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I dedicate this dissertation to my children, Eric and Hanah, who bring delight to my life. They have been the impetus that encourages me to overcome hardship and to face challenges in my life.
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ABSTRACT

The purpose of the study was to examine the impact of the affect and gender of pedagogical agents as learning companions (PALs) on learning, interest, self-efficacy, and agent persona. Two experiments were conducted to examine PALs’ affect separately in terms of affective expression and affective response. 142 students in a computer literacy course participated in Experiment I, which examined the effects of PALs’ affective expression (positive vs. negative vs. neutral) and gender (male vs. female). 56 pre-service teachers participated in Experiment II, which examined the effects of PALs’ affective response (responsive vs. non-responsive) and gender (male vs. female).

The results of Experiment I indicated that affective expression significantly influenced agent persona: Students who worked with the PAL expressing positive affect perceived the PAL’s persona more positively than students who worked with the negative PAL ($p < .05$). Also, students who worked with the PAL who did not express affect (neutral) perceived the PAL’s persona more positively than students who worked with the negative PAL ($p < .05$). Next, PALs’ gender significantly affected learning, interest, and agent persona: Students who worked with a male PAL learned more ($p < .01$), were more interested in the task and the PAL ($p < .05$), and tended to perceive the PAL’s persona more positively than students who worked with a female PAL ($p = 0.7$). Also, there was a significant interaction effect between affective expression and gender on agent persona ($p < .05$): When the PALs expressed positive affect, the persona of a male PAL was perceived more positively than that of a female PAL; however, this interaction was minimal when the PALs expressed negative or neutral affect. This interaction trend was also consistent for learner interest.
The results of Experiment II revealed that PALs’ affective response significantly influenced interest and self-efficacy: Students who worked with a PAL that responded to their affect showed significantly higher interest \((p < .05)\) and self-efficacy beliefs \((p < .05)\) than students who worked with a PAL that did not respond to their affect. Next, PAL gender significantly influenced learners’ perceptions of PALs’ persona and partially learner interest: Students perceived the persona of the male PAL more favorably \((p < .05)\) and showed higher interest when they worked with the male PAL \((p = .07)\).

Overall, PALs’ affect and gender influenced learners’ affective and cognitive characteristics as real human teachers or peers did (Wong & Dornbusch, 2000). This implies that PAL-learner relationships in computer-based learning can be consistent with human peer relationships in traditional classrooms. Given the finding of the study confirming the instructional impact of PALs’ affect and gender, researchers can design the gender and affect of PALs appropriately in the way that facilitate learning and motivation in computer-based environments.
CHAPTER I

INTRODUCTION

Context of Problem

The social context of cognition and its applications to learning and instruction has received increasing attention from theorists and researchers. Teaching and learning are highly social activities. Interaction with teachers, peers, and instructional materials is a major influence for cognitive and affective gains. From the very earliest interactions between parent and child to the more advanced relationships between graduate student and advisor, much of our learning takes place by way of social interaction. Thus, social interaction among participants in the learning contexts is seen as the primary source of cognitive and social development (John-Steiner, 1996; John-Steiner & Mahn, 2003; Lea & Nicoll, 2002; Matusov & Hayes, 2000; L. Piaget, 1995; Reynolds, William, & Miller, 2003; Rogoff, 1995).

Seminal psychologists, such as Piaget, Vygotsky, and Bandura, have already acknowledged the impact of social contexts and social interaction on learning and development. According to Piaget (1995), “social life transforms the very nature of the individual” (p. 210), and reasoning is processed by way of social mechanisms. Social interaction with equally able peers fosters cognitive
restructuring and becomes an impetus to cognitive growth. Social interaction with more knowledgeable peers or adults could also advance learners in the zone of proximal development. In Vygotsky’s theory (1978), higher-level development that forms intellectual and mental functions originates from socio-cultural contexts; intellectual development occurs while individuals work with other participants who are more experienced in the society. Similarly, Bandura (2001) argues that, in many areas of social life, people cannot directly control social systems and practices, so they have to get resources or expertise of others to accomplish what they desire. According to Bandura, learning occurs through not only learners’ active participation but also their observation of modeled attainments. The social presence of others as models plays a meaningful role for learning and self-efficacy beliefs.

Affect as an integral part of social cognition influences our rational thinking, decision-making, social memory, and learning. People’s memory, judgment, and the content of thinking are coordinated by an integrated system of affect and cognition. More specifically, our momentary moods influence daily social interactions and hence information processing and retrieval. Our affect conveys information about the interface between us and our environment, so we regularly use feelings to make judgments and decisions. Also, cognitive processes are responsive and tuned to meet the situational requirements signaled by feelings and guide us to choosing an appropriate processing strategy (e.g., top-down or bottom-up).

Therefore, educational interventions might be able to successfully reach their goals when they include the social cognitive dimension of learning and development. Traditionally, computer-based learning has been used to support individualized learning, tailored to meet individual students’ needs, and to provide immediate feedback, leading each learner to the achievement of mastery learning (J. R. Anderson, Corbett, Koedinger, & Pelletier, 1995). The recent perspective
of social cognition necessitates reframing the way we used educational technology and suggest a new metaphor of employing computers as social cognitive tools. In particular, pedagogical agents refer to an educational use of an anthropomorphized interface that renders personas to computers and emphasize social relations between agent and learner.

Pedagogical agents as learning companions (PALs) are a unique use of pedagogical agents. PALs adopt a peer metaphor to simulate peer interaction and to take advantage of the cognitive and affective gains of human peer-mediated learning. To build social relations with learners, PALs should be believable so that learners can perceive them as realistic virtual peers (Dautenhahn, Bond, Canamero, & Edmonds, 2002). At the center of believability is PALs’ ability to demonstrate affect (Bates, 1992; Dautenhahn, 1998; Lester & Stone, 1997; Lester, Voerman, Towns, & Callaway, 1999; Nijholt, 2001; Ortony, 2002). Affect is an essential part of social cognition to allow us to successfully function in daily social and intellectual life. Thus, the affective capability of PALs might be critical to be human-like and believable.

The affect of PALs might have unique importance in investigating and designing socially intelligent PALs. The emerging concept of social intelligence seems to refer to the more comprehensive human capability to function naturally and rationally in the social context of everyday life. Human intelligence without the inclusion of affective ability might indicate nothing but an “idiot savant”. This significance of human social intelligence can be applied to the design of anthropomorphized pedagogical agents. Moreover, the development of social understanding is differentiated by the nature of the social relationship – with parents, teachers, siblings, and friends. Thus, the affect of PALs might have different implications from that of pedagogical agents in general.

Further, gender difference manifests not only for academic interest and cognitive styles but also in affective experiences, such as emotional expression,
empathic accuracy, and emotional behavior (Adler, Kless, & Adler, 1992; Brody, 1999; Zillmann, Weaver, Mundorf, & Aust, 1986). Women consistently report that they express a wider range of feelings and more intense positive and negative emotions than men. Will this gender difference in human affect be consistent in PAL affect?

It is unknown whether gender and affect of PALs will influence learners’ affective and cognitive characteristics as in human relationships. Nass and colleagues (Nass, Fogg, & Moon, 1995, 1996; Nass & Moon, 2000; Nass & Steuer, 1993a, 1993b; Nass, Steuer, & Tauber, 1994; Nass & Sundar, 1995) indicate, in a number of studies on human-computer interaction, that people’s reactions to computers are social and natural and that people expect computers to conform to social rules as in the real world. These studies reveal that the role expectations and social stereotypes in the real world are projected consistently to human-computer interaction. Thus, it is highly plausible that the affect and gender of PALs influence learners’ expectations and perceptions of PALs.

In this regard, very few studies have been done. Since the findings of human emotion research spurred researchers to accommodate affect in human computer interaction, some studies have showed the positive impact of agent affect (Klein, Moon, & Picard, 2002; Scheirer, Fernandez, Klein, & Picard, 2002). However, these studies were implemented in game environments with incentives (e.g., one hundred dollar award for the best player). The implications of these studies might not be necessarily generalizable to learning environments. It needs to be rigorously investigated how PALs’ affect together with PALs’ gender effect motivation and learning in computer-based environments.
Purpose of the Study

The purpose of this study was to examine the impact of PAL affect and gender on learning, interest, self-efficacy, and agent persona in computer-based environments. In general, agent affect is defined in terms of the capabilities of recognizing, expressing, and responding to affect (Hudlicka, 2003; Picard, 1997). Emotion recognition is mainly engineered with hardware technology (Hudlicka, 2003; Partala & Surakka, 2003). Thus, this study focused on the latter two aspects. PALs’ affect was investigated in terms of affective expression and response. For PALs’ gender, the impact of male and female PALs was investigated.

Data were gathered in two phases with two controlled experiments. Experiment I examined the effects of PALs’ affective expression, which included three levels (positive vs. negative vs. neutral). Experiment II examined the effects of PALs’ affective responses to learners’ affect, which included two levels (responsive vs. non-responsive). Also, both experiments examined the effect of PAL gender by including male and female PALs. Outcome measures included learning, interest, self-efficacy, and agent persona.

Research Questions

The study investigated the general question: Will PAL affect and gender influence learning, interest, self-efficacy, learners’ perceptions of agent persona? The subsidiary questions included the following:

1. What is the impact of the affective expression of PALs (Experiment I)?
2. What is the impact of the affective response of PALs (Experiment II)?
3. What is the impact of the gender of PALs (Experiment I and II)?
4. Is there an interaction between PALs’ affect and gender (Experiment I and II)?

Significance of the Study

A major motivation of this study was to test the effectiveness of pedagogical agents that simulated peer interaction in computer-based learning. With the findings of the study, we will understand how to better design such agents to facilitate learning and motivation. The study will provide implications to the community interested in designing and developing pedagogical agents, more broadly, the community of educational technology.

Gender difference becomes more salient in using computers for education and is often attributed to social stereotypes relating computing more to males than females. The content of instructional software tend to appeal to male flavor (Cooper & Stone, 1996; Cooper & Weaver, 2003). In general, females are more sensitive to and aware of emotions than males (Brody, 1999). By examining PALs’ affect and gender together with learner gender, the study aimed at providing insight for designing computer-based interventions that could appeal to both genders.

Including agents in commercial and instructional computer applications has been growing popular recently, in contrast to this popularity, very few studies have been done in the perspective of educational research or instructional design. A variety of researchers have designed and developed agent systems for educational purposes. Yet, the major forces behind the interest in pedagogical agents are researchers in computer science and artificial intelligence. Those researchers often focus more on algorithmic development and system architecture and sometimes overlook the important issues in designing educational interventions, such as theoretical justification, instructional design, and rigorous evaluation. The findings of the study provide implications to multiple
communities, such as education, training, computer science, and human computer interaction, which are interested in designing and developing pedagogical agents and evaluating their validity.
CHAPTER II

REVIEW OF LITERATURE

Overview

Cognitive psychology has evolved away from “purely cognitive” variables of memory and thought to valuing learners’ motivational and belief systems formed in social contexts (Bruning, Schraw, Norby, & Ronning, 2004). This evolution has also led to another important understanding –the role of social interaction and socio-cultural influences in fostering cognitive development. In particular, from the perspective of distributed cognition, human cognition does not reside only inside one’s mind; instead, is distributed across tools, symbols, and participants in socio-cultural environments (Salomon, 2001). Environments are integral parts of a whole system of cognition. When individuals perform cognitive activities, tools, symbols, and contexts dynamically interact and build intellectual partnership with the individual and help expand one’s cognitive capabilities to improve performance.

Seminal developmental psychologists, such as Vygotsky and Piaget, presume that learning and intellectual development are social processes by nature and cannot be fully attained without social interaction within the context. The role of these participants differs for each theorist, however. Vygotsky (1978)
emphasizes guidance and support from more capable others, such as teachers or competent peers, who advance the knowledge of learners in the zone of proximal development. In Piaget’s theory, the role of peer partners is preferred. Here, learners need instigating partners, who cause cognitive conflicts by providing not necessarily correct answers or by suggesting new perspectives and thus promote reflection and coordination of learners’ actions and perspectives. Equal power relations between learners and partners is important in Piaget’s conception of social interaction (Tudge & Winterhoff, 1993). That is, interaction with less-capable partners is often preferable to that with adults or advanced partners (Matusov & Hayes, 2000).

In the similar context, Bandura (1997) emphasizes attribute similarity between social models and learners for successful modeling effects. People’s self-efficacy beliefs are enhanced when the personal characteristics of the models, such as age, competency, or gender, are similar to their own. This is because, when people appraise their competency, they compare it with the competency of those who look similar to themselves more frequently than to those who are dissimilar. The positive impact of peer models over adult models on learning and self-efficacy is supported empirically (Schunk, 1987; Schunk & Hanson, 1985, 1989; Schunk, Hanson, & Cox, 1987).

From the earlier years, educators observed the benefits of peer interaction that mediate effective learning and motivation. Since Bell and Lancaster initiated the systematic implementation of peer-mediated learning in late 18th century (Chiplin-Williams, 1997), a number of peer-mediated interventions have been implemented in small or large scale around the world. Recently, pedagogical agent technology with an anthropomorphized interface affords a new opportunity to simulate peer interaction in computer-based learning. Pedagogical agents can also address some limitations of human peer-mediated interventions. More
specifically, pedagogical agents as learning companions (PALs) serve as simulated peers in computer-based learning environments.

The design of effective PALs can be guided by the implications of human emotion research. Affect plays a significant role in social interaction. Our memory of daily social interactions can be reconstructed as a collection of social episodes. The mental representations of the social episodes are dominated and reorganized by momentary feelings (Forgas, 1979, 1981; Niedenthal & Halberstadt, 2000; Pervin, 1976). In classrooms, the affective states of teachers and peers function as social contexts to influence learners’ self-efficacy, motivation, cognitive gains, and behaviors. Also, affective experience is differentiated by gender. Gender difference is manifested in affective expressions, empathetic accuracy, and affective behavior. This affect-gender interaction becomes more salient in peer relationships. Given these implications, PALs can be designed as socially intelligent – that is, equipped with affective capabilities – and can build social empathetic relations to learners, which would in turn facilitate social interaction. However, it is unknown whether the impact of affect and gender in human relationships will be consistent in the PAL-learner relationship.

In this chapter, first, social cognitive theories are reviewed as the theoretical framework for PALs. Following that, the early works of human peer-mediated learning are overviewed; some limitations of the human peer mediated learning are discussed; and the potential benefits of using agent technology for peer mediation are suggested. Next, pedagogical agents as learning companions are characterized; the current status of research is reviewed; and, the potential for socially intelligent PALs is discussed. After that, the implications of human emotion research for designing affective PALs are reviewed. Lastly, based on the review of literature, the research problems and hypothesis of the current study are presented.
A Social Cognitive Framework

The social cognitive perspective to be reviewed in this section includes distributed cognition, social interaction, and social modeling. These theories argue for the importance of social contexts for learning from unique perspectives; but consistently stress the role of social interaction, in particular peer interaction for learning and social intellectual development.

Distributed Cognition

According to the view of distributed cognition, human cognition is distributed among individuals and across tools and symbols in a society (Hewitt & Scardamalia, 1998; King, 1998; Pea, 2001; Perkins, 2001; Salomon, 1988, 1989, 1990, 2001; Salomon & Almog, 1998). Traditionally it is presumed that cognition exists inside an individual’s mind and that cognitive processes occur internally. Information comes in through the sensory register; individuals perceive, select, and reorganize it onto the existing structure in their mind. Recently, however, a number of researchers have suggested that the human mind rarely works in solo; instead, it is shaped in social contexts while an individual is communicating with physical and social surroundings. Information is processed between individuals and cultural artifacts. Individuals co-construct the meaning through dynamic discourse with others. In our daily surroundings, it is not difficult to see that artifacts, such as letters on a keyboard, a shopping list, graphs and diagrams, and calculators, help individuals better perform cognitive activities and expand their cognitive capabilities. In conversation, one makes a statement based on the previous utterance of one’s interlocutor. Hence, one’s cognition evolves through discourse while interacting with others.

Intelligence, which is revealed through cognitive activities, is also distributed across individuals, symbols, and tools, as described by Pea (2001):
The environments in which humans live are thick with invented artifacts that are in constant use for structuring activity, for saving mental work, or for avoiding error, and they are adapted creatively almost without notice. These ubiquitous mediating structures that both organize and constrain activity include not only designed objects such as tools, control instruments, and symbolic representation like graphs, diagrams, text, plans, and pictures, but people in social relations, as well as features and landmarks in the physical environment (p. 48).

Intelligence is distributed in the both social and material dimensions. That is, intelligence manifested in practices and activities could be crafted while individuals collaborate with others and/or take advantage of the affordance of a designed artifact.

*Person-plus cognition vs. socio-cultural cognition*

As far as distributed cognition is concerned, however, there are varying interpretations among researchers -- some focusing more on individuals and others on social contexts. According to Perkins (2001), individuals and their surroundings are compound systems of thinking and learning, which he refers to as *person-plus cognition*. But there is still cognition such as higher order knowledge that cannot be distributed and rather resides in an individual’s mind. Thus, there is an asymmetry in distributed cognition. Yet, others (Lave & Wenger, 2001) argue that cognition spreads over mind, activity, artifacts, symbols, social process, and cultural factors, which comprise interdependent and inseparable system of cognition (*socio-cultural cognition*). We cannot construe an individual’s cognition without considering a distributed process of cognition within his/her social milieu. Learning and thinking take place while
communicating with others, tools, and symbols within a social context. In this perspective, the dynamic nature of the cognitive process is emphasized. Meanwhile, mediating these variations, Salomon (2001), argues for two entities of individual and distributed cognitions and their reciprocal interaction occurring when an individual engages in activities. Learning and thinking are joint products of an individual and surroundings. Overall, these researchers are concerned that, traditionally, learning and educational research tends to center around individuals’ mental process alone; but schools may not achieve their goals successfully as long as they show a bias toward only cognition inside one’s mind (Perkins, 2001). Learners rarely perform intelligent activities in a vacuum in the real world. Instead, they organize and accomplish tasks by dynamically interacting with and exploiting the resources surrounding them. Therefore, social interaction in socio-cultural contexts is an important impetus and brings intellectual development (Carpendale & Muller, 2004; J. Piaget, 1995; Vygotsky et al., 1978). In the next section, the view of developmental psychologists on social interaction is discussed.

**Social Interaction**

The social influence on intellectual development has often been an important thesis of developmental psychologists, such as Piaget and Vygotsky, who are frequently compared/contrasted regarding their views of socio-cultural influences on development (Bickhard, 2004; DeVries, 2000; Matusov & Hayes, 2000; Tudge & Winterhoff, 1993). This section reviews the similarities and differences of their perspectives on the role of social interaction for intellectual development. To explicate the importance of social interaction, Piaget brings the concepts of cognitive conflict and equal power relations; Vygotsky brings the concept of the zone of proximal development.
Socio-cognitive conflict and equal power relations

Neo-Piagetian psychologists (Carpendale & Muller, 2004) argue that Piaget’s theory is “fundamentally social”, and the social dimension is an integral part of his theory (Bickhard, 2004). According to Piaget (1962; 1995), an individual is a socialized entity; reasoning originates in interpersonal argumentation; and autonomous morality is the product of cooperation. Human beings are not only biologically and psychologically constituted, but also socially constituted. Internalization conceptualizes the process, through which society influences individuals. This process has traditionally been viewed as either cultural transmission (e.g., socialization and enculturation) or transformation of cultural input.

