.

7-7.2 Effects of speech and dynamic emoticons on children's motivation

On the whole, there is no remarkable difference in children's intrinsic motivation and performance during participating in the speech and the dynamic emoticon conditions, except of that with respect to girls' performance. It means that the e-learning environment with the application of speech or dynamic emoticons could equally encourage children to participate in learning activities. This provided designers with the available space for interface design flexibility in developing e-learning environments. It is possible for designers to freely adopt speech and dynamic emoticons to represent the auditory or visual modality and communication modes by verbal or nonverbal means by focusing the limitations and demands of the learning media and environment. Thus, the goals to inspire children's learning participation could be reached.

Comparing the influence on children's performance of the task in speech and dynamic-emoticon conditions, we found that boys showed no differences within the two conditions. However, girls showed better performance in the dynamic-emoticon condition than in the speech condition. The difference was also reflected in the boys' and girls' feelings of self determination, competence, relatedness, and tension which are four items of intrinsic motivation. When participating in the e-learning environment with speech or dynamic emoticons provided, boys showed no remarkable difference in the four kinds of feelings. However, girls showed stronger feelings of self-determination and competence within the e-learning environment with dynamic emoticons provided. Therefore, girls within the e-learning environment with dynamic emoticons showed stronger willingness to answer previously incorrectly answered questions until the correct answer was found. Consequently, girls within the e-learning environment with dynamic emoticons could achieve better performance than that of speech.

Furthermore, the study explored whether the effect of speech and dynamic emoticons on children's intrinsic motivation is different between levels of performance. The results indicated that the speech feedback can be used to reinforce intrinsic motivation for boys with a high level of performance. Contrary to boys, the dynamic-emoticon feedback can increase the intrinsic motivation of those girls who are at a high level of performance.

In general, the e-learning environment provided with speech or dynamic emoticons showed no significant difference on children's participating and learning motives. However, when the exploration was further conducted on the influence of children's experience of the four feelings of intrinsic motivation and performance for the e-learning environments separately with speech and dynamic emoticon provided, it could be found gender differences actually influenced children's feelings and performance when they participated in these two e-learning environments. Obviously, dynamic emoticons had a stronger influence on girls, while boys were influenced more easily by speech.

7-7.3 Gender differences in children's perception of speech and dynamic emoticons

From the results, we find gender differences in children's perception of and preference toward the two kinds of social cues. Girls clearly showed stronger preference to dynamic emoticons. Comparing the mean of the four independent variables within this research, it could be found that girls within the e-learning environment with dynamic emoticons provided showed higher average values than that with speech provided. However, for boys, it showed the contrary results.

Contrary to the acceptance and preferences for girls' attitudes toward dynamic emoticons, boys showed stronger sensitivity to speech. For example, the result of boys' rating of social presence was not statistically significant but in fact quite close. It appears that speech triggers boys' attention easier than dynamic emoticons. Consequently, the e-learning environment with speech provided could make boys derive stronger social presence.

As addressed in literature, the tendency for females to be better than males in detecting and decoding faces and other nonverbal indicators is culturally universal. Moreover, these gender differences are noticeable very early in development, and girls are more accurate in identifying emotional facial expression than boys. Thus, it is not surprising to find that girls are more responsive to computers with emoticons provided than boys. Interestingly, the gender differences in perception of emotional facial expressions in human-to-human communication also influence the way they interact with computers. As the CASA paradigm argues that people respond to humans and computers in identical ways, the present research revealed that children view the computer in a social role; or rather their interactions with computers reflect how they perceive and decode social cues within a real social context.

7-8 Limitations

The studies I, II, and III in this research were limited in two ways. Firstly, choosing 5th and 6th graders as the subjects for a study like this has the merit of their previous experiences with computers and their ability to fill in the questionnaire. Those subjects were recruited from two different elementary schools in Hsinchu County where the computer penetration rate is up to 76% and higher than other counties in Taiwan according to a report by DGBAS (Directorate General of Budget, Accounting and Statistics). Broadening the variety of the subjects may help future researchers to gather more comprehensive responses regarding the effects of the social cues of interactivity, speech, and emoticons provided by computers.

