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# A Virtual Change Agent: Motivating Pre-service Teachers to Integrate Technology in Their Future Classrooms

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## ABSTRACT

In this paper, we develop a conceptual framework for an anthropomorphic change agent to motivate pre-service teachers to integrate technology into teaching and learning. This agent is designed with a hybrid persona that simulates a mentor and plays both motivation and companion roles. Based on the theoretical grounding in motivation and change agency and related research, we propose that a computer-based change agent will impact pre-service teachers' attitudes toward technology integration and improve their abilities to be effective users of educational technology. The impact on learning and instruction is explained as a process of changing perceptions and concerns about the value of using technology to support their learning. We build on models of innovation-decision processes and attributes of adoption of innovation and concern-based adoption. Practical considerations for the design of a virtual change agent are provided with respect to appearance, voice and emotional expression. Further research is also discussed, especially regard to empirical validation of specific components of the framework and longitudinal studies of teacher attitudes.

## Keywords

Change agent, Learning companions, Motivation, Persuasive technologies, Pedagogical agent, Technology integration, Social computing, Virtual change agent

In the last 20 years, technological advances have resulted in new opportunities to use technology to improve learning and instruction. As a result, there is an increasing demand on teachers to develop the skills to make effective use of technology (Ertmer, Conklin, Lewandowski, Osika, Selo, & Wignall, 2003). Much technology has been placed in schools such as computers, educational software, etc., and much training for teachers' skills and knowledge of teaching with technology has been provided. Despite these efforts, many teachers still do not integrate technology effectively even when they have the technology and initial training (Beavers, 2001; Hope, 1998). This situation is attributed to a variety of factors, including lack of proper teacher education (Ward, West, & Isaak, 2002). Researchers have suggested that teacher education with regard to technology integration should go well beyond teaching technical skills. Specifically, training and education should take into account teacher motivation regarding the use of technology (Llorens, Salanova, & Grau, 2002).

Pre-service teacher education provides fundamental experience for the use of technology (Thompson, Schmidt, & Davis, 2003). Our focus is on issues involving pre-service teacher motivation (Doering, Hughes, & Huffman, 2003). Time and curriculum constraints in pre-service teacher training courses often limit an instructor's ability to provide support beyond introduction to and limited use of specific technologies. Methods to supplement the instructor's supportive role are needed. Methods of support such as mentoring and networking among teachers have been studied (Ward et al., 2002; Weidmann & Humphrey, 2002). However, these human-mediated supports are not always accessible or convenient. Therefore, pedagogical agents – animated human-like computer interface characters designed to facilitate learning – may be a potential solution in cases where human resources are not available (Baylor, 2001). The use of such agents to provide additional support for technology integration in pre-service teacher education is the specific focus of this paper.

*Pedagogical agents* respond to the learner in a social manner through human-like interactions (Kim & Baylor, 2006b). The human-like characteristics of pedagogical agents are advantageous for enhancing more positive and vivid interactions with pre-service teachers. In addition, pedagogical agents may also be perceived as empathetic, credible and trustworthy, positioning them to serve as effective agents of change. When pedagogical agents are perceived as empathetic, credible and trustworthy, they have been demonstrated to be effective in influencing attitudes (Baylor & Plant, 2005; Ryu & Baylor, 2005).

In situations where the adoption of an educational innovation is a desired outcome, the concept of a *change agent* is relevant (Fullan & Stiegelbauer, 1991; Rogers, 1995). A change agent is generally an individual who facilitates the

diffusion of an innovation for potential adopters (Rogers, 1995). The concept of a change agent has been highlighted in the context of educational technology innovations (Ellsworth, 2000; Huberman & Miles, 1984). However, most of the research has focused on the effects of a human as a change agent and has not considered the problem of insufficient human resources.

"Situational dependency" (Silverman et al., 2001, p.227) suggests that pedagogical agents are helpful when there is a need to increase companionship and decrease complexity. A pedagogical agent, then, would be valuable as a change agent in the context of educational technology integration given that it can provide virtual human companionship and can help decrease the perceived complexity of technology integration.

