

# Validating Pedagogical Agent Roles: Expert, Motivator, and Mentor

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**Abstract:** The purpose of this study was to operationalize, develop, and validate three distinct pedagogical agent roles: Expert, Motivator, and Mentor. The three agent roles were operationalized in terms of image, animation, voice, script, and affect. Two validation experiments with different student populations examined the learners' perception on the agent roles as implemented. The participants included 78 undergraduates in a computer literacy course and 72 pre-service teachers in an introductory educational technology course. The results support the effectiveness of each of the three agent role instantiations.

## Introduction

Pedagogical agents provide a new paradigm for computer-based learning, emphasizing the interaction between human and computer (Baylor, 1999; Kearsley, 1993). Researchers have suggested various metaphors or roles of computerized agents, such as agent as digital assistant, mentor, and learning companion (Baylor, 2000; Chan & Baskin, 1990; Negroponete, 1997). Or more generally, that agents should represent "characters" as in a play (Laurel, 1997), or social roles (Prendinger & Ishizuka, 2001). The impact of agent *roles* is of particular interest in the development of multi-agent systems, where agents have different purposes and intentions in interacting with each other. But even in a single-agent system, an important aspect of designing pedagogical agents is to carefully design their role within the learning environment to serve the intended educational purposes. It is thus necessary that the agent roles are internalized by the learner as intended by the designer.

This study attempted to provide the first step toward creating effective agents to represent three agent roles that are important for learning: expert, motivator, and mentor. First, we reviewed the general characteristics of human experts, motivators, and mentors. Based on the review, we operationalized the characteristics of the agent roles in terms of image, animation, voice, script, and affect. Next, we designed and developed the three agents. Last, we examined learners' perceptions in two experimental studies to validate the agent role implementations.

## Agent Operationalization: Expert, Motivator, and Mentor

Each agent role was three-dimensional and animated, and was developed by using Poser 4 and Microsoft Agent. The agents' gender (male) and the length of the scripts were kept constant in order to eliminate confounding effects. The specific operationalizations of each agent role are described below and summarized in Table 1.

### Agent as Expert

The development of expertise requires years of deliberate practice in a domain (Ericsson, Krampe, & Tesch-Romer, 1993). Experts exhibit mastery or extensive knowledge and perform better than the average within a domain. Also, experts are generally confident and stable in performance and not swayed emotionally by internal or external conditions. We operationalized the Expert based on the image of a professor in forties referred to as "Dr. Erickson". His appearance was formal with limited animation and he spoke in a formal and professional manner with limited intonation. He provided timely and accurate information. While presenting succinct comments, he was emotionally detached from the learners.




### Agent as Motivator

Learning and motivation are enhanced when learners observe a social model who has attributes similar to themselves. Also, verbal persuasion to the learners that they are capable to perform a task helps increase the learners' efficacy belief, a key construct of motivation (Bandura, 1997). We operationalized the Motivator based on the image of a peer in his twenties, considering that the target population for the study was college students. His appearance was casual and his gesture was expressive and enthusiastic. He spoke casually, sometimes using slang and was referred to as "Mike." He was not necessarily knowledgeable but rather suggested his own ideas, verbally encouraging the learner to sustain the tasks; and, by asking questions, stimulated the learners to reflect on their personal experiences. He expressed emotion throughout the learning process such as frustration, confusion, and enjoyment.

### Agent as Mentor

An ideal human instructor does not simply provide information but rather provides guidance for the learner to bridge the gap between the current and desired skill levels (Driscoll, 2000). In the same fashion, a true mentor should not be an authoritative figure; instead, a guide or coach with advanced experience and knowledge to work collaboratively with the learners to achieve goals. Thus, the agent as Mentor should demonstrate competence to the learner; at the same time, develop a social relationship to motivate the learner (Baylor, 2000). We operationalized the Mentor by incorporating the characteristics of both the Expert *and* Motivator so that he would both provide information and also motivate the learners by building a social relationship. He looked less formal than an expert. He spoke friendly, but somewhat professionally. His gesture was enthusiastic and expressive. The Mentor was knowledgeable and motivational, providing timely information and encouragement.

Table 1 summarizes the characteristics of the three agent roles.

	Expert	Motivator	Mentor
<i>Image</i>			
<i>Animation</i>	Limited gestures	Highly expressive	Highly expressive
<i>Voice</i>	Limited intonations	Enthusiastic, higher speed	Calm, engaging
<i>Script</i>	Information	Encouragement	Information & Encouragement
<i>Affect</i>	Low	High	High

**Table 1: Agent Roles, by Characteristics**

## Validation Studies

We validated that the operationalizations of the three agent roles were effective by assessing the learners' perceptions of the agent roles through two separate validation studies. To test how the participants perceived the agents' roles, we considered four sub-measures: 1) Agent's Purpose, 2) General Assessment of Agent, 3) Gesture, and 4) Emotional Expression. In the initial validation study, the participants mentioned varying perceptions regarding the agents' voices in open-ended questions; consequently, voice was added as an additional sub-measure in the second validation study.

### Initial Validation Study

### **Participants**

78 undergraduate students (30.0% male and 70.0% female) enrolled in a computer literacy class in a public southeast university participated in the study. The average age of the participants was 19.48 ( $SD=1.64$ ).

### **Procedure**

Participants were randomly assigned to one of the three agents, who appeared on the screen and provided comments on how to plan instruction for about five minutes. After that, the participants answered posttest questions. The whole session took approximately 15 minutes.