Secondly, to obtain the effects of social cues manipulated in this research, the experiment materials were developed in quiz-based learning environments and did not contain music or graphics as would normally be found in e-learning environments and that children would most likely be accustomed to. However, many children reported liking the program and were willing to play it again.

8. General Conclusion

我見青山多嫵媚 料青山見我應如是

When the green mountains look so charming to me, I believe I must look alike in their eyes

/辛棄疾 Xin Qiji

People appear to form affective attachments to and affective relationships with objects. As Norman (2004) states, people have evolved to interpret even the most subtle of indicators and are predisposed to anthropomorphize, to project human emotions, into anything. The anthropomorphic responses can also bring great delight and pleasure to the user of a product. Attributing human characteristics to objects or animals is a way of changing the values we place on them and how we can interact with them (Caporarel & Heyes, 1997). Our anthropomorphic perceptions may reflect the social nature of humans. Computers are responsive and interact with people in more engaging way, with which people might expect to have a social relationship. From this perspective, the research aims at incorporating social cues adopted from human-human interaction into human-computer interaction to intensify the sense of social presence in child-computer interaction and generate a connection with a social entity. The findings of the research make original and important contributions which are described as follow.

8-1 Contributions

8-1.1 Contribution to the CASA paradigm

The central purpose of the research is to extend the research focus and application of the CASA paradigm to children. It is concerned with whether children respond socially to computers in similar ways as adults. At the same time, it also questions if childhood animism allows children to be fundamentally social with computers regardless of social cues. This study provides empirical support for the claim that children's social responses to a computer can be elicited and affected by the social cues offered by the computer. A computer with social cues has stronger social presence and yields more social responses from children. These findings emphasize the importance of the social relationship that can develop between a computer and a child. Hence, children would be able to perceive a computer not merely as a tool but as a friend or a companion. Besides this, their interactions with computers reflect how they perceive and decode social cues within a real social context. The finding that children do have social responses to computers allows researchers to explore other interpersonal interactions for children in the context of interactions with computers.

8-1.2 Contribution to children's e-learning

The research expands not only what we know about CASA responses to include children, but allows us to see how the CASA paradigm can be applied in e-learning environments to foster children's intrinsic motivation. In study 1, a positive correlation between children's intrinsic motivation and the degree of perceived social presence was found. Studies suggest that high levels of social presence create an environment that is felt as accepting and will produce positive results on student learning. The social presence addressed in those studies involved the degree of interpersonal contact with the instructor and other participants in an online learning environment. The research further argues that the perceived social presence provided by a computer can function as a way to effectively enhance children's motivation with computerized learning with no instructor or other colleagues involved.

Besides this, most research in educational technology has considered computers as being neutral cognitive tools and has emphasized the cognitive and information processing aspects of learning (Lajoie, & Derry, 1993). Turkle described the computer as Rorschach to present the computer as a relatively neutral screen onto which people were able to express their thoughts and feelings. Nevertheless, Turkle has also indicated that the computational object is no longer effectively neutral. People perceive computers on a social dimension and attribute personality, intelligence, and emotion to them. Thus, the findings suggest that designers of educational technology may move beyond an emphasis on merely cognitive aspects of learning with computers and pay attention to the effects of social traits of computers.

Learning is a social activity that requires a close connection to achieve better quality. The social dimension of the activity is a critical aspect for the learners. We call for attention to the aspect of learners' social desires in e-learning design. Establishing an e-learning environment conducive to social interaction also helps to counterbalance the negative effects that a dehumanized computer environment may have on children. With technology advancing rapidly, computer-mediated learning may come in a variety of applications such as educational products, systems, interactive toys, or even robots. Creating a social interface for those applications can help counterbalance the feeling of isolation when children interact with them individually. Such relationships may in turn increase and sustain children's motivation with learning activity.