However, an individual does not yield passively to the pressure of social life; rather he actively selects among available possibilities, reconstructs them, and assimilates them in his own manner. For intellectual development, intra-individual (operation) and inter-individual (cooperation) dimensions are closely bonded. Development of knowledge involves an “epistemic triangle” consisting of the relations among an active individual, another person, and their object of knowledge (Chapman, 1991). Both the individual and the other person are familiarized with the object respectively via their own operative interactions; at the same time, they acquire knowledge and experience of each other through communicative interaction. To Piaget, cooperation does not mean a joint activity but a way of accessing another perspective through peers (Matusov & Hayes, 2000). Cooperation and free discussion play an essential role in the acquisition and construction of knowledge because they establish the most favorable condition for counteracting an individual’s egocentrism. Further, an individual’s ability to communicate with others allows one to exchange knowledge of the object as well as to coordinate one’s actions in cooperation.
Emphasizing the role of social interaction, Piaget acknowledges the value of peer interaction in terms of equal power relations and cognitive conflicts (Tudge & Winterhoff, 1993). Piaget argues that high-level development in thinking and affect is not possible to reach without the cooperation of equal partners (Matusov & Hayes, 2000). This is because equal power relations among peers could allow learners to actively take different perspectives. By taking perspectives of peers, learners can progress to and reflect on their own ideas and coordinate actions and perspectives to resolve contradictions among the different perspectives, which he refers to as *socio-cognitive conflict*. However, when working with advanced others, learners might not go through the process of argumentation and cognitive restructuring; instead, they may simply adopt the solutions of the others. Because equally able peers may not necessarily bring accurate information, learners can engage in free discussion for conflict resolution, which eventually leads them to the intellectual operation of reciprocity and equilibrium.

*The zone of proximal development*

Vygotsky’s theory is characterized by his focus on the influence of socio-cultural contexts on individuals’ intellectual development. Vygotsky (1978) emphasizes the role of social interaction and mediation for intellectual development: “Human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them (p. 88)”. Learning and development are interrelated from the very beginning of a child’s development. He distinguishes two qualitatively different levels of development. Lower-level development is naturally and biologically rooted. Higher-level development originates from socio-cultural contexts, forms intellectual and mental functions, and reorganizes lower-level functions, using cultural symbols, signs, and tools afforded by the society. Hence, successful learning is attained
only when learners are involved in the learning activities that allow them to interact with advanced others. Learners come to understand objects, symbols, and tools through negotiating the meaning with the others in the context. Intellectual development is not simply a matter of individual change; rather is the result of social interactions in cultural contexts.

At the center of learning and development is the concept of the zone of proximal development (ZPD), which refers to the distance between the actual and potential development of a learner that can be achieved with the assistance of advanced others. Those functions that children can do independently by themselves indicate their actual development. If children can solve a problem in collaboration with others, this solution will be indicative of their potential development. So, the ZPD defines such developmental functions that have not yet matured but are in the process of maturation. With assistance of more advanced others, learner can reach goals beyond the limit of their actual capabilities. Thus, social interaction with more knowledgeable peers or adults plays a critical role for learning according to Vygotsky.

According to this view, educational environments should be designed in the way that what is in the zone of proximal development today could be the actual developmental level tomorrow. Internalization of knowledge in the zone of proximal development is not an automatic reflection of external events. Learners bring a developmental history to the zone of proximal development; more capable others bring a support structure. As learners and capable others interact, they share cultural tools. This culturally mediated interaction is internalized, yields cognitive change, and becomes a new function of the learner.

The concept of instructional scaffolding to support the ZPD has been frequently applied to both classroom and technology-mediated learning. In instructional scaffolding, an instructor provides learners with well-planned prompts and help, such as asking questions, directing attention, or giving hints
about possible strategies, to enable them to do things which they could not do otherwise. Then, as student become more competent, the instructor’s support is withdrawn gradually (Beed, Hawkins, & Roller, 1991). Instructional interventions should afford well-designed instructional scaffolding (Bliss, Ashew, & Macrae, 1996) to advance learners in the zone of development.

Recently, however, some researchers point out that this view of scaffolding tends to focus too much on the adult’s contribution to the learning process and to reduce learners to only a recipient of adult help (Bruning et al., 2004; Gauvain, 2001). Bandura’s theory of social modeling to be described next argues that peers are more desirable social models than adults and that peers exert could positive influence on social cognitive attainments of learners, in particular their self-efficacy beliefs in a domain.

**Social Modeling**

Social modeling refers to psychological and behavioral changes that result from observing others in social contexts (Bandura, 1997; Schunk, 1987). Here, Bandura’s conception of social modeling is reviewed in terms of his concepts of human agency, vicarious learning, and attribute similarity.

**Human agency**

Bandura (1986; 1989; 1999; 2001; 2002) brings forth the concept of human agency to explain human functioning in the world. He distinguishes three modes of human agency: personal, proxy, and collective agency. Personal agency is exercised through individuals’ control over the nature and quality of one’s life. It is characterized with intentionality, forethought, self-monitoring, and self-regulation. Proxy agency is socially mediated agency, which enables people to obtain resources or expertise of others to accomplish what they desire. Collective agency is exercised through group action, which is “socially interdependent effort
More important, personal agency operates within a broad network of socio-cultural influences. In agentic transactions, people not only produce but also are produced by social systems. Interrelationship and interdependence between people and environments are emphasized for the successful intellectual social functioning in the world. In particular, proxy and collective agency focus on interpersonal relationship and seem to bear out the role of social interaction in the learning process. These two concepts of human agency can be appropriately translated into Bandura’s more popular conception of learning: Vicarious learning through social modeling with the inclusion of collaboration between models and learners.

**Vicarious learning**

In many areas of human functioning, people are not capable of directly controlling social and institutional systems and practices that affect their lives. People’s appraisals of their own efficacy are influenced through vicarious experience mediated through social modeling (Bandura, 1997). Modeling refers to the changes in behavior and beliefs that derive from observing others (Schunk, 1987). Learning takes place when one learns a task by doing it, which is referred to as *enactive learning*. But enactive experience is not the only source to make learning occur and for people to appraise their capabilities. Vicarious learning occurs when one learns about a task by observing that others perform or discuss it. Observing the attainments of the models also influences learners’ self-efficacy appraisal. In terms of proxy agency, learners actively search for competent models and take advantage of time, efforts, and resources of the models, who transmit knowledge, skills, and strategies that the learners pursue.

Learners make judgment about their personal capabilities in relation to the performance of the models by way of social comparison. Learners’ referential comparisons with others are made in terms of standard norms of how successfully
representative groups of people perform the target activities and determine one’s relative stance. Judgment about one’s competency in a certain area is heightened by his performance superiority relative to the standard norms; but lowered by performance inferiority to the norms. Hence, people’s appraisal of their competency depends on the talents of those chosen for comparison. In daily lives, people tend to compare themselves to everyday associates in similar contexts more frequently than to those who stand distant in status. This tendency introduces a concept exerting powerful influence on modeling effects, attribute similarity.

**Attribute similarity**

Attribute similarities between learners and social models have a critical influence on whether or not modeling effects are successful (Bandura, 1997). Learners tend to develop preconceptions linked to the attributes of social models, such as age, gender, ethnicity, competency, and so on. Modeling is a type of social comparison. Perceived similarity in personal characteristics between models and learners affect the relationship between the model and the learner (Schunk, 1987; Schunk et al., 1987).

Therefore, peer modeling often has a great deal of influence on learners’ self-efficacy and learning, more so than those of an adult model. Attribute similarity support the instructional potential of peer partners who share similar personal characteristics to learners’ own. In the same vein, Bandura (2001) cautions the danger of modeling which could sometimes impede the cultivation of learners’ competencies. This would be so when learners unduly rely on the competency of social models. To be effective, social models need to be more advanced in knowledge and skills than learners, but not overly so.

The next section introduces the practical applications of peer interaction, i.e., peer-mediated learning, discuss the major types and limitations, and suggest
the potential of simulating peer-mediated learning in computer-based environments.

Peer-Mediated Learning

A peer refers to “one belonging to the same societal group as defined by age, grade, or status (Merriam-Webster Online Dictionary)”. For a long time, educators have observed the benefits of peer interaction and implemented systematic peer-mediated interventions to increase achievements and motivation. Peer-mediated learning (also called peer-assisted learning) refers to learning through interactive help and support among peers (K. Topping & Ehly, 1998).

Early Works of Peer Mediated Learning

Historically, Andrew Bell, the superintendent of a school for orphans in India, is acknowledged as pioneering the systematic implementation of peer-mediated learning in the late 18th century (Chiplin-Williams, 1997). He devised a tutorial system in which older students teach younger students academic tasks. Later, Joseph Lancaster adopted and improved Bell’s approach to teach large number of students in his school. Since that time, a number of small- or large-scale projects have been initiated across grade levels and task domains (see Table 1). Also, the focus of peer-mediated learning has been varied with different titles, such as peer tutoring, peer monitoring, peer modeling, peer counseling, peer assessment, and so on.

In the earlier years, the motivation for and the expected benefits of peer-mediated interventions came from practical considerations. Goodlad (1989) summarized the benefits of peer-mediated learning from a practical point of view. First, peer-mediated learning can reach two goals of learning: traditional product-
oriented and process-oriented goals. Peer-mediated learning could serve as a strategy to offer intellectual structure (product of learning provided by teachers) transmitted in a socially pleasurable form (e.g., learners’ social interaction). Second, peer-mediated learning can provide learners with opportunities to take responsibility and to serve each other by sharing information and collaboration, regardless of their age and competency levels. This experience can offer moral education through shared responsibilities and contribute to the mutual growth of learners. Third, peer-mediated learning allows for more flexibility of education at a reasonable cost. Education requires personal care. For economic reasons, it is not likely that a ratio of teachers and students can be achieved to maintain detailed attention to individuals in need. Peer-mediated learning permits such individualized instruction at no extra cost. Lastly, peer-mediated learning can ease teachers’ tension with respect to classroom management. A whole class can be re-organized into smaller mixed level groups, which are assigned their own tasks to be completed and are evaluated both as an individual and a group. Well-coordinated peer-mediated learning can ease the strain dealing with large classes.

Also, the early interventions of peer mediation were grounded on behaviorism. Learning will be effective if every correct response to a question by a student is rewarded immediately and systematically, and this reward act as a stimulus to the learner to make a further step in learning. By giving every learner his or her own helper or teacher, peer mediation affords individualization (personal contacts) and immediate feedback. Thus, peer intervention schemes were highly structured following the precepts of programmed instruction strategies. A tutor who had only to present materials in a suitable order guided the tutee. Along this line, several peer-mediated programs were developed in Indiana University (Ellson, Barber, Engle, & Kampwerth, 1965), the South-West Regional Educational Laboratory (Niedermeyer & Ellis, 1971) and Brigham Young University (Harrison, 1972).
More Recent Works

More recent efforts in peer-mediated learning are supported by the social cognitive framework as discussed earlier. First, according to Piaget, learning depends on equilibration, a process to reconcile conflicts between existing and newly experienced beliefs. Sociocognitive conflicts (Doise & Mugny, 1984) that learners experience through peer interaction make cognitive growth occur. Symmetrical, reciprocal relationships among peers are highlighted in Piagetian peer interaction. Second, Vygotsky implies complementary relationships among peers in which one of the interactants is more competent than the other and guides or instructs. According to Tabacek and colleagues (1994), “peer tutoring has become one of the most soundly documented procedures of our time for facilitating academic and social gains for children (p.62)”. Review of the literature on and educational practices of peer-mediated learning since 1960s (K. Topping & Ehly, 2001) have confirmed that assertion implicitly and explicitly. Third, the concept of learning by teaching support peer-mediated learning and has gained popularity both in traditional classrooms and in computer-based environments. In order to teach, peer tutors have to reflect on and reorganize their understanding in a new perspective to make it meaningful to their tutees. Thus, teaching is learning twice. The act of helping and tutoring involves another cognitive challenge as well as increasing attention and motivation to the tutors’ learning. Table 1 presents some examples of peer-mediated intervention programs.
Table 1

*Peer-Mediated Learning Interventions*

<table>
<thead>
<tr>
<th>Programs</th>
<th>Goals</th>
<th>Peers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Technology Power, University of Minnesota</td>
<td>To increase mathematics and science interest in among low-income or minority students in inner-city schools</td>
<td>School children vs. university students</td>
</tr>
<tr>
<td>ASPIRA-MACE Bilingual Tutorial Reading Project, Chicago</td>
<td>To improve low reading achievement of Spanish-speaking students in Chicago public schools</td>
<td>School children vs. university students</td>
</tr>
<tr>
<td>Youth Tutoring Youth Program</td>
<td>To give young people the opportunity to assume responsible roles of teaching and helping others</td>
<td>Younger students vs. older students</td>
</tr>
<tr>
<td>The New York High School Homework Helper Program</td>
<td>To provide academic skill in general and to improve attitude in the area of math, reading, and English as a second language</td>
<td>High school students vs. university students</td>
</tr>
<tr>
<td>Paired Reading Schemes</td>
<td>To improve reading fluency and comprehension through modeling by the child of a competent reader and positive reinforcement of the child’s reading</td>
<td>Younger students vs. older students</td>
</tr>
<tr>
<td>Peer Assisted Learning in Bournemouth University</td>
<td>To form a collaborative learning community, a student-to-student support scheme for academic and personal development.</td>
<td>University students</td>
</tr>
</tbody>
</table>
Table 1 Continued

<table>
<thead>
<tr>
<th>Programs</th>
<th>Goals</th>
<th>Peers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer-Assisted Learning Strategies at Vanderbilt University</td>
<td>To make learning reading and math can be effective, feasible, and enjoyable by integrating instructional principles and peer mediation.</td>
<td>Classmates</td>
</tr>
</tbody>
</table>

**Empirical Evidence**

As seen above, peer-mediated learning takes a variety of forms. In general, studies support the benefits of peers over teachers across subject matters and grade levels (Arblaster, Butler, Taylor, & Arnold, 1991; Chiplin-Williams, 1997; Davenport & Howe, 1999; Deering, 1975; Feldman, Devin-Sheehan, & Allen, 1976; D. Fuchs, Fuchs, Mathes, & Simmons, 1997; L. S. Fuchs, Fuchs, Kazdan, & Allen, 1999; L. S. Fuchs, Fuchs, Phillips, & Hamlett, 1995; Gartner, Kohler, & Riessman, 1971; Jacobs, Watson, & Sutton, 1996; Kumar & Harizuka, 1998; Mathes, Howard, Allen, & Fuchs, 1998; Mathur & Rutherford, 1991; Niedermeyer & Ellis, 1971; Ortiz, Johnson, & Johnson, 1996; Shisler, 1986; K. Topping, 1987; K. Topping & Ehly, 2001). These studies found that students were more motivated and learned better from their peers than from teachers. Allen (1976) speculates cultural difference as the explanation. That is, peers are similar in general culture and background; on the other hand, teachers might be perceived as belonging to an “alien” world. Communication might be inhibited by differences in culture between teacher and learner (Goodlad & Hirst, 1989). Feldman and Allen (1973) reported that learners than adult teachers were more sensitive to non-verbal cues offered by other learners to show that they do not
understand something. Moreover, researchers observed the positive impact of role taking through peer-mediated learning (Goodlad & Hirst, 1989; Maher, 1982; Osguthorpe & Scruggs, 1986; Shisler, 1986). Social role is a concept used to designate a set of expectations that are associated with a particular position in the social structure, such as father or mother, teacher or student. Individuals inhabiting specific roles may feel constrained by the expectations of other people to behave in particular ways. For example, if a learner is temporarily given the role of teacher and put into interaction with another learner who is weaker in competency or lower in grade level, the strong learner’s behavior is constrained by the expectations of the weaker learner. The strong learner would, therefore, come to sympathize with the role of teacher. By putting students to live up to their responsibilities to guide peer learners, peer-mediated learning is likely to provide the students with an opportunity to develop an enhanced feeling of self-esteem. Even learners who are struggling academically in their grade level are competent in skills that more younger learners are struggling to acquire (Maher, 1982; Osguthorpe & Scruggs, 1986; Shisler, 1986). Through taking responsibility, the older students can experience the respect and admiration of younger students and, being provided with properly planned tasks, can enjoy the experience of success in social relationships.

Limitations

Even with theoretical and empirical supports, peer-mediated learning is not always smooth and easy to implement in traditional classrooms. King (1998) articulates a concern that the kind of transactional intellectual partnership among peers is not always possible to implement in classrooms for political reasons, such as less motivation or support from both advanced students and their parents.

Feldman and colleagues (1976) reviewed factors that were important in making peer-mediated learning effective: appropriate pairing, age similarity,
ability differences, and the number and duration of peer-mediated sessions. Sometimes, however, these factors are conflicting and impossible to implement simultaneously. For instance, pairing students of the same age is the simplest and most recommended -- both theoretically (e.g., social modeling) and empirically (Arblaster et al., 1991; Chiplin-Williams, 1997) -- form of peer mediated interventions. At the same time, high competency of a helper is supported intuitively and empirically (D. Fuchs et al., 1997; L. S. Fuchs et al., 1995). In practice, satisfying both conditions – having highly competent same-age peers -- is often challenging.

Second, some of peer-mediated interventions use college students or older students due to helpers’ competency in a domain. But coordination among different schools and grade levels takes tremendous efforts and resources and sometimes turns out to be disastrous (e.g., ASPIRA-MACE).

Third, additional logistical and motivational concerns have been expressed, such as helper motivation and training, miscommunication among the people involved, and monitoring peer-mediated sessions on track. In classrooms, it is often challenging to prevent pairs from distraction and to ensure that they stay on track to course goals.

Given the limitations, the next question might be how we can address the limitations without damaging the benefits of peer interaction. Can computer technology offer such opportunity through implementing simulated peers? In the last decade, some researchers in intelligent tutoring systems have observed the educational potential of adopting a peer metaphor in developing computer-based tutoring systems. Chan and Baskin (1990b) pioneered this approach to design learning companion systems, where learners learn instructional topic along with a simulated ‘learning companion’.

Simulated peers may have some benefits. First, they can be designed to overcome limitations of human peers by manipulating multiple factors considered
crucial for successful peer-mediated learning, such as the same age peers with varying competency levels and the flexible number and duration of implementations.

Second, computerized peers can provide a test-bed for various aspects of peer-mediated learning. By using technology, characteristics of simulated peers can be manipulated to investigate their effectiveness, which is not possible with human peers. For instance, different functions of simulated peers, such as peer tutors or peer tutees, can be examined with different levels of competency (Chan & Chou, 1997; Kim, 2003a). A peer’s gender can be matched or mismatched with learners’ gender to examine modeling effects (Baylor & Kim, 2003a; Cooper & Weaver, 2003). The number of peers and the duration of tutorial sessions can be adjusted according to different instructional strategies and contexts (Hietala & Niemirepo, 1998b; White, Shimoda, & Frederiksen, 2000). Findings of these examinations may provide implications for the implementations of human peer-mediated learning.

Third, in contrast to the traditional computer-based learning which focused purely on cognitive knowledge and skill acquisition, simulated peers with anthropomorphized interface, if designed well, can facilitate social interaction for learning and make computer-based learning social and natural. More detailed discussions on the potential of simulated peers commonly referred as pedagogical agents as learning companions, is presented in the next section.