A variety of roles and functions of pedagogical agents have been studied. Four major roles for pedagogical agents have been identified: (a) an expert who provides information, (b) a mentor who advises, (c) a motivator who encourages, and (d) a companion who collaborates (Baylor & Group, 2003; Baylor & Kim, 2005; Kim & Baylor, 2006a, 2006b). Many studies investigating pedagogical agents have focused on their impact on learning outcomes. Even in studies where positive effects on motivation were observed, motivational changes were considered secondary to learning outcomes and were not often studied independently (Ryu & Baylor, 2005). Recently motivational outcomes have been receiving more attention, and studies have shown that pedagogical interface agents can be effective in promoting motivation and attitude change (Baylor & Plant, 2005; Moreno et al., 2002; Moreno, Mayer, Spires, & Lester, 2001; Silverman et al., 2001). However, few studies focus specifically on motivation. In addition, despite the fact that pedagogical agents can be designed with specific characteristics beneficial for learners, there have been few attempts to study pedagogical agents that incorporate multiple roles or functions (Baylor & Ebbers, 2003). Instead, studies have tended to focus on agents with single and separate roles.

Given the limitations of prior research and the need for facilitating teacher motivation, this paper proposes a Virtual Change Agent (VCA) to improve pre-service teachers' attitudes towards technology integration. A VCA constitutes a blend of agent roles, including mentor, motivator and companion. For a VCA the expert-like characteristics are less relevant because pre-service teachers already have an instructor who plays the role of an expert. In discussing VCAs to motivate pre-service teachers to integrate technology, we address the following questions: (a) How could a pedagogical agent effectively play the role as a change agent? (b) What characteristics of a pedagogical agent would enable this role? (c) What theories, models and empirical research support the use of a VCA? and, (d) What design aspects should be considered to optimize the characteristics of a VCA? To investigate these questions, we examine established models of innovation adoption together with empirical studies on pedagogical interface agents. Our purpose is to elaborate a framework for a VCA to motivate pre-service teachers to effectively integrate technology into their classrooms.

## A Virtual Change Agent (VCA)

A VCA should incorporate the roles of mentor, motivator and companion. As a mentor, a VCA should guide and coach learners as well motivate students and stimulate reflection as in Multiple Intelligent Mentors Instructing Collaboratively (MIMIC; see Baylor, 2002; Baylor & Kim, 2005). As a motivator, a VCA encourages learners to perform a task and sustain at the task (Baylor & Kim, 2005). As a companion, a VCA accompanies learners in an empathic relationship throughout their learning processes (Kim & Baylor, 2006a). These companion characteristics are consistent with the characteristics of a motivator agent developed in MIMIC where the agent serves as a *coping model* and models solving a difficult learning task to enable an empathic relationship with the learners (Baylor & Kim, 2005).

These selected characteristics of a pedagogical agent as a mentor, motivator and companion enable the change agent to function as indicated by Rogers (1995) to:

- Match the pre-service teacher's need;
- Deal with the problem of information overload;
- Select the most relevant message for the individual;
- Establish relationships with pre-service teachers by being perceived as credible, competent, and trustworthy;
- View the situation empathically from their perspective;
- Seek to motivate their interests in technology integration;

- Stabilize new behavior through reinforcing messages; and
- Develop their ability to be their own change agents.

The characteristics of a VCA are operationally defined to include: a) a *mentor* to guide and coach pre-service teachers in developing their ability to be their own change agents by responding to individual needs and situations; b) a *motivator* to encourage them to integrate technology by relating technology integration to their situation and interest and providing reinforcing messages; and c) a *companion* to collaborate by establishing and maintaining credible, competent, and trustworthy relationships.

What justifies the inclusion of these three roles in a VCA? Pre-service teachers require a change agent who facilitates their adoption of technology innovation – a change agent who can perform the functions indicated in the list above can satisfy this requirement. Using technology for educational purposes is, surprisingly, an innovation for pre-service teachers, and it requires integrating technology into curricula (Doering et al., 2003). Teachers see technology as an important *educational* innovation. This attitude is quite different from the ways that teachers have been taught to use technology for such purposes as email, Internet searches, document production, and so on.

Pre-service teachers already have an instructor from whom, as an expert, they can obtain knowledge about the educational technology innovations; it is not necessary, therefore, to implement expert functionality in the VCA. What is needed is a change agent who can influence their *motivation*, not just their technical skills and knowledge. Further, an important feature of a change agent is *homophily*, which is the degree of similarity between a change agent and the adopters (pre-service teachers in this case), as this impacts the adopters' motivation (Rogers, 1995). This suggests that the VCA should possess abilities and attributes similar to those of the pre-service teachers. This concept is of importance with respect to designing the physical appearance of the agent.