8-1.3 Contribution to the field of Human-Computer Interaction

Humanizing computer interfaces has long been a major goal of both computer users and HCI practitioners since it was suggested that more humanized interfaces convey a sense of comfort and ease to the user (Laurel, 1990; Picard, et al., 2002; Sproull et al, 1996). The research demonstrates that it does not take an expert system or artificial intelligence to attain the goal of devising a humanized interface. Instead, incorporating some features of human-human interaction into the human-computer interaction would do the job. The simple and subtle social cues embedded in computer interface bring the human-computer interaction to a more sociable and intimate level. These findings are relevant to those who are seeking to make interacting with computers a more social experience. The research supports a relatively new approach to attain the goal of humanized and sociable computers: leveraging social cues in interpersonal communication.

The development of a sociable interface has never meant the direct embedding of social attributes without prudential consideration. Rather, it was required to study users' attitudes and perceptions more closely. Concluded from this research, the way computers interact with humans can adopt the features of “message exchange” and “role exchange” in interpersonal communication. That an individual is being directed in a proactive manner by the computer does not deprive him/her of control over the process. On the contrary, an individual who plays the roles of both sender and receiver experiences a greater sense of social presence during the interaction. Accordingly, it suggests that computer programs provide appropriate, timely and automatic guidance and anticipated responses to make the computer more sociable.

Both facial expression and speech play crucial roles in interpersonal communication. Comparing speech with facial expression, the former is a channel of verbal communication and an audio modality while the latter is one of nonverbal communication and a visual modality. It is difficult to debate which one is dominant because both of them have their own unique characteristics. However, the comparison of speech and the emoticon (a representation of facial expression) relates to a further issue, that of verbal communication versus nonverbal communication as well as audio modality versus visual modality. The research provides evidence that dynamics enrich emotional expression and play an important role in presenting emoticons. In addition dynamic emoticons and speech have the same impact on inducing social responses from children and motivating them in e-learning environments. Furthermore, gender differences in decoding verbal and nonverbal communications and perceiving auditory and visual modalities are observed. The results may provide designers with research based guidelines in consideration of speech or the emoticon to design sociable interactions for children.

8-2 Future research

8-2.1 Breadth and depth in researching effects of the social cues

As the application of computing technology matures, it opens up new possibilities for educational products. The results of this research could be extended to the interface design for educational products such as digital products, interactive toys, or even robots which allow children to build up knowledge by engaging in interactions with those products. One likely area of interest for future studies would include determining the limits of where social cues become a burden or annoyance rather than perceived as positive feedback and guidance. Another likely area for future study could involve how much control the user should or could have over navigation through the learning material before the information becomes disorganized or illogically related to the detriment of the learning experience.

Speech is a comprehensive and expressive medium that can convey a wide range of social cues by altering voice inflection, pitch, and tone. It tells gender, age, and more subtle human characteristics such as personality and emotion. Thus, how to capitalize on the social features of speech in an e-learning environment to engage children in learning and ease the feeling of solitariness and anxiety can be the subject of further study in the future. Exploring the subject can help understand children's preference for and perception threshold for social cues that speech entails in human-computer interaction. Besides this, people use more than one channel when communicating. Thus speech and emoticons used concurrently should also be studied to explore whether the social cues provided by multiple channels would have a redundancy effect, convey stronger social presence or would lead to distraction and diminish the effect due to the increased amount of social cues.

Ultimately, the research attempts to study the potential of interaction design from the aspect of social interaction. Future studies may further explore the impact of various cues and more possibilities in creating sociable interfaces by identifying the features of interpersonal communication that can be applied to the making of more sociable computer technology.

8-2.2 Longitudinal studies on children's social responses to computers

Effects of active interactivity, speech, and dynamic emoticon in the research shown significant results, but the time children interacted with computers was less 40 minutes on average. Thus, the question about the persistence of children's social responses to computers with social cues remains unanswered, such as: "will the positive effects of active interactivity persist over time?" "Will feedbacks of speech or dynamic emoticons still improve children's experiences and attitudes after hundreds of interactions?" In view of this, longitudinal studies that investigate children's social responses to computers over a long period of time would provide an insight into the issue and the design of social interaction.