Pedagogical Agents as Learning Companions (PALs)

This section starts with the introduction to pedagogical agents including definition and current examples. The section moves on to the specific role of pedagogical agents as learning companions. Diverse instructional functions of PALs are proposed from social cognitive perspectives and research. Backing upon
recent trends in human computer interaction and emotion research, affect and
gender of PALs are argued as important factors influencing social interaction
between computers and learners. The section concludes with the research
hypotheses of the current study.

Definition

_Pedagogical agents_  
Pedagogical agents are animated life-like characters (Johnson, Rickel, & Lester, 2000) that support learning in computer-based environments. Pedagogical agents are applied to facilitate learning through employing pedagogical strategies that emphasize social interaction between learners and agents. Pedagogical agents with an anthropomorphized interface can interact with learners more socially and naturally, which makes pedagogical agents distinct from traditional computer-based learning. Thus, a critical feature of pedagogical agents might be human-like with a viable persona. Research indicates that users perceives computing as more entertaining (Takeuchi & Naito, 1995) and engaging (Koda & Maes, 1996); they spend more time, make fewer mistakes, and write more comments (Walker, Sproull, & Subramani, 1994); further, communication between computer and user is more successful (Takeuchi & Nagao, 1993) when a computer application includes a human face in the interface than when without a human face. In particular, the instructional impact of pedagogical agent-based learning environments was supported. Learners exposed to an environment with a pedagogical agent demonstrated deeper learning and higher motivation than learners without an agent (Moreno, Mayer, Spires, & Lester, 2001). Students in a voice-plus-agent condition outperformed students in a text-only condition and students in a voice-only condition for both process and product measures of learning; also, the students in the voice-plus-agent condition perceived worked-
out examples as being less difficult than did their counterparts (Atkinson, 2002). Given this positive impact of human-like interface, researchers designed a variety of pedagogical agents in varying subject areas to better achieve instructional goals. Table 2 shows some examples of pedagogical agents.

Table 2

*Examples of Pedagogical Agents with Human-like Interfaces*

<table>
<thead>
<tr>
<th>Agents</th>
<th>Functions</th>
</tr>
</thead>
</table>
| Adele (Johnson et al., 2000) | • Supporting distance learning in the domain of medicine and dentistry.  
  • Interacting both verbally with text and speech and nonverbally with facial expressions and gestures. |
| Steve (Johnson et al., 2000) | • Taking the role of modeling as a SOAR training expert either up front or just-in-time.  
  • Demonstrating skills, monitoring students’ performance verbally and nonverbally. |
| Herman the Bug (Lester, Stone, & Stelling, 1999) | • Human-like alien inhabiting a learning environment called “design-a-plant” in the domain of botanical anatomy and physiology.  
  • Providing advice and encouragement and guiding learners’ problem solving verbally and nonverbally. |
| PPPersona (Andre, Rist, & Muller, 1999) | • A demonstrator of information, presenting online instruction.  
  • Guiding learners through web-based materials by using exaggerated pointing gestures. |
### Table 2 Continued

<table>
<thead>
<tr>
<th>Agents</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jacob</strong> (Evers &amp; Nijholt, 2000)</td>
<td>• Providing instruction and assistance for users’ problem solving in a virtual environment.</td>
</tr>
<tr>
<td></td>
<td>• Taking initiative to provide just-in-time support verbally and nonverbally.</td>
</tr>
<tr>
<td><strong>Gandalf</strong> (Cassell &amp; Thorisson, 1999)</td>
<td>• Playing an expert in the solar system.</td>
</tr>
<tr>
<td></td>
<td>• Guiding students through materials and answering the students’ questions verbally and nonverbally.</td>
</tr>
<tr>
<td><strong>AutoTutor</strong> (Graesser, Moreno, &amp; Marineau, 2003)</td>
<td>• Providing assistance in the domain of computer literacy.</td>
</tr>
<tr>
<td></td>
<td>• Answering students’ questions and providing feedback to students’ performances verbally and nonverbally.</td>
</tr>
<tr>
<td><strong>Dr. Erickson, Mike, and Rick</strong> (Baylor &amp; Kim, 2003b)</td>
<td>• Simulating the instructional roles of an expert, motivator, and mentor in the domain of instructional design.</td>
</tr>
<tr>
<td></td>
<td>• The expert provides information; the motivator provides encouragements; and the mentor incorporates both information and encouragement</td>
</tr>
</tbody>
</table>

Pedagogical agents often represent different human instructional roles, such as expert (Johnson et al., 2000), tutor (Graesser et al., 2003), motivator (Baylor & Kim, 2003c), mentor (Baylor, 2000; Baylor & Kim, 2003c), and learning companion (Chan & Baskin, 1990a; Dillenbourg & Self, 1992; Goodman, Soller, Linton, & Gaimari, 1998; Hietala & Niemirepo, 1998a; Kim,
For example, the agents, Steve and Adele, developed by CARTE (Johnson et al., 2000) represent pedagogical agents as experts in naval engineering and medical diagnosis. These agents observe learners’ performance and demonstrate expertise in the domain. Similarly, the AutoTutor (Graesser et al., 2003) was designed to engage learners in a dialogue to highlight their misconceptions and to encourage deeper reasoning. Baylor and Kim (2003c) effectively simulated agents as an expert, a motivator, and a mentor who served distinct instructional purposes. The expert agent provided learners with relevant information in the professional manner; the motivator agent provided verbal persuasion and encouragement, emphasizing affective affiliation with learners; and the mentor agent incorporated both qualities to simulate an ideal instructor. In contrast to the other agent roles, pedagogical agents as learning companions (PALs) adopt a peer metaphor, where the agent serves to learn “with” the learner, acting as a simulated peer. In this manner, PALs have the potential to strengthen social relations and to facilitate social interaction during the learning process.

**Pedagogical Agents as Learning Companions (PALs)**

PALs are pedagogical agents with the specific role of peers. PALs are thus differentiated from the earlier learning companion systems, which were simply application software without an embodied human-like interface. PALs with peer-like appearances and behaviors interact with learners to simulate traditional peer-mediated learning. PALs may be able to overcome some limitations such as pairing logistics and distractions, as discussed earlier.

Even with this instructional potential of PALs, however, very few studies have been done regarding the instructional impact of PALs. In particular, there are virtually no guidelines for the effective design of PALs. To enhance the efficacy of PALs, a number of questions need to be answered as regard to their desirable characteristics and functionalities. As Persson and colleagues (2002) point out,
believable social interaction requires agents that not only look right but also do the right thing. What does it mean to do the right thing? How can we design PALs to do so? What should they look like? What role should they play? What functions should they serve? In what ways can we ensure PALs to positively impact on learning and motivation? The next section suggests the potential functions of PALs derived from a social cognitive framework.

**Functions of PALs for Learning**

PALs can serve similar functions as human peers; in addition, the functions of PALs can be designed to meet specific instructional goals. Here, the potential functions of PALs for learning and motivation are suggested in terms of social cognitive theories. According to distributed cognition, PALs can share learners’ cognition and flexibly function as artifacts (*cognitive tools*) or collaborating partners (*social tools*). PALs as cognitive tools can bring knowledge and skills that learners intend to learn or offload simple and mechanical tasks to preserve the ample cognitive capabilities of the learners for higher mental activities (*person-plus cognition*). PALs as social cognitive tools can provide learners with social contexts by discussing and sharing ideas and perspectives with the learners. In these ways, PALs could play significant roles as social intellectual partners for learning. Similarly, Salomon (1990) suggests two types of outcomes in technology-mediated learning, effects of technology and effects with technology. Effects of technology include the acquisition of cognitive skills resulting from the use of technology. Effects with technology are cognitive changes occurring “while” the learner is working with computer software. PALs as both artifacts and collaborating partners support learners in attaining both outcomes.
Peer tutors: able peers

Ability (or competency) was an important factor affecting the effect of peer-mediated interventions and regarded as the prime consideration for appropriate pairing. According to the zone of proximal development (Vygotsky et al., 1978), PALs can function as more knowledgeable peers in the higher developmental stage than learners and provide the learners with scaffolding to advance the learners’ knowledge. When effectively designed, PALs can 1) provide support; 2) function as tools by sharing learning tasks; 3) extend the cognitive ranges of learners; 4) allow the learners to accomplish tasks not possible otherwise; 5) and be used selectively to aid the learners when needed (Driscoll, 2000; Greenfield, 1984). In addition, PALs with high competency may demonstrate knowledge and skills to effect cognitive modeling (Meichenbaum, 1977). Similarly, the concept of proxy agency in social cognitive theory suggests the inclusion of able PALs so that learners could take advantage of knowledge, skills, and strategies of the PALs.

PALs’ functioning as able peers are supported by practice and research. A major motivation of traditional peer-mediated interventions was to improve achievement and motivation of disadvantaged learners, with assistance of competent peers. In pedagogical agent-based environments, a highly competent pedagogical agent, serving as an “Expert” led to better learning than a low competent agent, a “Motivator” (Baylor & Kim, 2003b). Similarly, Kim and Baylor (2004a) found that a high-competent PAL enhanced student attitude and learning transfer. The desirability of PALs as highly competent peers is also consistent with instructional design guidelines that instruction should provide clear information to foster cognitive learning (Dick, Carey, & Carey, 2001; Gagne, Briggs, & Wager, 1992; Perkins, 1992).
Peer tutees: less able peers

Some concepts of social cognitive theories suggest that PALs should serve as less able peers. The concepts of cognitive conflict and equal power relations that learners may experience during peer interaction are highly beneficial to promote the learners’ cognitive development (Piaget, 1962; Tudge & Winterhoff, 1993). This is because, when working with advanced others, learners might not go through cognitive restructuring; instead, they simply adopt the solutions proposed by the others. Also, PALs might be more believable when their intellectual skills are less comprehensive, less precise, and less perfectly correct (Hayes-Roth & Doyle, 1998). According to Bates (1992), instead of expecting that PALs be especially active and smart, we may require only that PALs not be clearly stupid or unreal.

Traditional peer-mediated learning often indicates cognitive and motivational gains of tutors as well as tutees. Student tutors can have the opportunity to reflect on and re-organize what they know in order to teach their peers. Also, student tutors enhanced their self-concept significantly after serving as tutors. Similarly, PALs as less able peers can provide learners with the opportunity to teach PALs (learning by teaching), as in teachable agents (Brophy, Biswas, Katzlberger, Bransford, & Schwartz, 1999).

Also, empirical evidence supports the instructional impact of PALs as less able peers. In previous studies on learning companion systems, strong students significantly improved learning when they worked with a weak agent (Aimeur & Frasson, 1996); the students interacting with a less competent agent significantly increased learning from pre-test to post-test (Uresti, 2000). Also, Kim and Baylor (2004a) found that undergraduate students who worked with low competent PALs significantly increased their self-efficacy beliefs in the domain.
Affective peers

Affect is integrated in the natural process of learning. While learning, learners go through a variety of emotional states, such as interest, curiosity, excitement, confusion, frustration, discouragement (Kort, Reilly, & Picard, 2001). Thus, well-scaffolded instruction must include emotional support (Meyer & Turner, 2002). Also, the trend of classroom research seem to emphasize the integration of emotion and motivation simultaneously to enhance achievements (Clark & Artiles, 2000; Goldenberg, 1989; R. Lewis, 2001; Phelan, Davidson, & Cao, 1992; Skinner & Belmont, 1993; Sutton & Wheatley, 2003; Weiner, 2000; Wentzel, 1996; Wong & Dornbusch, 2000).

PALs as affective peers can build empathetic relationships with learners. An important mechanism of emotional development of children through adolescents is socialization by peers as well as parents. Human friends are likely to disclose to each other the emotional understandings and experiences they may hide from adults, helping each other acquire emotional competencies (Asher, Parker, & Walker, 1996). Simulating human friends, PALs can model various emotional expressiveness and reactions to help learners’ emotional development (Denham & Kochanoff, 2002). Also, they can be designed to elicit positive emotions and to diminish negative emotions of learners. Moreover, PALs’ affect could make PALs more believable and natural (Bates, 1994) and help strengthen social bonds with learners.

Peer models

Learners’ appraisals of their own efficacy are influenced through vicarious experience mediated through social models (Bandura, 1997). Positive instances of modeling can raise expectations that a new skill can be mastered and provide a great deal of information about how a skill is performed. Also, learners tend to develop preconceptions linked to attributes of social models, such as age, gender,
ethnicity, competency, and so on. Schunk (1987) indicated that attribute similarity between models and learners significantly affected modeling effects and increased learning and motivation. Peer models often bring better learning and self-efficacy than adult models (Schunk, 1987; Schunk & Hanson, 1985; Schunk et al., 1987). Similarly, in schools, students are less willing to take teachers as role models whose cultural milieu differs from their own. Students sometimes more easily acquire knowledge and skills from other students who share the same cultural tastes (Goodlad & Hirst, 1989).

PALs designed to have peer-like attributes can serve as peer models. Clarebout and colleagues (Clarebout, Elen, Johnson, & Shaw, 2002) suggest modeling as one of the typical roles of instructional agents. They emphasize that the instructional agents could not only demonstrate task performance but also reveal their reasoning process to solve problems. Along this line, an agent, Sam who was peer-like but slightly advanced in development, modeled narrative skills important for literacy and told stories in a developmentally advanced way. Children who listened to Sam resembled Sam’s linguistic styles and expressions more closely than they did with adult models (Ryokai, Vaucelle, & Cassell, 2003).

Collaborating partners

Collective agency is an essential constituent in the tripartite human agency of Bandura’s social cognitive theory (Bandura, 2002). Individuals do not live in isolation and are interdependent in a variety of social contexts. People have to pool their knowledge, skills, and resources; provide mutual support; and, work together to secure what they cannot accomplish on their own. Similarly, PALs can collaborate with learners by sharing learning tasks: PALs pool their domain specific skills, share tasks according to their expertise, and help a learner achieve their goals.
Research indicates the positive impact of peer collaboration. Collaborating peers encouraged each other to actively interact, such as to ask questions, explain and justify their opinions, articulate their reasoning, and elaborate and reflect upon their knowledge in computer-mediated environments (Greer et al., 1998; Soller, 2001). Collaborative writing between peers integrates both metacognitive prompting and scaffolding for the interactive process and results in not only better cognitive gains but also positive self-esteem as writers (Yarrow & Topping, 2001). The agent, Sam, who looked like a peer for pre-school children told stories collaboratively with children (Ryokai et al., 2003). While the children listened to Sam’s stories, they assisted Sam and suggested improvements.

However, in order for PALs to fully exert those potential functions, the fundamental step might be that we should design PALs to strengthen social relations and thus to facilitate social interaction with learners. In the social cognitive framework, Kim and Baylor (2004b) suggest the critical constituents to successfully design PALs as effective learning partners. The constituents include competency, interaction type, affect, gender, ethnicity, multiplicity, and feedback type. Figure 2.1 shows the graphical representation of the constituents and supporting concepts from social cognitive theory.

Regarding competency and interaction type of PALs, Kim and Baylor (2004a) found that students who worked with a PAL highly competent in the domain showed significantly more positive attitudes and better learning transfer than students with a low competent PAL; that students with a low competent PAL showed higher self-efficacy beliefs than students with a highly competent PAL; and that students with a proactive PAL showed better recall of learning than students with a responsive PAL. In a study on the ethnicity and gender of pedagogical agents as instructors, Baylor and Kim (2003a) reported that undergraduate learners working with agents of the same ethnicity perceived the agents as significantly more engaging and affable; the male agents’ personalities
were perceived as more extraverted and agreeable than the female agents; and the male agents impacted learner satisfaction and self regulation more positively than the female agents. While these results may not be generalized to different population of learners (e.g., K-12 learners) or to PALs in particular, they indicate the importance of the constituents to influence PALs’ impact.

The next constituent, the affect of PALs seems to be gaining more attention recently along with the findings of human emotion research. Affect as an essential part of human social cognition has interested researchers in agent technology. In the next section, it is discussed how PALs’ affect plays a role in designing PALs as believable virtual peers to establish social relations with learners.

![Figure 1. Constituents of PALs and supporting concepts.](image-url)
Needs for Socially Intelligent PALs

The recent trend of agent technology reflects the shifting view about agents from tools to actors who act autonomously and proactively, sometimes even outside the user’s awareness (Persson et al., 2002). Intelligent tutoring systems often use a metaphor of pedagogical actors as an interface (Mengelle, De Lean, & Frasson, 1998) and suggest “no virtual difference” between humans and autonomous agents (Vassileva, 1998).

Findings from human-computer interaction research seem to strengthen that trend. When a computer used natural and human language, users perceived their computing experiences as more enjoyable (Wexelblat, 1997). Reeves and Nass (1996) argue that people project human-human relations to human-computer interaction unconsciously. For instance, minimal social cues, such as scripts, role assignment, and human voices, could induce experienced undergraduate users to apply social rules to evaluate the performance of computers: praise of others was more valid than praise of self, praise of others was friendlier than praise of self, and criticism of others was less friendly than criticism of self (Nass & Steuer, 1993b). Users being told that they were interdependent with a computer as a team perceived the computer to be more similar to themselves and felt more affiliated with the computer than users without team-mating (Nass et al., 1996). In computer-mediated communication and agent-based environments, participants who had similar-ethnicity partners than participants who had different-ethnicity partners presented more persuasive and better arguments; elicited more conformity to the partners' opinions; and perceived their partners as more attractive and trustworthy (Lee & Nass, 1998).

Hence, it is construed that PALs attributed as human-like and perceived as social entities could facilitate the establishment of stronger social relations to learners. This kind of attribution and perceptions can provoke “illusion of life”
and thus impress the learners interacting with “living” virtual being (Rizzo, 2000). Then, social intelligence of PALs can be characterized by the inclusion of human-style social intelligence and differentiated from the conventional agent systems, which focus on engineering system architecture and the optimization of the agent systems to software engineering (Dautenhahn et al., 2002).

A defining feature of socially intelligent PALs might be their affective capabilities. This is because emotion is an integral part of human social and intellectual functioning in the world (Adolphs & Damasio, 2000; Damasio, 1994). From their experience in designing theatrical animated characters, Rousseau and Hayes-Roth (1998) include personality, moods, and interpersonal relationship as essential components of a social-psychological model for social synthetic characters. They emphasize that, to have minds, animated characters need to capture personality, emotions, and relationship; by doing so, the characters are able to play defined roles, follow specified social conventions, and respond to users with empathy. Hayes-Roth and Doyle (1998) also argue that presence of images without accompanying visual behaviors like facial expressions and gestures does not affect user’s perception of the characters; in contrast, voices with variations like moods, tones, and intonation affect users’ perception of the persona of the characters. Moreover, researchers argue that machines can not be intelligent without emotions (Minsky, 1988; Picard, 1997). The ability to display emotional states and to show emotional response is crucial to enhance believability of agents (Bates, 1994; Lester, Voerman et al., 1999; Ortony, 2002; Stern, 2002).