Well-known models of the diffusion of innovation are examined next, including the innovation-decision process model, the attributes of adoption of innovation model, and the concern-based adoption model. These models provide a conceptual basis to support the use of a VCA to motivate pre-service teachers to integrate technology.

## Conceptual Frameworks for a Virtual Change Agent (VCA)

### Motivation for Change

The use of educational technology is typically an innovation for pre-service teachers since it is different from their personal use of technology and requires them to adopt technology for teaching and instructional planning. What then makes pre-service teachers want to change their behaviors and attitudes regarding technology integration? This can be explained by three concepts: (a) the extent to which teachers are persuaded of the value of integrating technology, (b) how teachers perceive technology integration, and (c) what concerns teachers have about educational technologies.

#### *Persuasion*

Pre-service teachers need to be persuaded of the value of integrating technology into teaching and learning activities (Brush, Glazewski, Rutowski, & Berg, 2003; Christensen, 2002; Doering et al., 2003; Nelms, 2004; Weidmann & Humphrey, 2002). To become persuaded of the value of educational technology, existing beliefs often need to be changed, which is possible through a conversion process (Ertmer, 2005; Hall, George, & Rutherford, 1986). That process is explained by Rogers (1995) who points out that an individual's decision about an innovation is a process occurring over time and consisting of a series of actions and decisions. He proposes the innovation-decision process model that reflects the nature of sequential stages with five stages: knowledge, persuasion, decision, implementation and confirmation.

When applied to technology integration, the knowledge stage occurs when pre-service teachers obtain knowledge about the existence of a technology and how it works. At the persuasion stage, knowledge shapes pre-service teacher attitudes about technology integration. The decision stage involves activities that influence adoption or rejection of

the technology. The implementation stage involves the actual integration of technology into teaching. The confirmation stage involves a decision to continue or stop using a particular technology.

In order for an innovation-decision process to proceed, pre-service teachers should obtain both *awareness-knowledge*, which refers to acknowledging the existence of technology integration, and *how-to-knowledge*, which refers to understanding how to appropriately use technology for educational purposes (Rogers, 1995). However, studies suggest that it is more difficult to acquire the latter than the former (Christensen, 2002; Mills & Tincher, 2003). According to Rogers (1995), how-to-knowledge does not necessarily occur only at the knowledge stage; activities at the persuasion stage can help teachers obtain initial knowledge about a particular technology and its value in learning and instruction. Support in the persuasion stage can facilitate acquisition of how-to-knowledge. Further, such support can encourage positive attitudes toward technology integration and carry through to the implementation and confirmation stages (Rogers, 1995).

*Perception*

According to Rogers (1995), how people perceive the attributes of an innovation is important in forming a favorable or unfavorable attitude toward that innovation. Rogers (1995) identifies five relevant attributes: relative advantage, compatibility, complexity, trialability and observability. In case of technology integration, the notion of relative advantage is the degree to which pre-service teachers perceive technology integration as being better than what they are currently doing. It depends on "the degree of economic profitability, low initial cost, a decrease in discomfort, social prestige, a savings in time and effort, and the immediacy of the reward" (Rogers, 1995, p. 216). Technology integration as discussed in this paper is less dependent on economic factors since the infrastructure already exists. Rather, our focus is on the notion that technology integration primarily requires time and effort on the part of teachers. Compatibility is the degree to which users perceive technology integration as being consistent with their values, experiences and needs. Complexity is the degree to which users perceive technology integration as being difficult to understand and implement. Trialability is refers to the degree to which users can experiment with integrating technology. Observability is the degree to which the outcomes of technology integration are visible to users.

*Concerns*

The use of technology for teaching requires the development not only of knowledge, skills, and behaviors but also of appropriate attitudes (Llorens et al., 2002). Attitudes might be influenced by concerns, confidence, and so forth. For example, pre-service teachers' attitudes toward a technology are affected by their confidence in using it (Rovai & Childress, 2002). Even though technology is available, and teachers have the requisite skills and knowledge, if they are not confident in using technology for teaching, they might be unwilling to do so.