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Appendix A

Experimental questionnaire for study I

非常謝謝您參與這個電腦遊戲。

這份問卷是想了解您這次參與電腦遊戲的感受與想法，請您仔細研讀每一句敘述，根據您的親身感受，從**非常不贊成**到**非常贊成**中的圓點，圈選一個適合位置的圓點，以反映您對每句敘述的贊成程度。

再次強調問卷的目的是來了解您的意見，**所圈選的答案沒有對或錯**，都是依照您的感受，在每一題做適當的圈選。**您的看法對我們是非常寶貴的意見，請您能仔細地逐題回答，謝謝!**

1. 請問您是 ☐ 女生 ☐男生
2. 請問您的生日：__________ 年 __________ 月
3. 請問您會在家中使用電腦嗎? ☐ 從不使用 ☐ 偶爾使用 ☐ 經常使用 ☐天天使用
4. 請問您使用電腦的目的與活動：____

____

非常 不贊成	我覺得這個電腦是容易親近的 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我覺得這個電腦是冷漠的 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我覺得這個電腦是具有人性的 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我覺得這個電腦是敏銳的 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我喜歡和這個電腦玩數學遊戲 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我覺得我和電腦是同一國的 ● ● ● ● ● ● ● ● ●	非常 贊成

下頁還有喲!!

非常 不贊成	玩這個數學遊戲，讓我覺得自己很聰明 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我覺得是自己想要回答這些數學問題 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，讓我覺得很緊張 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，讓我覺得自己數學很好 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我覺得好像和朋友在一起 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我覺得很有成就感 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我可以自己選擇要做的步驟 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，讓我覺得有壓力 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，是我自願參與的 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，讓我覺得很親切 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我還想再跟這台電腦玩這個數學遊戲 ● ● ● ● ● ● ● ● ●	非常 贊成

下頁還有喲!!

非常 不贊成	玩這個數學遊戲，讓我覺得很自在 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我覺得這個數學遊戲是友善的 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	這台電腦像是我的朋友 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	這台電腦像是我的老師 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	這台電腦像是我的對手 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我喜歡這台電腦的數學遊戲 ● ● ● ● ● ● ● ● ●	非常 贊成

完成了，謝謝!!

Appendix B

Questionnaire for selecting emotions

非常謝謝您參與本問卷!!

下列的表情圖案是所示範的電腦遊戲的表情回應,包括一開始的打招呼、答對的回應、答錯的回應、下一步驟的提醒、最後回應。

根據剛才所示範的電腦遊戲過程,請您再適合的表情圖案的上方格子打勾,這個問卷的目的是來了解您的意見,**所圈選的表情圖案沒有對或錯**,都是依照您的感受做適當的圈選。

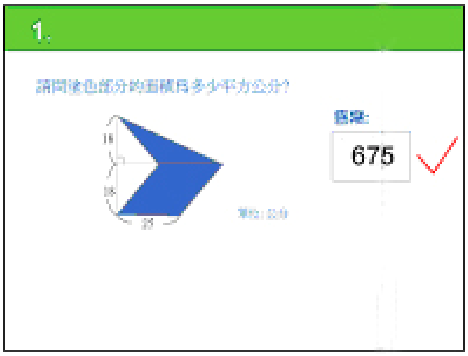
您的看法對我們是非常寶貴的意見,請您能仔細地回答,謝謝!

請問您是☐ 女生 ☐ 男生

嗨!!歡迎你!

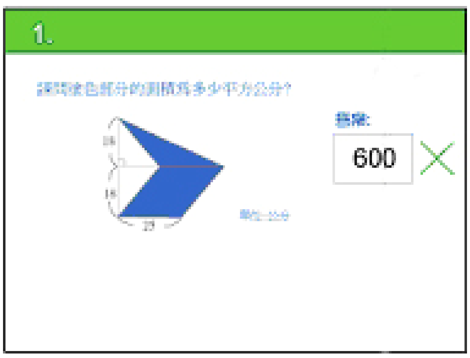
		

答對了!