Evidence has been accumulated for the positive impact of including agent affect on learner motivation towards working in pedagogical agent environments (Ball & Breese, 2000; Koda & Maes, 1996; Lester, Towns, Callaway, Voerman, & FitzGerald, 2000; Mori, Prendinger, & Ishizuka, 2003; Okonkwo & Vassileva, 2001; Towns, FitsGerald, & Lester, 1998). People prefer to work with characters
with emotional faces (Koda & Maes, 1996). An agent, Simley, expressed emotions (happy, pleased, surprised, sad, angry, and neutral) through facial and verbal expressions in a C++ programming course; students who worked with emotional Simley rated the agent as having better persona and increased their motivation than students who worked with non-emotional Simley (Okonkwo & Vassileva, 2001). To teach computer engineering, an agent, Cosmo, expressed 26 types of emotions differentiated in terms of quality and intensity, using full bodily movements. Students perceived Cosmo as engaging and interesting (Lester et al., 2000). In solving math quizzes, students who had an emotional agent expressing happy or sorry reported that the quizzes were less difficult and more enjoyable (Mori et al., 2003).

However, the impact of agent affect on learning has not been sufficiently examined. Scheirer and colleague (2002) reported that users in an experimental condition that frustrated them on purpose and provided emotional feedback (affect-support) performed better than users in other conditions. Consistent findings were reported in an environment including an embodied agent (Klein et al., 2002). These studies used game environments with an incentive (a chance to win $100 for the best player). The implication of those studies for learning environments may or may not be consistent. Also, many studies on agent affect or affective interaction between human and computer tend to center around the development of algorithms and hardware systems (Ball & Breese, 2000; Hudlicka, 2003; Partala & Surakka, 2003; Prendinger & Ishizuka, ; Rosis, Pelachaud, Poggi, Carofiglio, & Darolis, 2003; Scheirer et al., 2002) than the instructional impact of agent emotions.

In the next section, the findings of human emotion research are reviewed to find implications for designing PALs’ affect. This review addresses why affect could be considered important in the design of socially intelligent PALs.
Affect of PALs

Affect as an integral part of social cognition plays a crucial role in social intellectual life. This section reviews research on the association between cognition and affect first. Then it is discussed how the affective states of participants in learning contexts influence learners’ affective characteristics and learning and how gender of participants are integrated with their affective experiences. The section is concluded with the statement of the research hypotheses of the current study.

Why does PALs’ affect matter?

To be human-like, PALs need to be designed to integrate affect and cognition. Traditionally, affect was disregarded as unknowable or detrimental to rational cognitive functions (Forgas, 2001). However, since the early 1980s, evidence for the integral relationship between affect and cognition has been accumulated in the last two decades (Forgas, 2000, 2001; M. Lewis & Haviland-Jones, 2000; Ortony, Clore, & Collins, 1999; Trappl, Petta, & Payr, 2002). Now it is widely believed that affect is an integral part of rational behavior and human functioning (Adolphs & Damasio, 2000; Damasio, 1994; Forgas, 2000). Affect influences social thinking (Fiedler, 1991; Martin, 2000) and memory (Bower, 1981), facilitates effective decision making (Isen & Means, 1983), and reduces cognitive and judgmental errors (Forgas, 1998). Thus, PALs’ affect may influence learners’ experiences in learning.

The affect of PALs can be represented into two categories. Emotions and moods are distinct in their roles in social cognition (Forgas, 2001). Emotions are usually defined as intense, short-lived, and highly conscious affective states, which typically have salient causes and rich cognitive content. Emotion researchers typically study the cognitive antecedents of particular emotions and
the appraisal strategies people use to trigger an emotional response (Smith & Kirby, 2000). As distinct from emotions, moods are typically defined as relatively less intense, diffuse, and enduring affective states, which have no salient antecedent causes and thus little cognitive content (e.g., being simply in good or bad/positive or negative moods). Moods tend to be less subject to conscious monitoring and control; paradoxically, their effects on social thinking, memory, and judgments tend to be more enduring and cumulative. Mood researchers are typically interested in the cognitive consequences of moods for thinking, attention, memory, and judgments (Bower & Forgas, 2001; Clore, 2001; Fiedler, 2001; Petty, DeSteno, & Rucker, 2001). Despite the differences between emotion and mood, these two affective states interact and influence each other. That is, powerful emotions often leave a lingering mood state, while moods can also have an impact on how emotional responses are generated. The affective interaction between PALs and learners can be designed with rich emotional content or with dichotomous positive and negative moods.

The network theory of affect and cognition (Bower, 1981) implies that the affect of PALs could play a role to impact information processing and retrieval. Affect and cognition are integrally linked within an associative network of mental representations. Materials associated with the current mood are more likely to be activated, recalled, and used in constructive cognitive tasks. People process mood congruent materials more deeply, engage in greater associative elaboration of information from the materials, and learn the materials better. In a study in which participants read behavioral descriptions of target characters, participants in a positive mood spent longer reading and learned about more positive and socially desirable behaviors and traits of the characters, whereas the opposite was true to participants in a negative mood (Forgas & Bower, 1987). Also, students better recalled the lists of words learned earlier when their moods in learning and recall were matched (Bower, 1981; Bower & Forgas, 2001; Bower, Monteiro, &
Gilligan, 1978). When asked to recall autobiographic events, students retrieved more happy events when they were happy, whereas they retrieved more sad events when they were sad (Snyder & White, 1982). When asked to complete ambiguous word stems, depressed people produced more negative words than positive ones (Ruiz Caballero & Gonzalez, 1994). In the same study, the mood-priming effect also influenced the time to retrieve emotional memories. Depressed people took less time to retrieve unpleasant than pleasant memories, whereas non-depressed people showed the opposite pattern. By including the positive affect of PALs, we can stimulate learners’ positive affect.

There are interesting findings regarding the impact of positive and negative affect on learning. Our cognitive processes are responsive to environments signaled by our feelings in order to act in adaptive ways. Affect signals influence the spontaneous choice of a processing style compatible with an individual’s goals and task demands (Schwarz, 2002). Sad individuals are likely to spontaneously adopt a systematic, detail-oriented, bottom-up strategy. Happy individuals may prefer simple heuristics; explore new procedures and possibilities; and adopt an unusual, creative, top-down strategy. Thus, PALs’ affect can be adjusted to the nature of learning tasks and stimulate learners’ affect to signal the appropriate processing strategy for the tasks.

PALs as affective peers can help develop learners’ affective competencies. An important mechanism of emotional development of young children through adolescents is socialization by peers as well as parents. Human friends are likely to disclose to each other the emotional understandings and experiences they may hide from adults, helping each other acquire emotional competencies (Asher et al., 1996). Simulating human friends, PALs can model various emotional expressiveness and reactions to help learners’ emotional development (Denham & Kochanoff, 2002). Also, they can be designed to elicit positive emotions and to diminish negative emotions of learners. Moreover, PALs’ affect could make
PALs more believable and natural (Bates, 1994) and help strengthen social bonds with learners.

**PALs’ affect as a social context**

Affect is closely aligned with social contexts (Bower et al., 1978; Martin, 2000; Nakamura, Buck, & Kenny, 1990; Saarni, 2000, 2001). Affect is a context specific entity and influences our cognitive and social thinking processes (Fiedler, 1991; Martin, 2000). The cognitive tuning theory (Schwarz, 2002) asserts that cognitive processes are responsive to environments in order to act in adaptive ways. The cognitive processes are tuned to meet the contextual requirements signaled by our feelings.

In classrooms, the affective states of participants, such as teachers and peers, function as social contexts and influences learners’ affective characteristics, such as emotions, self-conception, and motivation (Sutton & Wheatley, 2003). Teachers’ expressions of their emotions then influence students’ attributions regarding the causes of their successes and failures (Weiner, 2000). For instance, high school students placed value on having teachers who cared about them (Phelan et al., 1992). Middle school students who believed that teachers cared about them were more motivated; less likely to be involved in delinquency (Wong & Dornbusch, 2000); and more likely to be helpful and cooperative and to follow classroom rules and norms (Wentzel, 1996). Third-, fourth-, and fifth-grade students’ interactions with their teachers were differentiated by their perceptions of how much their teachers liked them (Skinner & Belmont, 1993). In the similar fashion, teachers’ expressions of negative emotions have significant impact on students’ affect and behavioral problems. Lewis (2001) reports that there are significant positive correlations between students’ reports of aggressive techniques used by teachers (e.g., yelling at students who misbehave) and students’ disruption and levels of misbehavior. Given the implication, it is highly
plausible that PALs’ affect may play a role as social context and influence learners’ affective characteristics and learning. Further, human emotion research indicates significant gender difference in affective experience.

**Gender difference in affect**

Gender difference in academic interest and cognitive and interaction style have persisted over time (Arroyo, Murray, Woolf, & Beal, 2003; Barrett & Lally, 1999; Evans, Schweingruber, & Stevenson, 2002; Hakkarainen & Palonen, 2003; Kwan, Trauth, & Driehaus, 1985; Slotte, Lonka, & Lindblom-Ylanne, 2001). The gender difference becomes more salient in educational computing (Cooper & Weaver, 2003) and is often attributed to societal influence, such as stereotypes (Clegg, 2001; Kwan et al., 1985). This social stereotypes are, in turn, aligned with emotional functioning in the same and opposite gender and brings gender difference in emotional expression, empathic accuracy, and emotional behavior (Brody, 1999). Women consistently report that they express a wider range of feelings and more intense positive and negative emotions than men do. Both young girls and women express more hurt, disappointment and sadness than do their male counterparts (Brody, 1993). For empathic accuracy, women have greater nonverbal sensitivity in reading others’ emotions than men (Craig, Driscoll, & Gholson, 2002; Elfenbein, Marsh, & Ambady, 2002; Ickes, Gesn, & Graham, 2000). Men recognized facial expressions less accurately than women (Mufson & Nowicki, 1991). Hall (1984) also indicates that women are not only more facially expressive but also gaze at others more frequently than men do, which permits women to pick up larger amounts of nonverbal information to decode others’ emotions. Regarding emotional behavior, men scored higher on hostility than women, especially on items measuring assault and aggressiveness (Kopper, 1993). Female voices were judged to be more positive, pleasant, honest,
Emotional experiences of males and females depend on a variety of interacting factors including the nature of situation, participants, the culture they are from, ages, and social roles they play (Brody, 1999). Regarding the nature of the situation, women reported more positive affect (happy, cheerful, and friendly) while they were at work than at home; in contrast, men reported more negative affect (unhappy, irritable, and angry) while they were at work and more positive affect while at home (Larson, Richards, & Perry-Jenkins, 1994). Most important, peers are powerful agents contributing to the gender differences in emotional expression (Brody, 1999). Peers tend to impose sex role norms on emotional expression. They are most likely accepting the behaviors that confirm to the norms. For boys, popularity is associated with the denial of vulnerable or sad feelings and the expression of moderate amounts of aggression. For girls, popularity is associated with low levels of aggression as well as with the verbal expression of and sensitivity to feelings. In a detailed observational study (Adler et al., 1992), teenagers of either sex who expressed non-stereotypic emotions were less popular among their peers. College-aged women who responded with fear to a horror movie were rated by their male partners as more attractive than those who mastered their fear; however when men showed mastery of fear, they became more appealing to women (Zillmann et al., 1986).

The gender differences in the real world are similarly projected to computing environments. When computers were categorized as males or females, users conformed to the advice of a male computer on the masculine topic than on the feminine topic; they conformed to the advice of a female computer on the feminine topic than on the masculine topic (Lee, 2003). Female students showed significantly lower self-efficacy in computing than male students (Busch, 1996). In a computer-assisted biology lesson, when a human face was present on the
screen, girls who had reported low anxiety in the pretest performed better and were more motivated to use the program relative to girls who had reported high anxiety; in contrast, boys who had reported high anxiety performed better and were more motivated to use the program than boys who had reported low anxiety (Cooper & Stone, 1996).

**Problem Statements**

Given the impact of social contexts on learners’ affect and cognition, it is not known yet whether PALs’ affect could serve as social contexts in the same way as the affect of teachers and friends in classrooms does. Throughout history, humans have created artifacts that influence our minds and hearts. Affective communication between human and artifacts, such as literature or artworks is not an innovative idea. People cry when watching sad movies or reading a tragic fiction and feel good with happy endings. However, when we speculate that the affordance of each artifact might be unique (Gibson, 1979), it is of interest whether people could emotionally interact with computers. Stern (2002) optimistically anticipates that the interactivity of computers could afford the most powerful medium for creating affective stories or art. We need to examine whether this anticipation holds true with PALs. Will PALs’ affect be projected to learners and influence learners’ affective and cognitive characteristics accordingly? Will PALs’ expressions of positive or negative affect influence learning and motivation? Will the empathetic responses of a PAL motivate learners and bring better learning as does a human friend in traditional classrooms (Ellis, Ottaway, Varner, Becker, & Moore, 1997; Meyer & Turner, 2002; Saarni, 2000, 2001)? The answers to these questions have not yet been pursued through empirical examination.

Moreover, given that gender difference in affect is situation-specific, it is not clear whether PALs’ affect plays a role with respect to gender. Both male and
female college students reported that they experienced more intense emotion and expressed more emotion when interacting with an opposite-sex partner than a same-sex partner (Barrett, Robin, Pietromonaco, & Eyssell, 1998). Baylor and Kim (2003a) found that learners’ expectations or perceptions of pedagogical agents were differentiated according to the gender of the pedagogical agents. However, the effects of PALs’ affect and gender are still open to question. By designing PALs as male or female with the inclusion of their affect, we can investigate the effect of PALs’ gender and its relationship with affect.

Research Questions and Hypotheses

The study investigated the general question: Will PAL affect and gender influence learning, interest, self-efficacy, and agent persona? The subsidiary questions and the research hypotheses related to each question include the following:

1. What is the impact of the affective expression of PALs (Experiment I)?

Hypothesis 1.1: The effect on learning

Emotion research has indicated the close association of affect and cognition. Affect and cognition are integrally linked to impact on information processing and retrieval (Adolphs & Damasio, 2000; Bower, 1981; Bower & Forgas, 2001). The affective states of a person influence a processing style (Schwarz, 2002). For example, positive emotions stimulate heuristic, creative, and top-down processing of information, whereas negative emotions stimulate detail-oriented, systematic, and bottom-up processing of information. Individuals’ emotional experiences are attributed to immediate contexts (Saarni, 2001). PALs’ affective states might be transferred to learners (Picard, 1997) and influence their information processing and retrieval. According to the findings of human emotion research and human-computer interaction, the affective expression of PALs might
influence learning. However, there might not be enough information to specify the direction of this influence. An exploratory prediction for a relationship between PALs’ affective expression and learning was made: Students’ learning will be different according to PALs’ expressions of positive, negative, or neutral affect.

_Hypothesis 1.2: The effect on interest_

Affective states of participants play a role as part of the social context for learning and influence learners’ motivation toward the task (Sutton & Wheatley, 2003). When an agent expressed their emotions, students perceived the agent as more engaging and interesting (Lester et al., 2000), and the task as more enjoyable (Mori et al., 2003). It is expected that PALs’ positive affect will influence learners’ interest toward the task and the PAL positively.

_Hypothesis 1.3: The effect on self-efficacy_

Affect of participants in learning contexts influences learners’ self-conception (Sutton & Wheatley, 2003). In particular, teachers’ expressions of emotions affects students’ attributions about the causes of their successes and failures (Weiner, 2000). Thus, it is expected that PALs’ positive affect will influence learners’ self-efficacy beliefs in the task positively.

_Hypothesis 1.4: The effect on agent persona_

The type of emotional expressions of participants in learning contexts clearly differentiated learners’ perceptions and preferences of the participants. Students preferred for teachers who expressed positive emotions. So it is expected that learners will perceive PALs who express positive affect more favorably than PALs who express negative affect.
2. **What is the impact of the affective response of PALs (Experiment II)?**

*Hypothesis 2.1: The effect on learning*

In classrooms, students who believed that teachers cared about them were more motivated (Wong & Dornbusch, 2000) and more likely to be helpful and cooperative to follow classroom rules and norms (Wentzel, 1996). When PALs respond with empathy to learners’ emotional states, learners might be more motivated in the task and consequently perform better. So it is expected that PALs that respond to student affect will positively influence learning.

*Hypothesis 2.2: The effect on interest*

In classrooms, students who believed that teachers cared about them were more motivated (Wong & Dornbusch, 2000) and more likely to be helpful and cooperative to follow classroom rules and norms (Wentzel, 1996). When PALs care about learners’ emotional states, learners might be more interested in working with the PAL or in the task. Thus, it is expected that PALs that respond to student affect will positively influence learners’ interest toward the task and the PAL.

*Hypothesis 2.3: The effect on self-efficacy*

When an instructor does not demonstrate affect, students’ self-concepts tend to get lower (Turner et al., 2002). In the study, the students provided with cognitive support without affect set lower-than-average learning goals and showed higher-than-average avoidance behavior. Setting lower learning goals might be associated with lower self-efficacy in the tasks. Thus, it is expected that PALs that respond to student affect will positively influence learners’ self-efficacy beliefs in the task.
Hypothesis 2.4: The effect on agent persona

Studies indicate that learners are sensitive to the affect of participants in the learning contexts and prefer to work with those who care about learners. Thus, learners’ perceptions of PALs’ persona might be differentiated when PALs respond to learners’ emotions from when not. Thus, it is expected that PALs that respond to student affect will positively influence learners’ perceptions of agent persona.

3. What is the impact of the gender of PALs (Experiment I and II)?

Hypothesis 3.1: The effect on interest

The gender of pedagogical agents as instructors affected learners’ motivation (Baylor & Kim, 2003a). Students who worked with male agents were more satisfied with their performance and demonstrated more self-regulatory behaviors. Similarly, it is predicted that a male PAL will exert more positive impact in learners’ interest in the task and the PAL than a female PAL.

Hypothesis 3.2: The effect on agent persona

Learners’ perceptions of agent personality and persona were differentiated according to gender of pedagogical agents (Baylor & Kim, 2003a). Students perceived male agents as more extraverted, agreeable, and affable. Thus, it is expected that students will perceive the persona of a male PAL more positively than that of a female PAL.

4. Is there an interaction between PALs’ affect and gender (Experiment I and II)?
Hypothesis 4.1: The effect on agent persona

Females express a wider range of feelings and more intensive emotions than males (Brody, 1999). Peers tend to impose sex role norms on emotional expressions of each other. More specifically, teenagers of either sex who expressed non-stereotypic emotions were perceived as less popular. Hence, PALs’ affective expression might be perceived differently according to their gender. It is expected that PALs’ affect and gender will interact to influence learners’ perceptions of agent persona.
CHAPTER III

METHOD

The purpose of the study was to examine the impact of PAL affect and gender on learning, interest, self-efficacy, and perceived agent persona. PAL affect was examined in terms of affective expression and affective response. Thus, data gathering was conducted in two phases with two controlled experiments. Experiment I focused on PALs’ affective expression, and Experiment II focused on PALs’ affective response.

Experiment I

The purpose of Experiment I was to investigate the impact of PALs’ affective expression (positive vs. negative vs. neutral) and PALs’ gender (male vs. female) on learning, interest, self-efficacy, and perceived agent persona.

Participants

142 undergraduates in a computer literacy course in a large public university located in the southeast United States voluntarily participated in the study implemented as an optional part of class activities. Approximately 40% of the participants were males and 60% were females. 67% of the participants were Caucasian; 13% were African-American; 10% were Hispanic; 2% were Asian; and 8% were other. The average age of participants was 20.25 (SD = 2.27). The
participants were homogeneous regarding their prior experience in the learning task of instructional planning for e-learning.