The Concerns-Based Adoption Model (CBAM) is often used to assess pre-service teachers' attitudes toward and to guide support for their adoption of technology (Bradshaw, 1997; Hope, 1998; Mills & Tincher, 2003; Ward et al., 2002). This is especially true with Stages of Concern, which is one of the diagnostic tools developed in the model and used for probing potential adopters' attitudes toward an innovation as well as their progress (Hall et al., 1986). The Stages of Concern tool can assign pre-service teachers to these stages: awareness, informational, personal, management, consequence, collaboration and refocusing.

At the awareness stage, pre-service teachers are aware of the existence of a technology but they have little concern about it. At the informational stage, teachers want to know about it. At the personal stage, teachers are uncertain about the demands of technology integration and their ability and roles. At the management stage, teachers are concerned about technical challenges related to technology integration. At the consequence stage, they start inquiring about how technology integration affects students. At the collaboration stage, they consider how to work with their peers in the process of technology integration. At the refocusing stage, they start searching for ways to improve their technology integration.

We discuss next the implications for a VCA based on view of motivation and change agency.

**Implications for a Virtual Change Agent (VCA)**

How are pre-service teachers likely to become persuaded of the value of technology integration, develop their perceptions of technology integration, and become less concerned about or threatened by technology? What experiences are necessary for these changes? If a change agent can facilitate positive changes and supplement insufficient human resources, is a VCA capable of providing the experiences needed for the changes? These questions can be explored through three strategies based on the diffusion of innovation models explained in the previous section. These strategies are illustrated through a VCA's characteristics as a mentor, a motivator and a companion, as summarized in Table 1. Empirical research associated with these strategies are worthwhile pursuits, as indicated in the conclusion.

*Table 1.* Three strategies for a VCA to facilitate pre-service teachers' motivation for changes

| Strategy 1: Persuasion | | Strategy 2: Perception | | Strategy 3: Concern | |
|---|---|---|---|---|---|
| 3 Activities needed at the Persuasion Stage | VCA Characteristics | 5 Attributes of Adoption of Innovation | VCA Characteristics | 7 Stages of Concern | VCA Characteristics |
| *Vicarious trial* to mentally apply technology integration to their situations | Mentor to guide in their interpreting the information given and mentally applying technology integration to their situations | *Relative advantage* To perceive technology integration as being better than what they are currently doing | Motivator to encourage them to believe and to be confident in the advantage of technology integration | *0: Awareness* Pre-service teachers know the existence of the innovation but they hardly have concern about it. | Motivator to draw their arousal to technology integration and to provoke their interests in it |
| *Cue-to-action* To crystallize their favorable attitudes toward technology integration | Motivator to provoke their interest with relevant messages to their situations and their efficacy to be confident in adopting technology integration | *Compatibility* To perceive technology integration as being consistent with their values, experiences and needs | Motivator to arouse their attention and relate their current values and ideas to technology integration | *1: Information* They want to know about technology integration | Mentor to coach them in getting to know about technology integration by presenting its simple example |
| *Social reinforcement* To assure their beliefs in technology integration as well as to get their peers' positive evaluation on it. | Companion to empathize with them | *Complexity* To perceive technology integration as being difficult to understand and implement | Mentor to coach them through initiating their thought about a simple case | *2: Personal* They are uncertain about the demands of technology integration and their ability and roles for that. | Mentor to guide them to the understanding of what technology integration requires is beyond technical skills and knowledge<br><br>Motivator to encourage their confidence in their ability and self-efficacy |

| | | | | |
|---|---|---|---|---|
| | *Trialability*<br>To experiment technology integration in their situations | Mentor to guide them by presenting the opportunities of hands-on activity that match their needs | *3: Management*<br>They are concerned about technical challenges related to technology integration. | Motivator to encourage them to be concerned about the issues related to students' learning with technology |
| | *Observability*<br>To see outcomes of technology integration | Companion to empathize with their feeling that they want to others' successes and to show his own success story | *4: Consequence*<br>They start inquiring how technology integration affects students. | Mentor to guide them to the understanding of how effective technology integration could be, by offering the examples showing students' development resulted from technology integrated |
| | | | *5: Collaboration*<br>They consider how to work with their peers in the process of technology integration. | Companion to collaborate with them in the process of integrating technology |
| | | | *6: Refocusing*<br>They start searching ways to improve on their technology integration. | Mentor to guide the ways which they want to improve on their technology integration in |