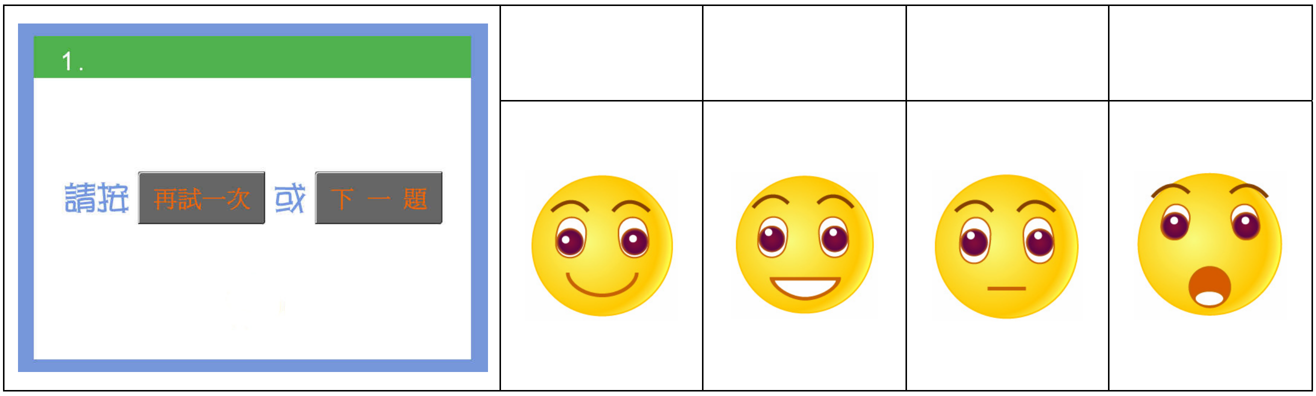
		

答錯了!



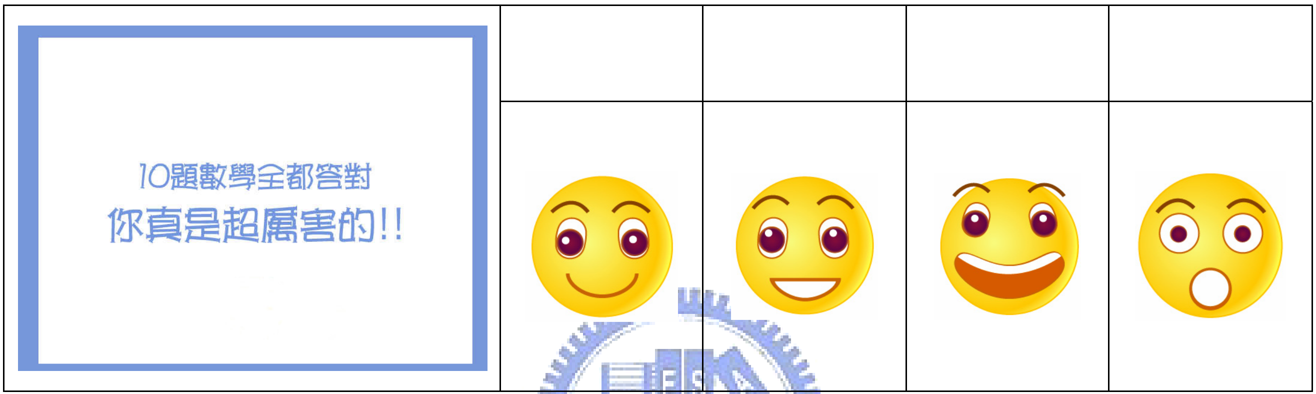
			

請問你要再試一次,還是要繼續下一題?