**Materials**

*Instructional module: E-Learn*

The instructional module was E-Learn, an agent-based research environment focusing on instructional planning for e-learning solutions. E-Learn was developed by Pedagogical Agent Learning Systems Laboratory at Florida State University to conduct research in partnership with instructors of a computer literacy course. The goal of E-Learn was to introduce basic concepts of designing e-learn classes. PALs provided information on what and how-to in two steps of Goals and Planning. Students’ task in the module was to write their ideas for designing an e-learning class to teach freshmen to be more efficient in time management, based on the information provided by the PALs. The topics of e-learning and time management were considered relevant to the course and students for two reasons. First, Internet Communications and Web Applications was one of the course topics. Second, efficient time management can be a real problem of the participants, the majority of whom were freshmen or sophomores. In particular, Experiment I focused on the PAL’s affective expression that was simplified to positive and negative emotions; so it was speculated that a short module like E-Learn might be efficient to pursue the research questions. The E-Learn module took approximately 30 minutes to complete. E-Learn screenshots are included in Appendix A.

When the participants entered E-Learn, a PAL appeared and introduced himself/herself as a peer. The PAL suggested the participants to request information from him/her, who provided information relevant to the task. At each
stage, the participants were prompted to “Click on me when you would like some more ideas”.

E-Learn included three phases of Introduction, Goals, and Planning. The Introduction briefly described the case scenario to the development of an e-learning session on time management for college freshmen. E-learning design was processed in two main stages: Goals and Planning. In Goals, the participants wrote instructional goals or objectives in a text-box field. In Planning, the participants wrote instructional strategies and activities in a text-box field. Each stage was indicated by large buttons located at the top of screens. At any time during the task, participants were able to move back and forth through the stages. Once the participants entered the Planning stage, an additional button, labeled FINISHED, was provided. When participants clicked the button, they were directed to the posttest questions.

*Agent scripts*

All information provided by E-Learn and the PALs were identical across the conditions. Depending on the experimental conditions, however, additional affective comments were conveyed by the PALs. These affective comments were very brief and did not significantly impact on the total instructional time for each condition. The scripts of each experimental condition are included in Appendix B.

*The design of the PALs*

Male and female PALs, both named Chris, were designed to represent a peer to the participants who were college students. The images of the PALs were designed to be approximately twenty years old, and they wore casual shirts and spoke informally, sometimes using slang. The participants estimated the PALs’ age as an average of 20.39 ($SD = 7.94$).
Independent Variables

Independent variables included PALs’ affective expression (Positive vs. Neutral vs. Negative) and PALs’ gender (Male vs. Female).

PALs’ affective expression

Affective expression was operationalized by verbal and facial expressions, voices, and head movements, as supported by human emotion research. The research indicates that people express and perceive emotions, mostly through facial expressions, acoustic sounds, and bodily movements together with verbal manifestations. According to Keltner and Ekman (2000), face is the primary source for expressing distinct emotions nonverbally. The distinctive features of individuals’ voices also have a powerful influence on how people decipher emotional messages (Bachorowski & Owren, 2002; Bradley & Lang, 2000). Bodily movements are clearly differentiated according to positive or negative feelings (Cacioppo, Priester, & Berntson, 1993; Chen & Bargh, 1999). In addition, Sinclair and colleagues (1998) indicate that the color red is interpreted as “upbeat,” and fosters heuristic processing aligned with positive affect, whereas the color blue is generally interpreted as more depressing and fosters systematic processing aligned with negative affect. So the background colors of the module were adjusted to experimental conditions.

In this study, the PALs’ affective expression had three levels: Positive, Negative, and Neutral. Psychologists typically classify affect as positive if it involves pleasure (e.g., happiness or satisfaction) and as negative if it includes distress (e.g., frustration or anger) (Ottati, Terkildsen, & Hubbard, 1997; Sutton & Wheatley, 2003). Thus, in the Positive affect condition, the PALs had a happy smiling face and an engaging posture, with eye gaze and head nodding. The participants perceived the positive PALs as significantly more “looking happy”
than the negative PALs ($p < .001$). In the Negative affect condition, the PALs had a somber and rather frowning face and an aloof posture, with evasive eye contact and less head nodding. The participants perceived the negative PALs as significantly more “looking sad” than the positive PALs ($p < .001$). In the Neutral condition, the PALs did not express affect. Overall, the adjustment of the emotion parameters in the voice/affect editing tool, Mimic Pro 2, operationalized the degree of positive, negative, and neutral expressions.

**PALs’ gender**

Either a male or female version of Chris, the PAL, was included depending on the experimental conditions. The two PALs were identical in all aspects (e.g., comments and emotional expressions), differing only by image and voice. Given that voice was a significant indicator for social presence (Mayer, Sobko, & Mautone, 2003; Moreno et al., 2001; Nass & Steuer, 1993b), human male and female voices were recorded. The images of THE male and female PALs are included in the screenshots in Appendix A.

**Dependent Variables**

Dependent variables included learning, interest, self-efficacy, and learners’ perceptions of agent persona.

**Learning**

Learning was measured by two open-ended recall and application posttest questions. In the recall question, students were asked to write all the ideas and information that the PALs had conveyed about designing an e-learning class. The number of legitimate ideas in the students’ answers was counted and coded by two instructional designers according to a process suggested by Mayer and Gallini (1990). Inter-rater reliability was evaluated with Cohen’s $Kappa = .94$. 
In the application question, the participants were asked to write a brief e-learning plan according the following prompt:

Applying what you’ve learned, develop an instructional plan for the following scenario: Imagine that you are a sixth grade teacher of a mathematics class. Your principal informs you that a member of the president’s advisory committee will be visiting next week and wants to see an example of your instruction about the multiplication of fractions.

Students’ instructional plans were evaluated by two instructional designers given a scoring rubric scaled 1 (Very poor) through 5 (Excellent). The scoring rubric focused on how specific their plans were in terms of the topic and strategies. This rubric has been used by Pedagogical Agent Learning Systems Research Laboratory at Florida State University (A. Baylor & Y. Kim, 2004; Baylor & Kim, 2003a, 2003b; Kim & Baylor, 2004a). Inter-rater reliability was evaluated as Cohen’s Kappa = .97. Table 3 shows the scoring rubric of the application question.

Table 3

<table>
<thead>
<tr>
<th><strong>Scoring Rubric for Application Question</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Point</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>
Interest

Getzels (1966) defines interest as a “disposition organized through experience which impels an individual to seek out particular objects, activities, understandings, skills, or goals for attention or acquisition.” The range of interests can be best expressed on the scale of “interested-disinterested” (L. W. Anderson & Bourke, 2000). In this study, interest referred to learners’ disposition toward working with the PALs and toward the task of instructional planning. Based on Anderson and Bourke’s guidelines, a questionnaire with seven items was developed and scaled from 1 (Strongly disagree) to 5 (Strongly agree). Item reliability was assessed as coefficient $\alpha = .87$. Learner interest was measured before and after the intervention. To avoid test-retest effect, the first 4 items out of seven were implemented in the pre-test, and the 5 items from the last were implemented in the post-test. Interest measures are attached in Appendix C.

Self-efficacy

In general, self-efficacy is defined as an individual’s belief in his or her competency of performing a particular task required to reach a goal (Bandura, 1986, 1997; Weiner, 1992). The direction of self-efficacy is best captured by “I can vs. I can’t” (Weiner, 1992) or “How sure are you ~” (Bandura & Schunk, 1981; Pajares, 1996). In this study, self-efficacy referred to learners’ belief about their competency in the task of e-learning design. A questionnaire with five items was scaled from 1 (Strongly disagree) to 5 (Strongly agree). Item reliability was evaluated as coefficient $\alpha = .95$. Learners’ self-efficacy beliefs were measured before and after the intervention. To avoid test-retest effect, the first 2 items out of five were implemented in the pre-test, and the 3 items from the last were implemented in the post-test. Self-efficacy measures are included in Appendix C.
**Perceived agent persona**

Agent persona was measured by a questionnaire derived from the Agent Persona Instrument (API), which includes 4 sub-measures: Facilitating learning, Credible, Human-like, and Engaging (Baylor & Ryu, 2003). The API was developed to measure the persona of pedagogical agents as instructors or mentors. Considering the different instructional role of PALs as peers, the researcher modified the API and derived a questionnaire with three sub-measures of Facilitating learning (4 items), Human-like (4 items), and Engaging (4 items). Item reliability within each category was evaluated as coefficient $\alpha = .91, .80,$ and .81 respectively. Agent persona measures are included in Appendix C.

**Procedure**

The experiment was conducted during a regular session of a computer literacy course. Participants were randomly assigned to one of the six conditions. The random assignment was administered by computer programming. The researcher administered the experiment with assistance of the course instructors. The overall procedures included the following:

- Participants were given a brief written introduction about the experiment. They were told that the activity was a research project and would not affect their course grades.
- The participants were asked to put on headphones.
- The participants logged on to the web-based E-Learn module by entering demographic information.
- The participants then answered pretest questions.
- The participants wrote their ideas to plan an e-learning class, based on the information provided by PALs in the three steps of Introduction, Goals, and Planning. They were given as much time as they needed to finish the entire
process. This session took approximately 30 minutes with individual variations.

- The participants answered the posttest questions for about 10 minutes.

**Design and Analysis**

The study employed a $3 \times 2$ factorial design. The variables include PAL affective expression (Positive vs. Negative vs. Neural) and PAL gender (Male vs. Female). With alpha set at .05 and with 23 subjects per treatment group, the probabilities of detecting a medium difference between means were evaluated as .70 for the main effect of affective expression, .80 for the main effect of gender, and .70 for the interaction effect respectively.

Preliminary data analyses were conducted to detect problematic observations and to assess violations of the assumptions for statistical procedures. For learning and agent persona, multivariate analysis of variance (MANOVA) was conducted. For interest and self-efficacy, multivariate analysis of covariance (MANCOVA) was conducted with prior interest and self-efficacy as covariates. The significance level for all the analyses was set at $\alpha < .05$.

**Experiment II**

The purpose of Experiment II was to investigate the effects of the affective response (responsive vs. non-responsive) and gender (male vs. female) of PALs on learning, interest, self-efficacy, and perceived agent persona.

**Participants**

Participants included 56 pre-service teachers enrolled in an introductory educational technology class in the same university as in Experiment I. The participants were chosen with some considerations: First, a longer period of
intervention might be necessary to allow enough time to implement affective interactions between learners (expressing their affect) and the PAL (responding to the affect). Second, in order to implement a longer intervention, the task needed to be relevant to the learners. Third, the relevancy may motivate them to express their affect more frequently. In principle, the students participated on a voluntary basis in the study that was implemented as a class activity. However, they could obtain extra credits for the course grade by participation. The majority of the students enrolled in the course participated in the study.

20% of the participants were male and 80% were female. 68% of the participants were Caucasian; 12% were African-American; and 20% were other. The average age of participants was an average of 20.71 (SD = 2.92). The participants were homogeneous regarding their prior experience in the learning task of instructional planning.

Materials

The instructional module was MIMIC, an agent-based research environment. The learning task was instructional planning (Baylor, 2002). MIMIC included five phases of Introduction, Case Study, Blueprints, Plan, and Assessment. Introduction briefly described a case study scenario involving 13-year-old Anna and her teacher, Mr. Lange in a Texan school, told the participants that their task was to design a plan for Anna and her peers to learn the economic concepts of supply and demand, and instructed the participants how to navigate in the environment.

Instructional planning was processed in four main stages: case study, blueprints, planning, and assessment. Each stage was indicated by large buttons located at the top of the screens. Case study consisted of a description of Anna and her problems in learning supply and demand, her teacher Mr. Lange, and her school in Texas. Links were provided so that participants could access Anna’s
homework and Mr. Lange’s lesson notes. These materials helped familiarize participants with the concepts of supply/demand to better understand the context of Anna’s difficulties. In Blueprints, the participants wrote instructional goals or objectives in a text-box field. As additional information, two links were provided regarding Texas Standards and Benchmarks for supply and demand. In Plan, the participants wrote instructional strategies and activities in a text-box field. In Assessment, the participants described assessment plans in a text-box field. In each stage, the participants were prompted to “Click on me when you would like some more ideas” by the PALs. Once the participants entered the assessment stage, an additional button labeled FINISHED was provided. When participants clicked the button, they were directed to the posttest questions.

In addition, for learners to express their emotional states, a panel of emoticons (i.e., icons expressing emotions) was appeared when the learners clicked a navigation button to move to the next phase. In the introduction, the participants were informed that they were required to express their current affective states by clicking the emoticons before proceeding to the next stage. When they expressed their affect by clicking an emoticon, the PAL responded to it or not according to experimental conditions. The emoticons included six affective states that commonly occurred in learning situations, derived from the Affective Model suggested by Kort and colleagues (2001): Interest, Boredom, Confidence, Anxiety, Satisfaction, and Frustration. Figure 2 shows these six emoticons.

![Emoticons](image.png)

*Figure 2. Emoticons.*
As described earlier, Experiment II required a longer duration of implementation to effectively investigate the affective interaction between the learners and the PALs. MIMIC took about an hour to complete.

Independent Variables

Independent variables included PALs’ affective response and gender.

Affective response

Affective response referred to whether the PAL responded to the learners’ affect with empathy or not. It had two levels: responsive vs. non-responsive. In the responsive condition, when learners expressed their affect by clicking any of the emoticons, the PAL immediately responded to the learners’ affect with empathy. The affective responses were brief and did not affect the overall instruction time. The scripts for the PAL’s response are included in Appendix B. In the Non-responsive condition, the PAL did not react to learners’ affect when they expressed their affect. In both conditions, the amount of information provided by the PALs was exactly the same.

Gender

As in Experiment I, either a male or female PAL was included depending on experimental conditions.

Dependent Variables

Dependent measures were the same as in Experiment I including learning, interest, self-efficacy, and perceived agent persona.
**Procedure**

The experiment was conducted during a regular session of an introductory educational technology course. Participants were randomly assigned to one of the four conditions. The researcher administered the experiment with assistance of the instructors. The overall procedures were consistent with Experiment I:

- Participants were given a brief written introduction about the experiment. They were told that the activity was a research project and that they could get extra credits for the course grade by participation.
- The participants were asked to put on headphones.
- The participants logged on to the web-based MIMIC module by entering demographic information.
- The participants then answered pretest questions.
- The participants wrote instructional plans, based on the information provided by PALs in each phase of MIMIC. They were given as much time as they needed to finish the entire process. This session took approximately an hour with individual variations.
- The participants answered the posttest questions for about 10 minutes.

**Design and Analysis**

The study employed a $2 \times 2$ factorial design. Variables included PAL affective response (Responsive vs. Non-responsive) and PAL gender (Male vs. Female). With alpha set at .05 and with 13 subjects per treatment group, the probability of detecting a medium difference between means was .30, and the probability of detecting a large difference was .80 for all the fixed effects (two main effects and the interaction effect).

Preliminary analyses were first conducted to detect problematic observations and to test assumptions for statistical procedures. For learning, two-way ANOVA was conducted. For interest and self-efficacy, multivariate analysis
of covariance (MANCOVA) was conducted with pretest interest and self-efficacy as covariates. For agent persona, multivariate analysis of variance (MANOVA) was conducted. The significant level was set at $\alpha < .05$. 
CHAPTER IV

RESULTS

This chapter reports the results of data analysis for the tests of hypotheses examined in Experiment I and Experiment II separately. Dependent variables for both studies included learning, interest, self-efficacy, learners’ perceptions of agent persona. Learning was measured by open-ended recall and application questions. Interest was measured by a questionnaire with five items. Self-efficacy was measured by a questionnaire with three items. Agent persona was measured by a questionnaire with sub-measures of facilitating learning, human-like, and engaging consisting of four items each.

Experiment I

Experiment I examined the effects of PALs’ affective expression (positive vs. negative vs. neutral) and gender (male vs. female).

Preliminary analysis

A preliminary analysis of the data was conducted to ensure compliance of the assumptions for the parametric statistics used in the study. Examination of scatter plots supported the assumption of normality and revealed linear relationships for all tests. Box’s test of equality of covariances supported the equal covariance assumptions for multivariate analyses.
Learning

Learning was measured by open-ended recall and application questions. Students’ answers on two questions were coded by two raters. For analysis, MANOVA was conducted with two items of recall and application. Table 4 presents the means and standard deviations for the learning measures.

Table 4

Means and Standard Deviations for Learning Measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>PAL affective expression</th>
<th>PAL gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Recalla</td>
<td>1.00</td>
<td>1.27</td>
</tr>
<tr>
<td>Applicationb</td>
<td>2.00</td>
<td>1.01</td>
</tr>
</tbody>
</table>

a. The number of ideas recalled. Maximum score = 10
b. Minimum score =1; Maximum score =5

The overall MANOVA revealed a significant main effect for PALs’ gender on learning, Wilks’ Lambda = .83, $F(2, 65) = 6.66, p < .01$, partial $\eta^2 = .17$. To identify the contribution of each dependent measure to the overall effects, univariate analyses (ANOVA) were further conducted. The univariate results revealed a significant main effect for gender on recall, $F(1, 66) = 7.08, p < .01$. Students who worked with the male PAL ($M = 1.52, SD = 1.84$) achieved significantly higher recall scores than students who worked with the female PAL ($M = .65, SD = .89$). The standardized effect size for this difference was Cohen’s $d = 0.60$, which indicated a medium effect according to Cohen’s guidelines.
There was no significant main effect for PALs’ affective expression on learning. Hypothesis 1.1 stating that PALs’ affective expression would positively influence learning was not supported. Table 5 presents the results of the multivariate analysis of variance test for learning.

Table 5

*Multivariate Analysis of Variance for Learning*

<table>
<thead>
<tr>
<th>Source</th>
<th>Wilks’ Lamda</th>
<th>$F$</th>
<th>Hypothesis $Df$</th>
<th>Error $df$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affect expression (A)</td>
<td>.99</td>
<td>.23</td>
<td>4</td>
<td>130</td>
<td>.92</td>
</tr>
<tr>
<td>Gender (G)**</td>
<td>.83</td>
<td>6.66</td>
<td>2</td>
<td>65</td>
<td>.00</td>
</tr>
<tr>
<td>$A \times G$</td>
<td>.97</td>
<td>.45</td>
<td>4</td>
<td>130</td>
<td>.77</td>
</tr>
</tbody>
</table>

**significant at $\alpha < .01$.

*Interest*

Interest was measured with a questionnaire with five items. For analysis, multivariate analysis of covariance was conducted with prior interest ($M = 1.96$, $SD = .97$) as a covariate. Table 6 presents the means and standard deviations for the interest measures.
Table 6

*Means and Standard Deviations for Interest Measures I*

<table>
<thead>
<tr>
<th>Measures</th>
<th>Condition</th>
<th>PAL affective expression</th>
<th>PAL gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Item 1</td>
<td>I was interested while doing the task.</td>
<td>2.48</td>
<td>1.11</td>
</tr>
<tr>
<td>Item 2</td>
<td>I was attentive while doing the task.</td>
<td>3.04</td>
<td>1.17</td>
</tr>
<tr>
<td>Item 3</td>
<td>I was absorbed while doing the task.</td>
<td>2.87</td>
<td>1.13</td>
</tr>
<tr>
<td>Item 4</td>
<td>I was interested while working with Chris.</td>
<td>2.43</td>
<td>1.17</td>
</tr>
<tr>
<td>Item 5</td>
<td>I was attentive while working with Chris.</td>
<td>2.65</td>
<td>1.23</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2.69</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Minimum score = 1; Maximum score = 5.