*Persuasion*

Three activities are necessary for pre-service teachers to effectively be persuaded of the value of technology integration: vicarious trial, cue-to-action and social reinforcement. A VCA with hybrid characteristics of a mentor, a motivator and a companion can serve to facilitate pre-service teachers' acquisition of how-to-knowledge and their formation of favorable attitudes toward technology integration. First, pre-service teachers need to go through a *vicarious trial* in order to mentally apply the innovation of technology integration to their situations (Rogers, 1995). This activity requires them to interpret the information that they receive and hypothetically project the interpretation onto their own situations. A VCA can guide the process by coaching them (as a mentor) to select a technology and envision using it, while providing them with essential advice. For example, the agent might ask: "How would you use this technology in your teaching? How would you have your students use it? Think about one example and then write down your ideas." Such a message is intended to reflect how a human mentor or tutor might respond to a student in that situation. The challenge is creating such automated agent responses is in recognizing the problem from the student's perspective and then providing an appropriate level of support. This paper does not address the diagnostic aspects of a VCA; rather, our focus is on the identification of appropriate messages once the situation has been diagnosed.

Second, pre-service teachers need a *cue-to-action* that crystallizes favorable attitudes toward technology integration (Rogers, 1995). Acknowledgment of the need for the innovation and its accessibility are not sufficient to adequately

motivate a teacher to integrate technology. A VCA can present a cue-to-action through the characteristics of a motivator to provoke interest with relevant messages related to individual. For example, the agent can inspire pre-service teachers in English Education by suggesting that students could illustrate the synopses of their stories with a concept map created using Inspiration as a way to integrate technology into teaching creative writing.

Lastly, pre-service teachers need *social reinforcement* of positive attitudes toward technology integration from their peers (Rogers, 1995). This activity allows them to observe their peers' positive evaluation on technology integration as well as to confirm their personal beliefs in the innovation. This activity is important as individuals tend not to adopt technology integration without interpersonal communication with satisfied peers (Tsai, 2001). A VCA can provide social-reinforcement as a companion to positively evaluate the technology integration and express feelings similar to those of other pre-service teacher peers.

*Perception*

A VCA can facilitate pre-service teachers' in acquiring positive perceptions of the five attributes of technology integration. For *relative advantage*, a VCA implements the characteristics of a motivator who encourages them to believe that their current amount of time and effort in technology integration will decrease and that they will be confident in its advantage. For *compatibility*, the characteristics of a motivator are also used for relating technology integration to their current values and ideas. For instance, a VCA could arouse pre-service teachers' attention by mentioning their pedagogical belief and encouraging them that their belief holds true when incorporating technology into their lesson planning.

Pre-service teachers can become overwhelmed and puzzled by technology integration because of its complexity. A VCA can help them manage *complexity* through serving as a mentor to coach them through a simple case. Such an agent might say: "What do you think about this? Just have students use Inspiration to sequentially list things to do for their projects and logically set timelines." To help users perceive the *trialability* of technology integration, a VCA could guide them by presenting the opportunities of hands-on activity that match their needs. For example, the VCA might say: "Your major is Art Education. Take look at this Website. How might you use this site with your students?"

For *observability*, it is necessary to show that their peers succeed in acquiring the positive effects of technology on students' learning. The characteristics of a companion can be used for a VCA to empathize with pre-service teachers' feeling that they want to see others' successes and to share his own success story.

*Stages of concern*

Research suggests that once proper supports are provided to pre-service teachers according to their particular level of use and development, their motivation toward technology integration improves (Bradshaw, 1997; Hope, 1998; Mills & Tincher, 2003; Ward et al., 2002). Hall and his colleagues (1973) emphasize the role of a change agent to understand potential adopters' needs and to provide them with interventions to facilitate their moving toward a more positive stage to adopt an innovation. However, they also caution that the movement should not be forced (Ellsworth, 2000). In this way, a VCA could be advantageous given that its non-humanness will likely be perceived as less forceful, providing the pre-service teachers with more freedom for their own decisions to accept or reject the information (Baylor, 2001).