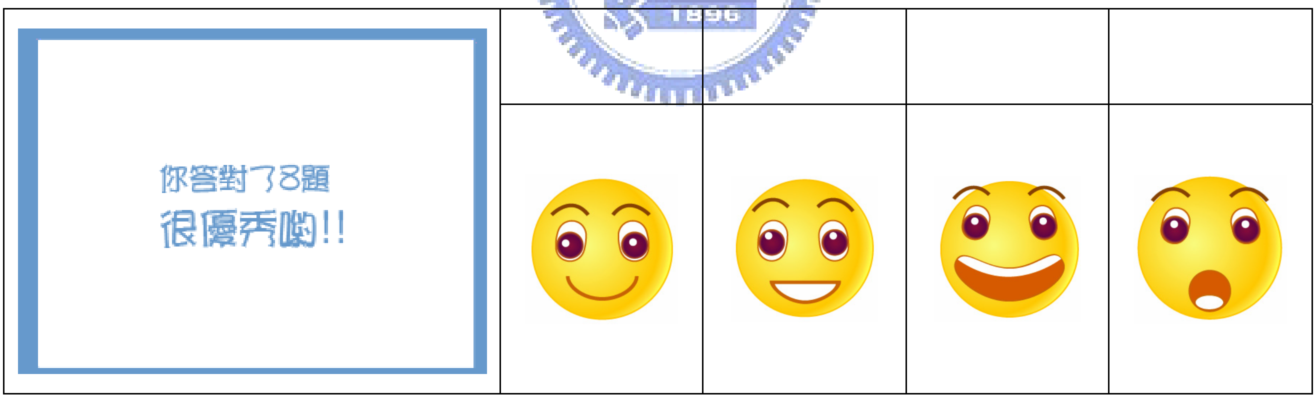


下列是電腦根據同學完成遊戲後的結果，所給予的回應

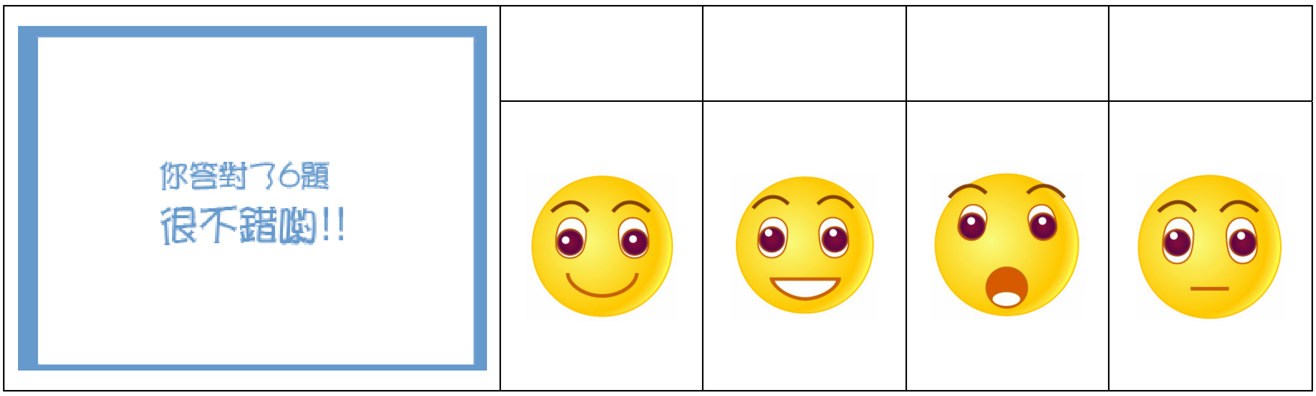
10 題數學全部答對，你真是超厲害的!!



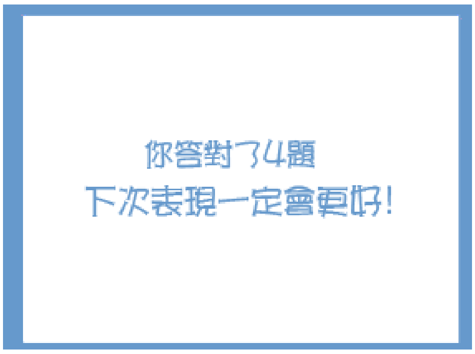
你答對了 8 題，很優秀喲!!



你答對了 6 題，很不錯喲!!



你答對了 4 題，下次表現一定會更好!

十分謝謝您的合作，謝謝!