The overall MANCOVA revealed a significant main effect for PALs’ gender, Wilks’ Lambda = .893, \(F(5, 127) = 3.05, p < .05\), partial \(\eta^2 = .11\). Students who worked with the male PAL showed significantly higher interest toward the task and the PAL than students who worked with the female PAL. Hypothesis 3.1 stating that a male PAL would positively influence interest was supported by the results.

There was no significant main effect for PALs’ affective expression on interest. Hypothesis 1.2 stating that PALs’ positive affect would positively
influence interest was not supported by the results. Table 7 presents the results of the multivariate analysis of covariance test for interest.

Table 7

**Multivariate Analysis of Covariance for Interest I**

<table>
<thead>
<tr>
<th>Source</th>
<th>Wilks’ Lamda</th>
<th>$F$</th>
<th>Hypothesis $Df$</th>
<th>Error $df$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affect expression (A)</td>
<td>.92</td>
<td>1.06</td>
<td>10</td>
<td>254</td>
<td>.39</td>
</tr>
<tr>
<td>Gender (G)**</td>
<td>.89</td>
<td>3.05</td>
<td>5</td>
<td>127</td>
<td>.01</td>
</tr>
<tr>
<td>A × G*</td>
<td>.89</td>
<td>1.58</td>
<td>10</td>
<td>254</td>
<td>.11</td>
</tr>
</tbody>
</table>

*Roy’s Largest Root = 2.51 5 128 .03

* significant at $\alpha < .05$, ** significant at $\alpha < .01$.

Incidentally, the test of Roy’s Largest Root indicated the statistical significance of the interaction effect between affective expression and gender ($p < .05$), with the significance of Wilks’ Lamda remaining $p = .11$. The researcher took a detailed look at the data. Figure 3 shows a graphical representation of the relationship of affective expression and gender on interest.
A visual inspection suggested a trend that students’ interest in the female PAL conditions was consistent regardless of the types of PAL affect. However, students’ interest in the male PAL conditions was differentiated according to the types of PAL affect. Simple Trend Analysis was conducted to test the statistical significance of this trend. The results indicated a significant linear relationship of PAL gender only in the positive PAL conditions, $F(1, 136) = 5.21, p < .05$. When the PALs expressed positive affect, students in the male PAL condition tended to show higher interest than students in the female PAL condition.

**Self-efficacy**

Self-efficacy was measured with a questionnaire with three items. For analysis, multivariate analysis of covariance was conducted with prior self-
efficacy \((M = 2.39, SD = 1.1)\) as a covariate. Table 8 presents the means and standard deviations for the self-efficacy measures.

Table 8

*Means and Standard Deviations for Self-Efficacy Measures*

<table>
<thead>
<tr>
<th>Measures</th>
<th>Condition</th>
<th>PAL affective expression</th>
<th>PAL gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pal Positive</td>
<td>Pal Negative</td>
<td>Pal Neutral</td>
</tr>
<tr>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Item 1</td>
<td>I can write a lesson planning for e-learning.</td>
<td>2.93</td>
<td>1.14</td>
</tr>
<tr>
<td>Item 2</td>
<td>I am confident in designing a lesson plan for e-learning.</td>
<td>2.74</td>
<td>1.12</td>
</tr>
<tr>
<td>Item 3</td>
<td>I am competent in designing a lesson plan for e-learning.</td>
<td>2.98</td>
<td>1.01</td>
</tr>
<tr>
<td>Total</td>
<td>2.91</td>
<td>1.08</td>
<td>2.74</td>
</tr>
</tbody>
</table>

Minimum score = 1; Maximum score = 5.

There were no main effects for PAL affective expression and gender on self-efficacy. Hypotheses 1.3 stating that PALs’ positive affect would positively influence learners’ self-efficacy beliefs in the task were not supported by the results. Table 9 presents the results of the multivariate analysis of covariance test for self-efficacy.
Table 9

**Multivariate Analysis of Covariance for Self-Efficacy I**

<table>
<thead>
<tr>
<th>Source</th>
<th>Wilks’ Lamda</th>
<th>$F$</th>
<th>Hypothesis $Df$</th>
<th>Error $df$</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affect expression (A)</td>
<td>.97</td>
<td>.72</td>
<td>6</td>
<td>256</td>
<td>.64</td>
</tr>
<tr>
<td>Gender (G)</td>
<td>.99</td>
<td>.29</td>
<td>3</td>
<td>128</td>
<td>.84</td>
</tr>
<tr>
<td>A × G</td>
<td>.97</td>
<td>.71</td>
<td>6</td>
<td>256</td>
<td>.64</td>
</tr>
</tbody>
</table>

**Agent persona**

Students’ perceptions of agent persona were assessed with sub-measures of facilitating learning (4 items), human-like (4 items), and engaging (4 items). The mean scores of each category were calculated for analyses. Multivariate analysis of variance was conducted with the three sub-measures. Table 10 presents the means and standard deviations for the agent persona measures.

Table 10

**Means and Standard Deviations for Agent Persona Measures I**

<table>
<thead>
<tr>
<th>Measures</th>
<th>Condition</th>
<th>PAL affective expression</th>
<th>PAL gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Facilitating</td>
<td>2.59</td>
<td>1.07</td>
<td>.93</td>
</tr>
<tr>
<td>Human-like</td>
<td>2.82</td>
<td>.96</td>
<td>.87</td>
</tr>
<tr>
<td>Engaging</td>
<td>3.06</td>
<td>.97</td>
<td>.83</td>
</tr>
</tbody>
</table>

Minimum score = 1; Maximum score = 5.
There were partial interactions between PAL affective expression and gender on perceived agent persona. The overall MANOVA conducted as protected testing indicated a significant interaction effect \((p < .07, \text{ partial } \eta^2 = .05)\). The visual inspection of this relationship suggested partial interactions between PAL affective expression and gender. The graphical representation of the interactions drawn by the mean score of the three sub-measures is shown in Figure 4. To test the interactions in detail, Partial Interaction tests were further conducted. The tests examined the interaction effects between one treatment (PAL gender) by every orthogonal contrast on the other treatment (PAL affective expression), controlling for family-wise error rates.

*Figure 4.* Interaction of affective expression and gender for agent persona I.

The results of the Partial Interaction tests revealed three significant interactions between PAL gender and affective expression. First, PALs’ positive...
and negative affect interacted with PAL gender, $F(1, 133) = 5.61, p < .05$. When the PALs expressed positive affect, students rated the persona of the male PAL significantly as more favorably than that of the female PAL. This difference, however, was not significant when the PALs expressed negative affect. Second, PALs’ positive and neutral affect interacted with PAL gender, $F(1, 133) = 6.00, p < .05$. When the PALs expressed positive affect, students rated the persona of the male PAL significantly as more favorably than that of the female PAL. This difference was minimal when the PALs did not express their affect (neutral affect). Third, PALs’ positive versus negative and neutral affect interacted with PAL gender, $F(1, 133) = 7.73, p < .01$. When the PALs expressed positive affect, students rated the persona of the male PAL significantly as more favorably than that of the female PAL. This difference was minimal when the PALs expressed negative and neutral affect. Overall the interaction effect of affective expression and gender was significant only in the positive affect condition. Given the results, the researcher was confident in arguing for the interaction effect of affective expression and gender on agent persona. Thus, it was concluded that Hypothesis 4.1 stating that PALs’ affect and gender would interact to influence learners’ perceptions of agent persona was supported by the results.

The overall MANOVA also revealed a significant main effect for PALs’ affective expression, Wilks’ Lambda = .70, $F(6, 252) = 8.33, p < .001$, partial $\eta^2 = .16$. To identify the contribution of each sub-measure to the overall effects, univariate analyses (ANOVA) were conducted.

The univariate results revealed a significant main effect for PAL affective expression on facilitating learning, $F(2, 128) = 3.75, p < .05$. Students who worked with the positive PAL ($M = 2.59, SD = 1.07$) perceived the PAL significantly as more facilitating to their learning than students who worked with the negative PAL ($M = 2.12, SD = .93$). The standardized effect size for this difference was Cohen’s $d = 0.47$, which indicated a medium effect according to
Cohen’s guidelines. Also, students who worked with the neutral PAL ($M = 2.63$, $SD = .94$) perceived the PAL as significantly facilitating to their learning than students who worked with the negative PAL ($M = 2.12$, $SD = .93$). The standardized effect size for this difference was Cohen’s $d = 0.55$, which indicated a medium effect according to Cohen’s guidelines.

The univariate results revealed a significant main effect for PAL affective expression on engaging, $F (2, 128) = 14.77$, $p < .001$. Students who worked with the positive PAL ($M = 3.06$, $SD = .97$) perceived the PAL as significantly more engaging than students who worked with the negative PAL ($M = 2.25$, $SD = .83$). The standardized effect size for this difference was Cohen’s $d = 1.09$, which indicated a large effect according to Cohen’s guidelines. Also, students who worked with the neutral PAL ($M = 3.12$, $SD = .77$) perceived the PAL as significantly more engaging than students who worked with the negative PAL ($M = 2.25$, $SD = .83$). The standardized effect size for this difference was Cohen’s $d = 1.09$, which indicated a large effect according to Cohen’s guidelines. Hypothesis 1.4 stating that learners would perceive positive PALs more favorably than negative PALs was supported by the results.

The overall MANOVA for protected testing revealed the significant effect for PAL gender on agent persona ($p < .10$, partial $\eta^2 = .05$). The univariate analyses were thus further conducted with the sub-measures respectively to examine the contribution of the individual sub-measures to the overall effect. The results indicated that students who worked with the male PAL perceived the PAL persona as significantly more positively than students with the female PAL for all the sub-measures: facilitating learning ($p < .05$), human-like ($p < .05$), and engaging ($p < .05$). Thus, it is concluded that the male PAL was perceived more favorably than the female PAL. Hypothesis 3.2 was supported by the results. Table 11 presents the results of the overall multivariate analysis of variance test for agent persona.
Table 11

*Multivariate Analysis of Variance for Agent Persona I*

<table>
<thead>
<tr>
<th>Source</th>
<th>Wilks’ Lambda</th>
<th>F</th>
<th>Hypothesis Df</th>
<th>Error df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affective expression (A)**</td>
<td>.70</td>
<td>8.33</td>
<td>6</td>
<td>252</td>
<td>.00</td>
</tr>
<tr>
<td>Gender (G)</td>
<td>.95</td>
<td>2.40</td>
<td>3</td>
<td>126</td>
<td>.07</td>
</tr>
<tr>
<td>A × G</td>
<td>.91</td>
<td>1.97</td>
<td>6</td>
<td>252</td>
<td>.07</td>
</tr>
</tbody>
</table>

**significant at α < .01

Experiment II

Experiment II examined the effects of PALs’ affective response (responsive vs. non-responsive) and gender (male vs. female) on learning, interest, self-efficacy, and perceived agent persona.

*Preliminary analysis*

A preliminary analysis of the data was conducted to ensure compliance of the assumptions for the parametric statistics used in the study. Examination of scatter plots supported the assumption of normality and revealed linear relationships for all tests. Box’s test of equality of covariances supported the equal covariance assumptions for multivariate analyses. Levine’s test for homogeneity of error variances supported the equal variance assumption for univariate analyses.

*Learning*

Learning was measured by open-ended recall and application questions. Unexpectedly, a large portion of the students did not answer the applicaton
question. Consequently, only the recall question was included in the analyses. Students’ answers were coded by two raters. For analysis, univariate analysis of variance was conducted. Table 12 presents the means and standard deviations for learning from Experiment II.

Table 12

Means and Standard Deviations for Learning II

<table>
<thead>
<tr>
<th>Measures</th>
<th>Condition</th>
<th>Affective response</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Responsive</td>
<td>Non-responsive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M  SD</td>
<td>M  SD</td>
</tr>
<tr>
<td>Learning (Recall)</td>
<td>2.79  1.72</td>
<td>3.00   2.07</td>
<td>3.45  1.64</td>
</tr>
</tbody>
</table>

There was no significant effect for affective response and gender on learning. Hypotheses 2.1 stating that responsive PALs would positively influence learning was not supported by the results. Table 13 presents the results of the univariate analysis of variance test for learning.

Table 13

Univariate Analysis of Variance for Learning II

<table>
<thead>
<tr>
<th>Source</th>
<th>Df</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affect response (A)</td>
<td>1</td>
<td>.02</td>
<td>.89</td>
</tr>
<tr>
<td>Gender (G)</td>
<td>1</td>
<td>1.29</td>
<td>.27</td>
</tr>
<tr>
<td>A × G</td>
<td>1</td>
<td>.78</td>
<td>.78</td>
</tr>
<tr>
<td>Error</td>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As in Experiment I, interest was measured with a questionnaire with five items. For analysis, multivariate analysis of covariance was conducted with prior interest ($M = 3.85$, $SD = 1.16$) as a covariate. Table 14 presents the means and standard deviations for the interest measures from Experiment II.

**Table 14**

*Means and Standard Deviations for Interest Measures II*

<table>
<thead>
<tr>
<th>Measures</th>
<th>Condition</th>
<th>Affective response</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Responsive</td>
<td>Non-responsive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Item 1</td>
<td>I was interested while doing the task.</td>
<td>4.14</td>
<td>.54</td>
</tr>
<tr>
<td>Item 2</td>
<td>I was attentive while doing the task.</td>
<td>4.26</td>
<td>.43</td>
</tr>
<tr>
<td>Item 3</td>
<td>I was absorbed while doing the task.</td>
<td>3.93</td>
<td>.62</td>
</tr>
<tr>
<td>Item 4</td>
<td>I was interested while working with Chris.</td>
<td>3.50</td>
<td>.86</td>
</tr>
<tr>
<td>Item 5</td>
<td>I was interested while working with Chris.</td>
<td>3.86</td>
<td>.36</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>3.94</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Minimum score = 1; Maximum score = 5

The overall MANCOVA revealed a significant main effect for PALs’ affective response, Wilks’ Lambda = .53, $F (5, 20) = 3.54, p < .05$, partial $\eta^2 =$
Students who worked with the responsive PAL showed significantly higher interest toward the task and the PAL than students who worked with the non-responsive PAL. Hypothesis 2.1 stating that PAL affective response would positively influence interest was supported by the results.

The overall MANCOVA revealed the significance of protected testing for agent gender on interest (\(p < .10\), partial \(\eta^2 = .38\)). However, the univariate results indicating the impact of PAL gender on student interest revealed that only two items out of five were significant (\(p < .05\)). This indicated that the effect of PAL gender on interest might be weak and there was not enough evidence for this effect. Thus, it was concluded that Hypothesis 3.1 stating that male PALs would positively influence learners’ interest was not supported by the results. Table 15 presents the results of the multivariate analysis of covariance test for interest.

<table>
<thead>
<tr>
<th>Source</th>
<th>Wilks’ Lamda</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affect response (A)*</td>
<td>.53</td>
<td>3.54</td>
<td>5</td>
<td>20</td>
<td>.02</td>
</tr>
<tr>
<td>Gender (G)</td>
<td>.62</td>
<td>2.47</td>
<td>5</td>
<td>20</td>
<td>.07</td>
</tr>
<tr>
<td>A × G</td>
<td>.69</td>
<td>1.81</td>
<td>5</td>
<td>20</td>
<td>.16</td>
</tr>
</tbody>
</table>

* significant at \(\alpha < .05\)

**Self-efficacy**

As in Experiment I, learners’ self-efficacy was measured with a questionnaire with three items. Multivariate analysis of covariance was conducted with prior self-efficacy (\(M =3.06, SD = 0.84\)) as a covariate. Table 16 presents the means and standard deviations for the self-efficacy measures from Experiment II.
Table 16  

Means and Standard Deviations for Self-Efficacy Measures II

<table>
<thead>
<tr>
<th>Measures</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Affective response</td>
</tr>
<tr>
<td></td>
<td>Responsive</td>
</tr>
<tr>
<td>I can do instructional planning.</td>
<td>4.11</td>
</tr>
<tr>
<td>I am confident in writing an instructional plan.</td>
<td>3.83</td>
</tr>
<tr>
<td>I am competent in writing an instructional plan.</td>
<td>3.94</td>
</tr>
<tr>
<td>Total</td>
<td>3.96</td>
</tr>
</tbody>
</table>

Minimum score = 1; Maximum score = 5.

The overall MANCOVA revealed a significant main effect for PALs’ affective response, Wilks’ Lambda = .71, $F(3, 31) = 4.29, p < .01$, partial $\eta^2 = .29$. Students who worked with the responsive PAL showed significantly higher self-efficacy than students who worked with the non-responsive PAL. Hypothesis 2.3 stating that PALs’ affective response would positively influence learners’ self-efficacy beliefs in the task was supported by the results. Table 17 presents the results of the multivariate analysis of covariance test for self-efficacy.
Table 17

Multivariate Analysis of Covariance for Self-Efficacy II

<table>
<thead>
<tr>
<th>Source</th>
<th>Wilks’ Lamda</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affect response (A)**</td>
<td>.71</td>
<td>4.29</td>
<td>3</td>
<td>31</td>
<td>.01</td>
</tr>
<tr>
<td>Gender (G)</td>
<td>.84</td>
<td>1.97</td>
<td>3</td>
<td>31</td>
<td>.14</td>
</tr>
<tr>
<td>A × G</td>
<td>.84</td>
<td>1.86</td>
<td>3</td>
<td>31</td>
<td>.16</td>
</tr>
</tbody>
</table>

** significant at $\alpha < .01$.

Agent persona

As in Experiment I, students’ perceptions of agent persona were measured with sub-measures of facilitating learning (4 items), human-like (4 items), and engaging (4 items). The mean scores of each category were calculated for analyses. Multivariate analysis of variance was conducted with the three sub-categories. Table 18 presents the means and standard deviations for the sub-categories of agent persona.

Table 18

Means and Standard Deviations for Agent Persona Measures II

<table>
<thead>
<tr>
<th>Measures</th>
<th>Condition</th>
<th>Affective response</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Responsive</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Facilitating</td>
<td></td>
<td>3.12</td>
<td>.93</td>
</tr>
<tr>
<td>Human-like</td>
<td></td>
<td>3.37</td>
<td>.57</td>
</tr>
<tr>
<td>Engaging</td>
<td></td>
<td>3.67</td>
<td>.61</td>
</tr>
</tbody>
</table>

Minimum score = 1; Maximum score = 5.
The overall MANOVA revealed a significant main effect for PALs’ gender, Wilks’ Lambda = .85, $F(3, 46) = 3.08, p < .05$, partial $\eta^2 = .15$. To identify the contribution of each sub-measure to the overall effects, univariate analyses (ANOVA) were further conducted.

The univariate results revealed a significant main effect for PAL gender on facilitating learning, $F(1, 48) = 3.8, p < .05$. Students who worked with the male PAL ($M = 3.56$, $SD = .64$) perceived the PAL significantly as more facilitating to their learning than students who worked with the female PAL ($M = 3.14$, $SD = .82$). The standardized effect size for this difference was Cohen’s $d = 0.57$, which indicated a medium effect according to Cohen’s guidelines.

The univariate results revealed a significant main effect for PAL gender on human-like, $F(1, 48) = 6.95, p < .05$. Students who worked with the male PAL ($M = 3.59$, $SD = .52$) perceived the PAL as significantly more human-like than students who worked with the female PAL ($M = 3.14$, $SD = .69$). The standardized effect size for this difference was Cohen’s $d = 0.74$, which indicated a medium-large effect according to Cohen’s guidelines.