A VCA can facilitate pre-service teachers' moving toward more positive stages of concerns about technology integration. For those who are at the *awareness stage*, it implements the characteristics of a motivator to draw their arousal to technology integration and to provoke their interests in it. For those at the *information stage*, a VCA can coach them in learning about technology integration by presenting a simple example. For those at the *personal stage*, the characteristics of a mentor can guide them to the understanding that what technology integration requires is beyond technical skills and knowledge. In addition, the characteristics of a motivator are used to encourage their confidence in their ability and self-efficacy. For those at the *management stage,* a VCA utilizes the characteristics of a motivator to encourage them to be concerned about the issues related to students' learning with technology. For those at the *consequence stage*, the characteristics of a mentor are used in order to guide them to the understanding of

how effective technology integration could be, by offering examples that show students' development resulting from technology integration. For those at the *collaboration stage*, the characteristics of a mentor are used for collaborating in the process of integrating technology. For those at the *refocusing stage,* the characteristics of a mentor are used to guide the ways in which they want to improve their technology integration.

So far, how a VCA can persuade pre-service teachers to have more positive attitudes toward technology integration with better perception of technology integration while addressing their individual concerns about technology integration was examined through three activities for persuasion, five attributes for perception, and seven stages of concern. The use of the characteristics of a mentor, a motivator and a companion for each activity, attribute and stage was proposed. How then, can those characteristics be embedded in a VCA? What should be considered in order for each message to be effectively conveyed through the characteristics of a mentor, a motivator and a companion? Based on the empirical studies on pedagogical agents, critical design considerations are examined in the next section.

## Design Considerations for a Virtual Change Agent (VCA)

The role characteristics of mentor, a motivator and a companion that constitute a VCA are summarized according to the diffusion of innovation models, as listed in Table 2. Next, a set of design considerations will be derived from empirical studies on pedagogical agents to suggest ways to design appropriate characteristics for the VCA, including its appearance, voice and emotional expression. Figure 1 illustrates how these design considerations are integrated into a design framework for virtual change agents.

*Table 2*. Summary of VCA characteristics within the context of diffusion of innovation models

| Characteristics of a Virtual Change Agent | Diffusion of Innovation Models | | |
|---|---|---|---|
| | Innovation-decision process model: Persuasion stage | Attributes of adoption of innovation model | Concern-based adoption model: Stage of concern |
| Mentor | Vicarious trial | Complexity<br>Trialability | Information stage<br>Personal stage<br>Consequence stage<br>Refocusing stage |
| Motivator | Cue-to action | Relative advantage<br>Compatibility | Awareness stage<br>Personal stage<br>Management stage |
| Companion | Social reinforcement | Observability | Collaboration stage |

### A Single Virtual Agent

The characteristics among a mentor, a motivator and a companion are embedded in a single virtual agent. This is contrary to the suggestion of Baylor and Ebbers (2003) that two agents may be better than one agent. They found that two agents, one as an expert and one as a motivator, had more positive effects on learning, especially recall, than one agent acting as a mentor in which the expert and motivator functions were combined (Baylor & Ebbers, 2003). However, the purpose of using agents in their study was different from the purpose of the conceptual framework of this paper in that the former was to facilitate learning and the latter was to motivate changes in persuasion, perception and concerns. That is, the former is more related to cognitive aspects and the latter is more related to affective and attitudinal aspects.

Their explanation that one mentor agent with the combined roles of an expert and a motivator might have increased students' cognitive load as compared to receiving the information separately as needed from two agents with distinctly different personas and messages, is not necessarily applicable when affective and attitudinal aspects are the outcomes of interest. Rather, if multiple agents of a mentor, a motivator and a companion are used, the agents would have multiple channels to provide messages that would likely be perceived as overlapping; this would likely make the pre-service teachers confused as to the purpose of each agent (particularly as the agents' appearance and voice would not facilitate classification of them in a distinct role), leaving them to feel overwhelmed or distracted.

Therefore, a single agent is considered a better choice in order for the characteristics of a mentor, a motivator and a companion to be embedded for a change agent.