Appendix C

Experimental questionnaire for study II and study III

非常謝謝您參與這個電腦遊戲。

這份問卷是想了解您這次參與電腦遊戲的感受與想法，**所圈選的答案沒有對或錯**，都是依照您的感受，在每一題做適當的圈選。**您的看法對我們是非常寶貴的意見，請您能仔細地逐題回答，謝謝!**

5. 請問您是 ☐ 女生 ☐男生
6. 請問您的生日：__________ 年 __________ 月
7. 請問您會在家中使用電腦嗎? ☐ 從不使用 ☐ 偶爾使用 ☐ 經常使用 ☐天天使用
8. 請問您使用電腦的目的與活動：____
9. 請問螢幕左下角的編號: ______________________
10. 根據您參與這個電腦數學遊戲的感受，在適合的位置圈選這個數學遊戲的特質；

冷漠的	5	4	3	2	1	0	1	2	3	4	5	熱誠的
不易親近的	5	4	3	2	1	0	1	2	3	4	5	易親近的
遲鈍的	5	4	3	2	1	0	1	2	3	4	5	敏銳的
不具有人性	5	4	3	2	1	0	1	2	3	4	5	具有人性的

11. 請根據您參與這個電腦數學遊戲的感受，針對以下的敘述，從**非常不贊成到非常贊成**中的圓點，圈選適合的圓點，反映您對每句敘述的贊成意見。

12.

非常 不贊成	我喜歡和這個電腦玩數學遊戲 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我覺得我和電腦是同一國的 ● ● ● ● ● ● ● ● ●	非常 贊成

…………….還有下一頁呦!!

非常 不贊成	玩這個數學遊戲，讓我覺得自己很聰明 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我覺得是自己想要回答這些數學問題 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，讓我覺得很緊張 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，讓我覺得自己數學很好 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我覺得好像和朋友在一起 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我覺得很有成就感 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，我可以自己選擇要做的步驟 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，讓我覺得有壓力 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，是我自願參與的 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	玩這個數學遊戲，讓我覺得很親切 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我還想再跟這台電腦玩這個數學遊戲 ● ● ● ● ● ● ● ● ●	非常 贊成

................還有下一頁呦!!

非常 不贊成	玩這個數學遊戲，讓我覺得很自在 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我覺得這個數學遊戲是友善的 ● ● ● ● ● ● ● ● ●	非常 贊成
非常 不贊成	我喜歡這台電腦的數學遊戲 ● ● ● ● ● ● ● ● ●	非常 贊成

完成了，謝謝!!

Vita

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Education:	
2002-Present	**PhD candidate**
	Institute of Applied Arts , National Chiao Tung University, Taiwan
1999, June	**Master of Science in Industrial Design**
	Department of Industrial Design, National Cheng Kung University, Taiwan
1991, June	**Bachelor of Science in Industrial Design**
	Department of Industrial Design, National Cheng Kung University, Taiwan

Academic Position	
1999, August ~2007, July	**Lecturer** Department of Industrial Design, Shih Chien University, Taipei, Taiwan

Research Interests	
	Interactive Design,
	Design of Social Interface,
	Product Design,
	Psychology and Design of Interactive Technology

Work Experience:	
1995-1997	Product designer Product Design Department, D-Link corporation
1993-1995	Product designer Home appliance Department, TECO corporation

Honors and Awards	
2007	**Honorary member** of Phi Tau Phi Scholastic Honor Society (Chapter in NCTU 2007)
1997	**Best Design Award,** DFE-1208 (D-Link),Taiwan External Trade Development Council
1998	**National Awards of Excellence**, DP-300 (D-Link), Taiwan
1995-1998	Products had been exhibited at Cebit Show (Germany), Japan Electronic (Japan), and Comdex (USA)

Patent	
1997	Design Patent TW. 055801
1996	Design Patent TW. 056852
1996	Design Patent TW. 058005

Research Projects	
2006-2007	**Project Director** Toward a more sociable design: the effects of speech and emoticon on children Sponsor: National Science Council
2004-2005	**Project Director** Exploring the Motivator in the interaction Design of Electronic Learning Toys Sponsor: Shih Chien University

2003-2004	**Project Director**
	An Innovative Approach to Product Development in Post-Pc Era
	Sponsor: Shih Chien University
2002-2003	**Project Director**
	A Study for User Interface Differentiation on Product Design Information Web Page
	Sponsor: Shih Chien University

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