The univariate results revealed a significant main effect for PAL gender on engaging, $F(1, 48) = 4.11, p < .05$. Students who worked with the male PAL ($M = 3.79$, $SD = .52$) perceived the PAL as significantly more engaging than students who worked with the female PAL ($M = 3.51$, $SD = .43$). The standardized effect size for this difference was Cohen’s $d = 0.59$, which indicated a medium effect according to Cohen’s guidelines. Hypothesis 3.2 stating that male PALs would positively influence learners’ perceptions of agent persona was supported by the results.

There was no significant effect for affective response on agent persona. Hypothesis 2.3 stating that PALs’ affective response would positively influence learners’ perceptions of persona was not supported. There was no interaction effect of affective response and gender on agent persona. Hypothesis 4.1 stating
that PALs’ gender and affect would interact to influence learners’ perceptions of agent persona was not supported by the results. Table 19 presents the results of the multivariate analyses of variance test for agent persona.

Table 19

*Multivariate Analysis of Variance for Agent Persona II*

<table>
<thead>
<tr>
<th>Source</th>
<th>Wilks’ Lamda</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affect response (A)</td>
<td>.90</td>
<td>1.77</td>
<td>3</td>
<td>46</td>
<td>.17</td>
</tr>
<tr>
<td>Gender (G)*</td>
<td>.85</td>
<td>2.72</td>
<td>3</td>
<td>46</td>
<td>.05</td>
</tr>
<tr>
<td>A × G</td>
<td>.98</td>
<td>.29</td>
<td>3</td>
<td>46</td>
<td>.83</td>
</tr>
</tbody>
</table>

* significant at $\alpha < .05$. 
CHAPTER V

DISCUSSION

This section reviews the results in terms of the research hypotheses and discusses the findings in line with previous studies. Limitations and suggestions for future research conclude the section.

The effect of PALs’ affective expression

There were four hypotheses were made regarding the effects of PALs’ affective expression: First, PALs’ affective expression would positively influence learning (Hypothesis 1.1), second, PALs’ positive affect would positively influence learners’ interest in the task and the PAL (Hypothesis 1.2), third, PALs’ positive affect would positively influence learners’ self-efficacy beliefs in the task (Hypothesis 1.3), and last, PALs’ positive affect would positively influence learners’ perceptions of agent persona (Hypothesis 1.4). The results supported only Hypothesis 1.4 that PALs’ affective expression would positively influence learners’ perceptions of PAL persona. Students who worked with the PALs that expressed positive affect perceived the PALs as significantly more facilitating to their learning and more engaging than students who worked with the PALs that expressed negative affect. This result was consistent with human emotion research indicating that students in classrooms placed value on having teachers who showed positive affect (Wong & Dornbusch, 2000). Also, students who worked with the PALs that did not express affect (neutral affect) perceived the
PALs as significantly more facilitating to their learning and more engaging than students who worked with the PALs that expressed negative affect. Overall, these results are supported by a previous study (R. Lewis, 2001). In classrooms, teachers’ expressions of negative emotions were less favorable and associated with learners’ negative affect. Similarly, in the current study, PALs’ negative affect was perceived less favorably than positive and neutral affect.

However, PALs’ affective expression did not influence learning, interest, and self-efficacy. The author speculated that the lack of variations in PALs’ emotional expressions might be a reason. In the current study, the PALs expressed one constant type of affect throughout the instruction — all happy, all sad, or nothing. The learners who were randomly assigned to one affect condition might be less aware of PALs’ emotional states, at least not enough to change their affective and cognitive characteristics. This speculation seems to be plausible when we consider the results for perceived agent persona. The impact of positive and neutral PALs was not distinctive, rather both were perceived favorably. Also, previous studies reporting the motivational impact of agent emotions implemented a full range of emotional variations. For instance, learners showed their preferences for and higher interest in an emotional agent expressing 26 emotional variations (Lester et al., 2000). However, even with the emotional variations, the agent’s emotions did not influence learning. Also, Baylor and students compared an agent who demonstrated positive emotions with an agent who demonstrated evasive emotions in computer-based math instruction for GED students (Baylor, Shen, & Warren, 2004). Their study did not support any impact of agent emotions on learning and motivation. This lack of evidences for the impact of agent affective expression might lead to questioning the value of the implementation of agent affective expression for learning and motivation. In particular, thinking of cost-effectiveness, more rigorous evaluations might be
needed as regards to implementing emotional agents for instructional applications. Future research is invited to validate this skepticism.

The effect of PAL affective response

Four hypotheses were made regarding the main effect of PAL affective response: First, PALs’ affective response would positively influence learning (Hypothesis 2.1), second, PALs’ affective response would positively influence learners’ interest in the task and the PAL (Hypothesis 2.2), third, PALs’ affective response would positively influence learners’ self-efficacy beliefs in the task (Hypothesis 2.3), and fourth, PALs’ affective response would positively influence agent persona (Hypothesis 2.4). The results supported Hypotheses 2.2 and 2.3 expecting the positive impact of PAL affective response on interest and self-efficacy respectively. Students were more interested in the task and the PALs and showed higher self-efficacy beliefs in the task when PALs were responsive to their affect with empathy than when not. These results were parallel with the findings of human emotion research in classrooms. When students understood that their teachers cared about them, the students’ motivation and self-concept were improved (Wong & Dornbusch, 2000). In the same fashion, when the PALs cared about the learners’ emotions by responding with empathy, the learners’ interest and self-efficacy were enhanced.

This positive impact of affective response may provide an important implication for the design of PAL affect for learner motivation. To be effective, PAL affect should be tied in with learners’ affect when possible. Remember the results of Experiment I, which did not support the impact of PAL affective expression on motivation. Rather than being simply a “happy” talking head, a PAL should respond to or deal with learners’ affect and flexibly adapt its affect to learners’ own in order to effect learner motivation.
However, the presence of PAL affective response did not influence learning. This was consistent with the results of Experiment I, which did not support the impact of PAL affective expression on learning. This finding confirms the current knowledge of affective pedagogical agents research, which has supported their motivational impact, but not the impact on learning yet (Ball & Breese, 2000; Lester et al., 2000; Rizzo, 2000; Towns et al., 1998).

The inconsistent impact of PAL affect on motivation and learning might suggest that the implementation of agent emotions be judicious. Typically, in instructional settings, there are different goals and an emphasis, which focus more or less on cognitive skill acquisitions or on affective gains. Given the finding of the current study, PAL affect might be utilized in the context emphasizing motivational changes effectively, but not necessarily in the context where knowledge and skill acquisition matters.

The effect of PALs’ gender

Two hypotheses were made regarding the effect of PAL gender: First, a male PAL would positively impact on interest (Hypothesis 3.1) and second, the persona of a male PAL would be perceived more favorably than that of a female PAL (Hypothesis 3.2). The results of Experiment I supported the significant positive impact of the male PAL on interest and the marginal impact on agent persona. Students who worked with the male PAL showed higher interest in the task and the PAL than students who worked with the female PAL. Also, students with the male PAL tended to perceive the PAL more favorably, e.g., more facilitating to their learning and engaging than students with the female PAL. Experiment II resulted in the positive impact of the male PAL consistently on learners’ perceptions of PAL persona. Students perceived the persona of the male PAL
more favorably than that of the female PAL. That is, the male PAL was perceived as more facilitating to learning, human-like, and engaging.

Incidentally, the statistical results revealed the significant positive impact of the male PAL on learning in Experiment I. Students who worked with the male PAL significantly recalled more than students who worked with the female PAL. In Experiment I, the male PAL was more effective for students’ interest and consistently for learning than the female PAL. The superior impact of the male PAL to the female PAL in the current study is analogous to the previous studies indicating learners’ high motivation toward and favorable perceptions of male pedagogical agents over female agents (Baylor & Kim, 2003a; A. L. Baylor & Y. Kim, 2004a, 2004b).

However, students’ recall scores across the conditions were very low ranging 1.52 (highest) through .65 (lowest) out of the total of 10 points. As a reason for these overall low scores, the author speculated the students’ low motivation toward the activity, which was optional during a regular class session. Thus, the advantage of the male PAL over the female PAL for learning from Experiment I may need to be carefully cited.

The positive impact of the male PAL on students’ interest and recall was not supported in Experiment II. Some speculations can be made regarding the results. First, the demographics of the participants might be a possible reason for the contrasting results between Experiment I and II. Experiment I included more male students (40% of total participants) than Experiment II (20%). Second, the low statistical power of Experiment II due to low enrollment can be another reason. Third, the different results from the two experiments might reflect on the findings of human relations. Men are generally more influential than women (Carli, 2001). Men possess higher level of expert and legitimate power than women, and women generally have greater difficulty exerting influence than men do (Carli, 1999). However, gender difference can be reduced when women temper
their competence with displays of communality and warmth (Carli, 2001). In a similar fashion, the superior influence of the male PAL on interest and learning might be reduced when the PALs demonstrated kind of communality and warmth by expressing empathy to learners’ affect in Experiment II. Overall, the current study confirmed “Media Equation”. As Reeves and Nass (1996) argued, the stereotypic expectations of human relationships in the real world seemed to be applied to PAL-learner relationships.

The interaction effect of PAL affect and gender

Hypothesis 4.1 stated that PALs’ affect and gender would interact to influence learners’ perceptions of PAL persona. The results of Experiment I indicated significant partial interaction effects. The interactions between PAL affective expression and gender on learners’ perceptions of agent persona were significant only in the contrasts between positive versus negative and/or neutral affect conditions. When students worked with the PALs who expressed positive affect, they perceived the male PAL more favorably than the female PAL. However, when students worked with the negative and/or neutral PALs, this interaction was not significant, rather remaining minimal.

In Experiment II, an affect-gender interaction on agent persona was not supported by the results. Affective response did not interact with gender to influence learners’ perception of PAL persona. This result of Experiment II seemed logical, given the results of Experiment I indicating that the interaction between affect and gender was significant only in the contrasts between positive versus negative and/or neutral affect conditions. In Experiment II, the PALs consistently expressed positive affect across the conditions, regardless of the presence or absence of affective response.

Incidentally, the results of Experiment I revealed an interaction trend between affective expression and gender on learner interest. This interaction trend
on interest appeared in the same pattern as on agent persona. When the PALs expressed positive affect, students who worked with the male PAL tended to show higher interest in the task and the PAL than students who worked with the female PAL. However, the interaction trend was not noticeable in the negative and/or neutral conditions. Table 20 presents the summary of the results of the hypothesis tests.

Table 20

Summary of Hypothesis Testing

<table>
<thead>
<tr>
<th></th>
<th>Affective expression (Exp I)</th>
<th>Affective response (Exp II)</th>
<th>Gender</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Exp I</td>
<td>Exp II</td>
</tr>
<tr>
<td>Learning</td>
<td>NS</td>
<td>NS</td>
<td>$S^{**}$ ($M&gt;F$)</td>
<td></td>
</tr>
<tr>
<td>Interest</td>
<td>NS</td>
<td>$S^*$ ($Res&gt;NonR$)</td>
<td>$S^*$ ($M&gt;F$)</td>
<td>NS</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>NS</td>
<td>$S^*$ ($Res&gt;NonR$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agent persona</td>
<td>$S^{***}$ ($Posi &gt; Neg$) ($Neu &gt; Neg$)</td>
<td>NS</td>
<td>ME ($M&gt;F$)</td>
<td>$S^*$ ($M&gt;F$)</td>
</tr>
</tbody>
</table>

1. S: significant effect, ME: Marginal effect ($p = .07$), NS: no significant effect.
2. *: $p < .05$, ** $p < .01$, *** $p < .001$.
3. Shaded areas: not hypothesized.

The significance of the current study might be that the study examined the impact of the specific aspects of PAL affect by separating out affective expression and response and the interaction effects with PAL gender. To summarize the results, PALs’ expression of positive affect impact on learners’ perception of PAL persona positively. PALs’ response to learners’ affect enhanced learner motivation (interest and self-efficacy). Male PALs positively influenced students’
recall of learning, interest, and their perceptions of PAL persona in Experiment I. Lastly, PAL affective expression interacted with PAL gender to influence PAL persona and, partially, interest as well. Overall, the study confirmed the findings of previous studies on human emotion, human relations, human-computer interaction, and pedagogical agents. With the findings of the study, the researcher wishes to provide implications in the design of effective PALs and to contribute to the knowledge bases of multiple communities, such as educational technology, human-computer interaction, intelligent tutoring systems, educational psychology, and so on.

Limitations and Recommendations

There were some limitations in the study. First, affective experience is a feeling state known only to the individual; thus, the best way to really measure experience is to ask people to think about their feeling states (Brody, 1999). However, Brody also points out that people may not want to articulate socially unacceptable feelings to others. The measurement of interest and self-efficacy in the current study was somewhat limited because it relied solely on the participants’ self-reports. Second, the number of participants in Experiment II was limited due to low course enrollment. This resulted in low statistical power, which was sensitive only to large mean differences across the conditions. Third, students’ answers to the application question in Experiment II were not included for analysis due to the large number of missing data, which was problematic. Fourth, the study was conducted by two one-time implementations taking about 30 minutes and one hour each. Continuous implementations and longer durations may or may not produce consistent results.

Given the findings and limitations, future research is invited to replicate the current study. First, the study was grounded on social interactions, which might need mutual engagement of PALs and learners. Learner characteristics,
such as age, gender, or academic ability, may or may not interact with PAL affect and gender. Especially, it would be interesting to see whether the advantage of male PALs shows up with younger learners. Thus, it might be worthwhile re-examining the variables of the current study together with varying learner characteristics. Second, studies that indicated the motivational impact of pedagogical agents tended to be conducted on a short-term basis; however, it is open to question whether the impact of PALs on motivation would sustain in the long term. Lastly, PALs can be a test-bed to examine the ways to crack stereotypic expectations associated with gender. Compared to humans, PALs are easy to be manipulated according to research constructs of interest. The findings of research on PALs can provide implications for studies on human relations.
APPENDIX A: SCREENSHOTS OF APPLICATIONS

Experiment 1: E-Learn

<table>
<thead>
<tr>
<th>Log-on</th>
<th>Task Introduction</th>
</tr>
</thead>
</table>

System Navigation

Stage 1: INTRO

Stage 2: GOALS

Stage 3: PLANNING
Experiment 2: MIMIC

<table>
<thead>
<tr>
<th>Log-on</th>
<th>Task Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Log-on" /></td>
<td><img src="image2" alt="Task Introduction" /></td>
</tr>
</tbody>
</table>

**System Navigation**

**Orientation**

**Case Study**

**Emoticons**

---

98
<table>
<thead>
<tr>
<th>Stage 1: Blueprints</th>
<th>Stage 2: Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Blueprints Image" /></td>
<td><img src="image2" alt="Plan Image" /></td>
</tr>
</tbody>
</table>

**Blueprints**

*Stage 1: Blueprints*

1. **Stage 1:** This stage is the first step in the process. It involves creating a blueprint. It is where you start planning the project.

2. **Stage 2:** This stage involves preparing the plan. It is where you design the project in detail.

3. **Stage 3:** This stage focuses on assessment. It involves evaluating the project.

**Plan**

*Stage 2: Plan*

1. **Stage 1:** This stage is the first step in the process. It involves creating a plan. It is where you start planning the project.

2. **Stage 2:** This stage involves preparing the plan. It is where you design the project in detail.

3. **Stage 3:** This stage focuses on assessment. It involves evaluating the project.

**Assessment**

*Stage 3: Assessment*

1. **Stage 1:** This stage is the first step in the process. It involves creating an assessment. It is where you start evaluating the project.

2. **Stage 2:** This stage involves preparing the assessment. It is where you design the assessment.

3. **Stage 3:** This stage focuses on evaluation. It involves evaluating the project.

**Affective Response**

*Stage 4: Affective Response*

1. **Stage 1:** This stage is the first step in the process. It involves creating an affective response. It is where you start responding to the project emotionally.

2. **Stage 2:** This stage involves preparing the affective response. It is where you design the affective response.

3. **Stage 3:** This stage focuses on evaluation. It involves evaluating the project emotionally.
## APPENDIX B: PAL SCRIPTS

### Experiment I: Scripts for the Positive PAL

<table>
<thead>
<tr>
<th>Phase</th>
<th>Section</th>
<th>Script</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Intro</td>
<td>Intro) Hi There! My name is Chris (Kris). We’re in a lesson design team together. I’ll be your teammate to work with you on changing a regular course to an E-Learning course. I’m so happy I am working with you! I’ve already read a lot on the subject. Click on the Course Notes button below to see how a former teacher, Mike, taught this class.</td>
</tr>
<tr>
<td></td>
<td>Course Notes</td>
<td>I guess that Mike did what most teachers do. He relied on his face-to-face interactions with the students to make the course relevant to them. In E-Learning this can’t be done. Students just can’t interact with a computer as they can with a face-to-face teacher.</td>
</tr>
<tr>
<td></td>
<td>Initial</td>
<td>It’s time to get started!! I know you can do this! I think this is going to be fun! Click on the links below when you would like some more of my ideas. When you’re done here, click the “Planning E-Learning” button.</td>
</tr>
<tr>
<td></td>
<td>Observation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Goals</td>
<td>What are instructional goals?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hmm…This is interesting!! For instructional goals, we may first need to state what we want the students to learn from the course. If we first specify the goals on what the students should learn, our e-learning course will not get off track, right?</td>
</tr>
<tr>
<td>Goals</td>
<td>How to write goals?</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>Actually, I’ve read about how to write goals. One acronym I learned was ABD: Audience, Behavior, and Degree. Audience is the learners, Behavior is the learners’ action, and Degree means how well the learner did the class. I’m sure you can remember this. Just keep focusing! So, in our example, the audience is freshmen learners, right? What’s the behavior that we want from the students in the e-learning course? Also, degree is how well the students have to do the behavior. Remember? It’s that acronym I talked about! ABD! It’s not enough to state that students just “learn” time management. It may have to focus on specific actions like this example: “The student has to use his calendar effectively.” I find this example really useful to me! I bet it’ll help you too!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planning</th>
<th>Initial Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>It seems that the purpose here is to write an E-Learning plan for the Time Management course. We can make a course teaching plan in several steps. You are doing great so far! Keep up the good work! Click the links below when you would like some more of my ideas. When you’re done here, click the “Exit” button</td>
<td></td>
</tr>
</tbody>
</table>
### How to write eLearning plans?

Hmmm… I’ve learned from my readings that we should have a good lesson sequence for effective teaching. First, how about starting with introducing our course goals to the students? Next, Let’s describe ways of finding out what the learners already know about time management and how that will be reviewed. Then, let’s describe how the new information will be presented. And last, let’s describe the activities and assignments the students will complete. We have roughly four steps. Ok, four steps. I know we can remember this! This is just common sense!

### How to include activities in eLearning?

Activities in E-learning may include interactions through chat rooms, discussion boards, e-mails, animations, questions/answers, and simulations. You know, I bet you’re going to do a great job creating this plan!

### Exit

This will take you to the exit survey. Are you sure you’re ready to exit?