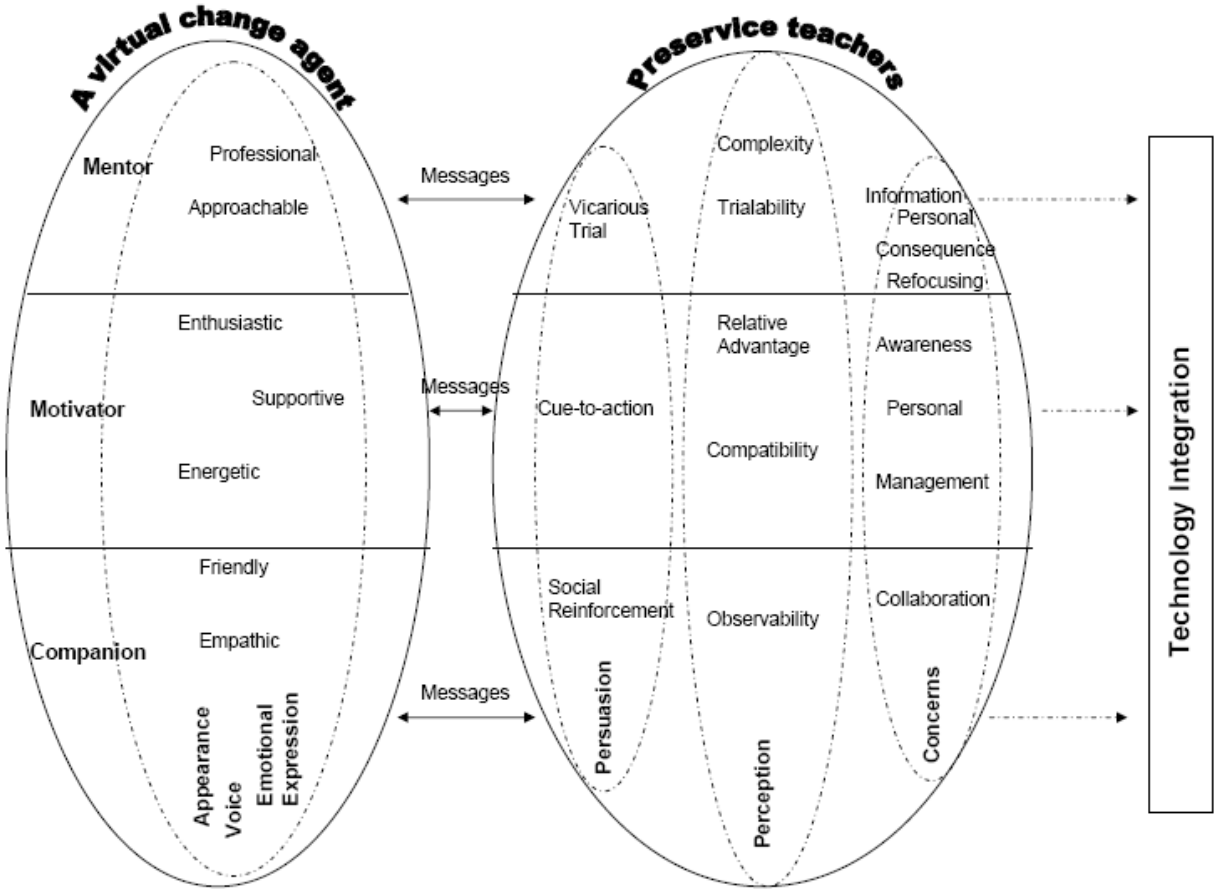


*Figure 1.* Conceptual framework for the design of a virtual change agent

How, then, can the multiple characteristics be embedded effectively in a single VCA? In order to answer this question, the next sections will examine specific design considerations with regard to appearance, voice and emotional expression.

**Appearance**

According to Bandura (1986), an individual tends to be persuaded by others with whom he identifies; that is, the degree to which others are perceived as being similar to himself affects his changes. In fact, Baylor & Plant (2005) investigated how pedagogical agents influenced the change of female undergraduates' attitudes and beliefs about engineering, and they found that the appearance of pedagogical agents was a critical aspect in impacting female undergraduates' perception of a social model for engineering. Although female students perceived male agents as more knowledgeable since those agents looked more like engineers to them, the agent that they perceived as most similar to themselves was the most effective in impacting their self-efficacy, stereotypes and attitudes toward engineering (Baylor, Rosenberg-Kima, & Plant, 2006).