### **Results**

*Agent's Purpose:* The results revealed that the participants' perception of the agent's purpose were significantly different across the conditions,  $\chi^2=30.00$ ,  $p<0.001$ . In the Expert agent condition, 96.4% of the participants perceived the agent's purpose as "To give me information". In the Motivator agent condition, 85.1% of the participants perceived the agent's purpose as 'To motivate them'. In the Mentor agent condition, 16.0%, 16.0%, and 68.0% of the participants perceived the agent's purpose as 'To give them information', 'To motivate them', and 'To give them information and motivate them' respectively.

*General Assessment of Agent:* The results revealed a significant difference for this measure including two questions: 1) "How Motivational" and 2) "How Expert-like",  $F [2, 77]=3.89$  and  $12.67$  respectively. In Tukey HSD test, Motivator ( $M=3.00$ ,  $SD=1.1$ ) was significantly higher than Expert ( $M=2.29$ ,  $SD=0.71$ ) for the question asking "How Motivational". For the question of "How Expert-like", Expert ( $M=3.89$ ,  $SD=0.88$ ) was perceived significantly higher than Motivator ( $M=2.52$ ,  $SD=1.19$ ).

*Gesture:* There was a significant difference for the question of "How Motivational was the Gesture",  $F [2, 77]=5.02$ ,  $p<0.05$ . In Tukey HSD post-hoc test, Motivator ( $M=2.70$ ,  $SD=1.20$ ) was significantly higher than Expert ( $M=1.86$ ,  $SD=0.85$ ). However, there was no significant difference for the question of "How Expert-like was the Gesture".

*Emotional Expression:* The results showed significant differences,  $F [2, 77]=10.09$  and  $6.21$  respectively for questions, 1) "How Motivational was the Emotional Expression" and 2) "How Expert-like was the Emotional Expression" at the 0.05 level. In Tukey HSD test, Motivator ( $M=3.04$ ,  $SD=1.13$ ) scored significantly higher than Expert ( $M=1.82$ ,  $SD=0.90$ ) for "How Motivational of Emotional Expression". For "How Expert-like Emotional Expression", Expert ( $M=3.43$ ,  $SD=1.10$ ) scored significantly higher than Motivator ( $M=2.48$ ,  $SD=1.12$ ).

## **Second Validation Study**

### **Participants**

71 pre-service teachers (12.5% male and 87.5% female) enrolled in an introductory educational technology class in the same university as in the initial study participated in the second validation experiment. The average age of the participants was 19.6 ( $SD=3.93$ ).

### **Procedure**

The experiment was conducted during a regular session of the course. The participants were randomly assigned to one of the three agent conditions (Expert, Motivator, and Mentor). They logged on the web site with MIMIC (Multiple Intelligent Mentors Instructing Collaboratively), which was designed to help the students learn instructional planning. The average time to complete the process was approximately one hour.

### **Results**

*Agent's Purpose:* The results revealed that the participants' perception of the agent's purpose was significantly different across the agents,  $\chi^2=21.2$ ,  $p<0.001$ . In the Expert agent condition, 100 percent of the participants perceived the agent's purpose as 'To give them information'. In the Motivator agent condition, 91.7 percent of the participants perceived the agent's purpose as 'To motivate them'. In the Mentor agent condition, 73.7% of the participants perceived the agent's purpose as 'To give them information and motivate them'.

*General Assessment of Agent:* The question "How Expert-like" showed a significant difference,  $F [2, 69]=8.21$ ,  $p < .001$ . In Tukey HSD test, Expert ( $M=3.31$ ,  $SD=0.97$ ) scored significantly higher than Motivator ( $M=2.25$ ,  $SD=0.94$ ).

*Gesture:* There were no statistically significant differences for this sub-measure.

*Emotional Expression:* There were no statistically significant differences for this sub-measure.

*Voice:* There was a significant difference regarding how learners rated the voice as expert-like,  $F [2, 69]=5.95$ ,  $p < .004$ . In Tukey HSD test, Expert ( $M=3.37$ ,  $SD=1.15$ ) scored significantly higher than Motivator ( $M=2.41$ ,  $SD=1.14$ ). There were no significant differences regarding how the learners rated the voice as motivational.

## Discussion

Overall, the three agent roles were effectively implemented (based on characteristics in Table 1) and empirically validated. In the initial validation study, the statistical results strongly supported this operationalization in terms of the students' role perceptions including each sub-measure (agent's purpose, general assessment of agent, emotional expression, and gesture). In the secondary validation study, the statistical results were less satisfying but the most critical measures (agent's purpose and general assessment) strongly supported that the agents' roles were effectively operationalized.

A possible reason for the slightly different results from the initial and second validation studies is likely due to the different interventions. In the initial validation study, the participants concentrated on evaluating the three agents without any accompanying tasks for a relatively short time period (approximately 15 minutes). However, in the second validation, the participants were asked to create instructional planning with assistance of the agents for about an hour. The task was demanding and took a significant amount of mental capacity of the learners. Thus, it was plausible that they might focus more on the task itself and pay less attention to the agents' roles. Another explanation may be that the second set of participants (pre-service teachers) may be more particular about differentiating pedagogical roles, given their interest and background in the area. Even so, overall, the participants' perceptions of the three agents' roles (Expert, Motivator, and Mentor) corresponded to the purpose of the agent roles as intended.

While these results only support these particular instantiations of Expert, Motivator, and Mentor agent roles, designers of pedagogical agent roles in eLearning environments may find the set of agent role characteristics (regarding image, voice, animation, script, and affect) useful for both design and evaluation. Future research needs to determine whether these agent roles are found to be valid when implemented as female agents or representing different ethnicities. Of course, the content to be taught with the resulting stereotypes (e.g., a female agent teaching engineering, or male agent teaching nursing), may also have an effect on agent role perception. Finally, while two different groups of learners were included as part of this study, learners of different ages and backgrounds may also have different agent role perceptions as well.

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