Well, I gotta go! I sure enjoyed working with you! Bye!
## Experiment I: Scripts for the Negative PAL

<table>
<thead>
<tr>
<th>Phase</th>
<th>Section</th>
<th>Script</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Intro</td>
<td>Hi There! My name is Chris. We’re in a lesson design team together. I’ll be your teammate to work with you on changing a regular course to an E-Learning course. You know, I don’t really want to, but I can work with you. I’ve already read some on the subject. Click on the Course Notes button below to see how a former teacher, Mike, taught this class.</td>
</tr>
<tr>
<td></td>
<td>Course Notes</td>
<td>I guess that Mike did what most teachers do. He relied on his face-to-face interactions with the students to make the course relevant to them. In E-Learning this can’t be done. Students just can’t interact with a computer as they can with a face-to-face teacher.</td>
</tr>
<tr>
<td></td>
<td>Initial Observation</td>
<td>(Sigh) Time to get started!! I don’t know...Maybe you can do this. Maybe you’ll think it’s fun. Click on the links below when you would like some more of my ideas. When you’re done here, click the “Planning E-Learning” button</td>
</tr>
<tr>
<td>Goals</td>
<td>What are instructional goals?</td>
<td>Ohhh.. This sounds complicating. For instructional goals, we may first need to state what we want the students to learn from the course. If we first specify the goals on what the students should learn, our e-learning course will not get off track, right?</td>
</tr>
</tbody>
</table>
### Goals

How to write goals?

Actually, I’ve read about how to write goals. One acronym I learned was ABD: Audience, Behavior, and Degree. Audience is the learners, Behavior is the learners’ action, and Degree means how well the learner did the class. That’s a lot to remember. [sigh] Oh, well. . .

So, in our example, the audience will probably be freshmen learners. What’s the behavior that we want from the students in the e-learning course? Also, degree is how well the students have to do the behavior. I guess we should try to do this. [sigh] Ok. What was that acronym again? Oh yeah – ABD.

It’s not enough to state that students just “learn” time management. I think they should focus on specific actions, like this example: “The student will be able to use his calendar effectively.” Hmm. Maybe I can use this example. [sigh] What a drag.

### Planning

Initial Observation

It seems that the purpose here is to write an E-Learning plan for the Time Management course. We may be able to make a course teaching plan in several steps. Is this the best you can do?. [sigh] Well, just keep plugging away.

Click the links below when you would like some more of my ideas. When you’re done here, click the “Exit” button.
## Planning

**How to write eLearning plans?**

Well… I’ve learned from my readings that we should have a good lesson sequence for effective teaching. First, how about starting with introducing our course goals to the students? Next, let’s describe ways of finding out what the learners already know about time management and how that will be reviewed. Then, let’s describe how the new information will be presented. And last, let’s describe the activities and assignments the students will complete. We have roughly four steps. Hmmm. Four steps. This is just too hard.

## Activities in eLearning

**How to include activities in eLearning?**

Activities in E-learning may include interactions through chat rooms, discussion boards, e-mails, animations, questions/answers, and simulations. I guess you might do ok on this plan.

## Exit

**Exit**

This will take you to the exit survey. Are you sure you’re ready to exit?

Well, I gotta go! I sure enjoyed working with you! Bye!
**Experiment I: Scripts for the Neutral PAL**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Section</th>
<th>Script</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>Intro</td>
<td>Hi There! My name is Chris. We’re in a lesson design team together. I’ll be your teammate to work with you on changing a regular course to an E-Learning course. I’ve already read a lot on the subject. Click on the Course Notes button below to see how a former teacher, Mike, taught this class.</td>
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<td></td>
<td>Course Notes</td>
<td>I guess that Mike did what most teachers do. He relied on his face-to-face interactions with the students to make the course relevant to them. In E-Learning this can’t be done. Students just can’t interact with a computer as they can with a face-to-face teacher.</td>
</tr>
<tr>
<td><strong>Goals</strong></td>
<td>Initial Observation</td>
<td>Time to get started. Click on the links below when you would like some more of my ideas. When you’re done here, click the “Planning E-Learning” button</td>
</tr>
<tr>
<td></td>
<td>What are instructional goals?</td>
<td>Hmm… For instructional goals, we may first need to state what we want the students to learn from the course. If we first specify the goals on what the students should learn, our e-learning course will not get off track, right?</td>
</tr>
</tbody>
</table>
### Goals

<table>
<thead>
<tr>
<th>How to write goals?</th>
</tr>
</thead>
</table>
| Actually, I’ve read about how to write goals. One acronym I learned was ABD: Audience, Behavior, and Degree. Audience is the learners, Behavior is the learners’ action, and Degree means how well the learner did the class.

So, in our example, the audience is freshmen learners, right? What’s the behavior that we want from the students in the e-learning course? Also, degree is how well the students have to do the behavior.

It’s not enough to state that students just “learn” time management. It has to focus on specific actions like this example: “The student will be able to use his calendar effectively.” |

### Planning

<table>
<thead>
<tr>
<th>Initial Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>It seems that the purpose here is to write an E-Learning plan for the Time Management course. We can make a course teaching plan in several steps. Click on the links below when you would like some more of my ideas. When you’re done here, click the “Exit” button</td>
</tr>
</tbody>
</table>
## How to write eLearning plans?

Hmmm… I’ve learned from my readings that we should have a good lesson sequence for effective teaching. First, how about starting with introducing our course goals to the students? Next, let’s describe ways of finding out what the learners already know about time management and how that will be reviewed. Then, let’s describe how the new information will be presented. And last, let’s describe the activities and assignments the students will complete. We have roughly four steps.

<table>
<thead>
<tr>
<th>Planning</th>
<th>How to include activities in eLearning?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Activities in E-learning may include interactions through chat rooms, discussion boards, e-mails, animations, questions/ answers, and simulations.</td>
</tr>
</tbody>
</table>

### Exit

This will take you to the exit survey. Are you sure you’re ready to exit?

Well, I gotta go! I sure enjoyed working with you! Bye!
**Experiment II: Generic scripts**

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Hey, glad you could make it. I’m Chris. I’ll be your teammate to work with you on instructional planning. I’ve already read a lot on the subject. Click on me when you would like some more of my ideas.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Study</td>
<td><strong>Initial Observation</strong></td>
</tr>
</tbody>
</table>
| Anna’s Homework | 1. ‘Supply and Demand’ certainly is not an easy topic, and economics isn’t exactly my favorite subject, but it can matter so much in the real world!  
2. It looks to me like she didn’t really “get it” While she could correctly determine what happens when demand equals supply, she had definite problems explaining the basic underlying concepts. Further, she had difficulty seeing how the two concepts interrelate, as evident in her answers to questions 1 and 2.  
3. What do you think about that? Do you agree that those seem to be the major problems in her understanding? |
| Concept Notes | Aha! It’s clear Mr. Lange understands the basic concepts of supply and demand. But knowing is one thing and teaching is another. Let’s figure out how we can make these concepts understandable to Anna. Ya know, I’m sure we’ll do great work together! |
| Illustration | 1. Sometimes a picture is worth a thousand words! Do you agree that it helps to make better sense of the concepts, especially how they interrelate? But, as I’m sure you know, providing the illustration alone won’t be enough for the students to learn.
2. What do you think about taking the approach where we get the students to have first a deep and meaningful understanding of each concept, and then putting them together like the illustration? |
|--------------|-------------------------------------------------------------------------------------------------|
| Blueprints   | **Initial Observation**
Wooaa… Time to get started! Here we want to list exactly what we want Anna to learn. Hmmmm. This feels a little overwhelming at first but I like a good challenge! Click on me when you would like some more ideas. |
| Why do this? | 1. Do you have any idea why writing goals and objectives is a good idea? We could just start planning the lesson, but this could be a problem. I remember the days when I was a student. Some teachers never seemed to be clear about what they wanted us to learn. They wound around across topics, and we were totally lost!
2. We can’t let our lesson be like that! Let’s make our goals and objectives as specific and as clear as possible. This will keep our lesson focused and on track! |
| How to get started? | 1. Let’s see. Maybe we could start by just writing down what we want Anna to be able to do after learning Supply and Demand.
2. Let’s also check out the Texas standards and benchmark links as they may give us ideas. |
| **What should it look like?** | 1. One acronym for writing goals and objectives is ABCD. A equals Audience, B equals Behavior, C equals Condition, and D equals Degree.  
2. So, in our example, the audience is Anna and her classmates. How about the behavior that we want from Anna and her classmates? So what conditions should we expect the learners to be in when they do the behavior? Looks like degree is how well the learner has to do the behavior. Got any ideas on how well the learner has to do it here?  
3. Ok. So, audience, behavior, condition, degree. Hey! That’s A B C D! We can remember that! Don’t we do good work together?!  
4. Here are some examples of objectives  
   1) With the aid of the text, the seventh graders can correctly list at least four causes of the Civil War.  
   2) Given ten questions, a fifth grader in social studies will match each general with his battle with no errors. |

| **Plan** | **Initial Observation** | Wow! We entered a new phase. It would be fun if we successfully solve this new task. The purpose here is to write the plan of activities for Anna. Alright - Let’s do it! Click on me when you would like some more ideas. |

| **Why develop an instructional plan?** | 1. You know, when you get a new MP3 player, you probably follow the user manual instructions or, at least you should, to make it easier to program!  
2. That’s the same thing we’re doing, providing Mr. Lange with a good “manual” to teach “Supply and Demand” to Anna. This way it’ll help him focus his instruction. |
### How to plan instruction?

1. Man, making an instructional plan isn’t that easy, but it is clearly important.
2. Consider classes you have taken where the teacher kept your attention and made sure that you could remember what you had already studied and then she would clearly present activities to learn the new information—and it made sense!
3. She always made sure that you got to practice what you’d learned and she’d give you really useful feedback on our practice. Not only that, she’d summarize everything so you would be reminded of the important points one more time.
4. What a great class! I bet you really learned the material! Ok-so how about using these experiences to get started!

### Other considerations?

1. For a good plan it is critical that the teacher doesn’t overwhelm the students with too much information, and also that the interest of the students is maintained.
2. You know, when I think of my best college teacher, he motivated me all the time. Yeah! He challenged me, didn’t overwhelm me with information, and he always kept me interested in learning and doing my best! I bet you had an experience like I did!
3. So, if we make this instruction just like our favorite classes, then Anna will have a great learning experience, too!

### Assessment

**Initial Observation**

Well, we made it!! We’re at the final step of developing the instruction. Click on me when you would like some more ideas.
<table>
<thead>
<tr>
<th>Why develop an assessment?</th>
<th>This part of the plan is especially relevant cause it is the only way to know if Anna actually learned what we wanted her to learn! Without this part, we’d never know if we were successful! Here we get to find out whether Anna achieved the specific instructional goals that we set earlier.</th>
</tr>
</thead>
</table>
| What should the assessment look like? | 1. This part’s hard for me. I bet you’ll figure out how to do this a lot faster than I did.  
2. The goal of assessment is to test a student in the best way possible to see if she understands the material. There are lots of ways to figure out if a student knows the material. But first, I know we have to match our test questions with our objectives so we can show that Anna learned the material.  
3. Hmmm… Let’s see. If you were taking a computer class on how to use Microsoft Word, would it be better to take a paper test to show you know it, or to demonstrate your ability using MS Word on the computer? Yeah, this was just a really simple example. But I bet you can figure out how to create the right assessment for the material you are teaching. |
| Exit | Well, I gotta go! I sure enjoyed working with you! You really know your stuff! You’ll be an excellent teacher! Good luck! |
Experiment II: Scripts for affective response

Interest:
- Great! I’m so glad you’re finding this interesting!
- I’m glad you like this stuff!
- I guess this is relevant to you, huh?

Boredom:
- Hang in there! It’ll be better soon!
- It’s ok to be bored. Just yawn and keep on going!
- Everyone gets bored sometimes. Can you do anything to make it less boring?

Confidence:
- I am SO glad you feel good about this!
- Great! What a good feeling to be confident in something important like this!
- How great! You’re getting it! Keep up the good work!

Anxiety:
- Everyone gets anxious about stuff they’re learning from time to time. Just hang in there!
- You can do this! Just keep working on it and you’ll get through it!
- Don’t worry. You’re gonna do fine. Just don’t give up!

Satisfaction:
- It feels good to do a job well, doesn’t it?
- I’m so glad you’re happy with what you’re doing!
- Obviously you’ve done a good job. Congrats!

Frustration:
- I can understand why you’re frustrated, but you can do it!
- I would be frustrated too if I were just learning this for the first time. Don’t give up!
- Don’t let the frustration get you down. Just keep going, ok?
APPENDIX C: INSTRUMENTS

**Interest Measures**

Respond to the following statements indicating the strength of your agreement/disagreement with the statement. Remember that there are no right or wrong responses.

<table>
<thead>
<tr>
<th>1 = Not at All, 2 = Little, 3 = Neutral, 4 = A Little, 5 = Very Much</th>
<th>NA</th>
<th>L</th>
<th>N</th>
<th>AL</th>
<th>VM</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much are you interested in designing a lesson plan for E-learning?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>How much are you interested in learning about designing a lesson plan for E-learning</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree</td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>I was interested while doing the task.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I was attentive while doing the task.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I was absorbed while doing the task.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I was interested while working with Chris.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>I was attentive while working with Chris.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
## Self-Efficacy Measures

Respond to the following statements indicating the strength of your agreement/disagreement with the statement. Remember that there are no right or wrong responses.

1 = Not at All, 2 = Little, 3 = Neutral, 4 = A Little, 5 = Very Much

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>How well can you write a lesson plan for E-learning?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How sure are you that you can design a good lesson plan for E-learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can write a lesson planning for E-learning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am confident in designing a lesson plan for E-learning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am competent in designing a lesson plan for E-learning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Agent Persona Measures

Respond to the following statements indicating the strength of your agreement/disagreement with the statement. Remember that there are no right or wrong responses.

1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree

<table>
<thead>
<tr>
<th>Facilitating learning:</th>
<th>SD 1</th>
<th>D 2</th>
<th>N 3</th>
<th>A 4</th>
<th>SA 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>The agent led me to think more deeply about the presentation.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
<td></td>
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<tr>
<td>The agent encouraged me to reflect what I was learning.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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<tr>
<td>The agent kept my attention.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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<tr>
<td>The agent presented the material effectively.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Human-like:</th>
<th>SD 1</th>
<th>D 2</th>
<th>N 3</th>
<th>A 4</th>
<th>SA 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>The agent has a personality.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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<tr>
<td>The agent's emotion was natural.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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<tr>
<td>The agent was human-like.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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<tr>
<td>The agent showed emotion.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Engaging:</th>
<th>SD 1</th>
<th>D 2</th>
<th>N 3</th>
<th>A 4</th>
<th>SA 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>The agent was expressive.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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<tr>
<td>The agent was enthusiastic.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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<tr>
<td>The agent was motivating.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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<tr>
<td>The agent was friendly.</td>
<td>☐ ☐ ☐ ☒ ☒</td>
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</tbody>
</table>
APPENDIX D: HUMAN SUBJECT APPROVAL MEMORANDUM

Florida State University
Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2783
(850) 644-6073 · FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 4/30/2004

To: Yanghee Kim
8332 Chickasaw Trl.
Tallahassee, FL 32312

Dept: EDUCATIONAL PSYCHOLOGY AND LEARNING SYSTEMS

From: John Tomkowiak, Chair

Re: Use of Human Subjects in Research
Pedagogical Agents as Learning Companions: The Effects of Affect and Gender on Learning, Interest, Self-efficacy, and Agent Perceives

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Secretary, the Chair, and two members of the Human Subjects Committee. Your project is determined to be Exempt per 45 CFR § 46.101(b) 2 and has been approved by an accelerated review process.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If the project has not been completed by 4/29/2005 you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to assure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000446.

Cc: Amy Beylor
HSC No. 2004.336
APPENDIX E: INFORMED CONSENT FORM

Dear student,

Yanghee Kim, a PhD candidate in the College of Education requests your participation in a research study at FSU entitled “Pedagogical agents as learning companions: The effect of affect and gender on learning, interest, self-efficacy, and agent persona.” The purpose of the research is to investigate the effectiveness of using computerized characters (pedagogical agents) with a human peer metaphor. Participants of this course have been selected due to the fact that the content of the course reflects computer-based instructional applications.

The activities for which data will be collected involve using a computer program and answering questions regarding your use of instructional strategies and your attitude and motivation to use the pedagogical agents for your learning. You have the choice to participate in the activities, which will take about 30 minutes. However, you must be at least 18 years old to participate. The activities will not affect your course grade. There are minimal risks if you agree to allow your data to be used as part of this research. However, you are free to choose not to allow your data to be included.

The possible benefits of your participation in this research study are increased knowledge about using advanced technology to help improve learning. Further, your participation allowing your data to be used will contribute to the development of strategies for improving the effective use of pedagogical agents (computerized characters).

The researcher will maintain confidentiality of your records to the extent allowed by law. The data will be kept in a locked cabinet, removed any master list containing any information regarding participant identification. Participants will be identified by computer-generated id numbers. Any other personal information will be traceable. The results of this research may be published but not reveal your name or identity.

Any questions you have concerning the research study or your participation in it, before or after your consent, will be answered by Yanghee Kim, 307 Stone Building, 644-0149 and by her major professor, Amy L. Baylor, 307 Stone Building, 644-5203. Or if you have questions about your rights as a participant in this research, you can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Office of the Vice President for Research, at 644-8633.

By signing this form, you indicate that you have read the above informed consent form and understand that you may withdraw your consent and discontinue participation at any time without penalty or loss of benefits to which you may otherwise be entitled. In signing this consent form, you are not waiving any legal claims, rights or remedies. A copy of this consent form will be offered to you.

Participant’s Signature __________________________ Date __________________________
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Yanghee Kim was born and raised in Kwangju, a southwestern city of South Korea. She earned a Bachelor of Arts degree in Teaching English as a Foreign Language from Chonnam National University in 1987 and a Master of Arts in Educational Technology from the same university in 1998. She held multiple positions as a professional educator for 13 years in Korea and was an English teacher in a variety of school settings in addition to serving as an administrative officer of the school. Teacher training in Korea is a bit different from teacher preparation in the United States, in which each district has its own teacher training center. As an advanced teacher, Ms. Kim was appointed to be an in-service teacher trainer for the Kwangju Teacher Training Center. During this period, her persistent interest was in integrating educational technology into classrooms in a way that substantially benefit K-12 learners. She actively shared her experiences in running classroom technology with pre- and in-service teachers through a variety of teacher preparation programs and model lessons.

During this time, Ms. Kim realized that the application of educational technology should be based on theoretical foundations and rigorous empirical research. She therefore decided to pursue a career as an educational researcher and joined the doctoral program in Instructional Systems at Florida State University, where she met her major professor, Dr. Amy L. Baylor. Based on Dr. Baylor’s encouragement, Ms. Kim began working in Pedagogical Agents Learning Systems Lab, funded by the National Science Foundation. At this lab,
they investigate various characteristics of pedagogical agents, such as instructional roles, personal characteristics, and media features.

During her studies in the IS program at FSU, Ms. Kim was awarded Gagne/Briggs Outstanding Doctoral Student Award, Ruby Diamond Future Professor Award, and Liliana Muhlman Masoner Outstanding International Student Award by the Department of Educational Psychology and Learning Systems at FSU in the year of 2004. In 2003, she was awarded ECT Foundation Mentorship Endowment Award by the Association of Educational Communication and Technology. Ms. Kim has accepted a position as Assistant Professor in the Department of Instructional Technology at Utah State University and will begin work there in August, 2004.