Along this line, a young female agent would likely serve most effectively as a VCA. Pre-service teachers tend to perceive teaching as a female occupation since the majority of them are in fact female; therefore, they would be likely be most persuaded by a young female agent with whom they would identify. However, a slightly older appearance is suggested for a VCA given the need for it to mentor the pre-service teachers as a slightly advanced

companion. In addition, other research has shown that for a pedagogical agent to effectively impact motivational outcomes it is best when the agent is slightly older (Kim, Baylor, & Reed, 2003).

### Voice and Emotional expression

How, then, can the characteristics of a mentor, a motivator and a companion be included in a young and slightly older female agent? One answer might be to adapt the agent's voice and emotional expression. In fact, many researchers have suggested that careful design of both verbal and visual communication is necessary to carry out a particular role or functionality within a pedagogical agent (Baylor, Ryu, & Shen, 2003b; Lester, Towns, & FitzGerald, 1999).

Considering that pedagogical agents' voices impact communication (Atkinson, 2002; Atkinson, Mayer, & Merrill, 2005; Mayer, Sobko, & Mautone, 2003; R. Moreno et al., 2001), it is justifiable that a VCA would appropriately utilize her voice according to the characteristics of a mentor, a motivator or a companion as needed. As simulated in prior research, a professional but approachable voice for the characteristic of a mentor, an enthusiastic, energetic and supportive voice for the characteristic of a motivator (Baylor & Kim, 2005), and a friendly and empathic voice for a companion (Kim & Baylor, 2006a) can be used for a VCA.

In addition, emotional expression through the VCA's verbal and non-verbal communication needs to be considered. Many researchers found that contextually appropriate "facial expressions, eye contact, gestures, and emotional responses" improved interaction between students and pedagogical agents (Lester et al., 1999; Warren, Shen, Park, Baylor, & Perez, 2005, p.3). Thus, a VCA should have synchronized emotional expression with a human or human-like expressive voice.

To summarize, possible ways to design a VCA have been examined based on prior research on pedagogical agents in terms of the use of a single agent and its appearance, voice and emotional expression. These design considerations are proposed on the premise that the messages that a VCA convey are constructed according to pre-service teachers' motivational needs for change in their persuasion, perception and concerns toward technology integration.

## Conclusion

In order to account for the application of a VCA to motivate pre-service teachers to integrate technology for their future classrooms, this paper illustrates how a VCA can persuade pre-service teachers to have positive attitudes toward technology integration with better perception of technology integration while addressing their concerns. Based on the innovation-decision process model, the attributes of adoption of innovation model, and the concern-based adoption model, this paper explains pre-service teachers' changes toward technology integration through implementing the characteristics of a mentor, a motivator and a companion VCA. For the effective embodiment of those characteristics, design considerations grounded on prior research have been proposed in terms of the use of a single virtual agent and its appearance, voice and emotional expression.

Future studies could and should examine the impact on attitudes of preservice teachers toward technology integration based on the VCA framework presented here. It would also be interesting and probably revealing to examine the effect of individual components of the framework in isolation from other components. For example, comparisons of a VCA's message construction based on one or two selected components that are theoretically neutral with regard to change agency stages or motivation theory might verify the need to include all of those components to attain desired effects. Development of various appearance, voice and emotive aspects of the agent, tailored to individual student characteristics, are worth investigating as part of a research agenda aimed at the personalization of instruction. Furthermore, even if one small scale experiment showed that preservice teachers' positive attitudes toward technology integration were improved through a VCA, longitudinal studies might be necessary to determine whether or not their attitudes would be easily interfered with through subsequent experiences.

Although the rationale for the use of a VCA and suggestions for future research have been made, a few practical, technological issues still remain: To what extent can interactions between pre-service teachers and a pedagogical agent be dynamic? Is it feasible to satisfy individual motivational needs? It might be possible to use annotated

concept maps as a way to assess changes in preservice teachers' perceptions and attitudes with regard to specific technologies (see Spector & Koszalka, 2004; Taricani & Clariana, 2003).

In spite of these unresolved issues to be tested through empirical study, the framework presented here can serve to provide future research directions and initial design guidelines for a VCA to motivate pre-service teachers to integrate technology in their teaching and instruction.

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