

# The API (Agent Persona Instrument) for Assessing Pedagogical Agent Persona

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**Abstract.** This paper describes the development and validation of an instrument for measuring pedagogical agent persona as perceived by the learner. After collating items used to assess agent persona from other empirical studies, a factor analysis was conducted with two samples of undergraduate students working within the Multiple Intelligent Mentors Instructing Collaboratively (MIMIC) agent-based research environment. The first sample ( $n=80$ ) was used for an exploratory factor analysis, and five factors were identified. By conducting a confirmatory factor analysis with 133 participants, four agent persona factors were identified: 1) *Credible*, 2) *Facilitating Learning*, 3) *Engaging*, and 4) *Human-like*. The two latent variables were Informational Usefulness (constituted of *Credible* and *Facilitating Learning*) and Emotive Interaction (constituted of *Engaging* and *Human-like*).

## Introduction

There is a growing interest to develop more lifelike pedagogical agents in order to create more effective and interactive learning environments. The key assumption with using anthropomorphic or life-like agents is that they can serve as an engaging vehicle for facilitating more interactive and meaningful communication between learners and the computer (Craig, Gholsen, & Driscoll, 2002; Lester, Voerman, Towns, & Callaway, 1999; Moreno, Mayer, & Lester, 2000). The presence of a life-like character has been found to have a positive effect on learners' interactive experience. By engaging the learner, such agents can create more meaningful learning experiences (Baylor, 2000; Lester, Towns, & FitzGerald, 1999; Towns, FitzGerald, & Lester, 1998) and can in turn positively impact learning performance (Atkinson, 2002; Moreno, Mayer, Spires, & Lester, 2001).

While researchers continue to determine the particular affordances of pedagogical agents on learners' performance, it is already evident that pedagogical agents can have a strong positive effect on learners' perception of learning. Baylor (2001, 2002a, 2002b) consistently found that students perceived 3-dimensional animated agents within the MIMIC environment to be useful, credible, worthy of their attention, and that they internalized the agents' pedagogical perspectives. It is speculated that one key advantage of using anthropomorphic agents is that more human-like characteristics lead the learner to be more positive about the learning process. In an effort to measure learners' perceptions of pedagogical agent persona features, there have been several studies that employ scales based on user ratings. Lester and his colleagues have conducted extensive studies on the affective impact of lifelike pedagogical agents (e.g., Lester et al., 1997; Lester, Towns et al., 1999; Lester, Voerman et al., 1999; Towns et al., 1998). In one particular study, the researchers used 18 questions to measure learners' perception and found that learners perceived the agent as being very helpful, credible, and entertaining. Craig and colleagues (2002) re-applied this scale to find similar persona effects on learners' perception with pedagogical agents.

Recently, van Eck and Adcock (2003) raised this issue of establishing a reliable and valid scale to measure agent persona effects. They rigorously conducted a factor analysis and constructed the Attitude Toward Agent Scale (ATAS), which consists of two sub-scales, pedagogical efficacy of the agent and agent's attitude toward teaching. In order to establish the scale, they adapted questions from a human teacher rating scale that measured how effectively human teachers teach students. However, there are some potential problems with this method because a pedagogical agent is not a human teacher but rather a machine-generated teacher. Thus, students may have different perceptions

about what is the best persona for a human teacher versus a pedagogical agent. For instance, issues specific to agents, such as their image or animation may affect students' acceptance and/or believability of the agent (van Mulken, Andre, & Muller, 1998). Also, students may be strongly affected by the agent's voice, such as whether it is a machine-generated or a real human voice (Mayer, Sobko, Fennell, & Mautone, 2002; Moreno & Mayer, 2002; Moreno et al., 2000). However, van Eck and Adcock (2003) did not include these characteristics in their instrument, given their focus on conversational agents. In the next sections, we describe the development and validation of the API (Agent Persona Instrument) that we developed to measure perceived pedagogical agent persona while considering features unique to the computer-based aspects of the agent.

## Methods

### Participants and Instrument Development

Two samples for this study were selected. The first sample consisted of 80 undergraduate students (55 % Male, 45% Female). This sample was used to conduct an exploratory analysis to identify a factor model. The second sample consisted of 133 undergraduate students (30% Male, 70% Female) for a confirmatory factor analysis to validate the identified factor model. All participants were from a public southeast University. To develop an item pool for the instrument we collected the instruments used in other studies that investigated pedagogical agent persona (Andre, Rist, & Muller, 1999; Baylor & Ryu, 2003; Lester et al., 1997; Moundridou & Virvou, 2002; van Eck & Adcock, 2003; van Mulken et al., 1998), together with the ATAS (van Eck & Adcock, 2003). After collating all 66 items from these studies, we selected appropriate items from the initial item pool and revised them, deleting duplicate items and those that did not specifically measure agent persona. The final initial instrument was comprised of 38 items with a 5-point Likert scale, with 1 for “*strongly disagree*”, 2 for “*disagree*”, 3 for “*neutral*”, 4 for “*agree*”, and 5 for “*strongly agree*”.

## Results

### Exploratory Factor Analysis: Determination of dimensionality

Several steps were performed to specify the factor model. First, as an initial step, two factor analyses for the first sample ( $n=80$ ) were conducted to ascertain the factorial structure for the 38 items. Principal component analysis and maximum likelihood analysis were performed on the raw scores of the first sample. The explained variances were 60.86%, 65.10%, and 68.76% for the three, four, and five factor model respectively. Next, the maximum likelihood procedure was performed for three, four, and five factor models to estimate the initial factor model.

The decision to select five factors was determined based on several considerations. First, the 5-factor model explained 68.76% of the total variance of the 38 question items. Second, the commonalities of all items ranged from 0.51 to 0.81 except for two question items with 0.38 and 0.42. Since the items were anticipated to show inter-correlations, an oblique rotation method was used to obtain the rotation result. Then, strength of association between items and subscales were examined to determine if any items should be deleted. The criterion was set at .70 as a more conservative level, and 8 items below .70 were deleted. All remaining items fit as part of the five factors. After deleting the 8 items, another factor analysis was conducted to evaluate the revised set of items with 5 factors. The explained variance of the revised factor model was improved to 72.66%. The five factors were labelled to represent the agent persona features of *Credible*, *Facilitating Learning*, *Mentor-like*, *Engaging*, and *Human-like*.

The overall reliability of Cronbach's alpha was estimated at 0.97 for the first sample. The internal consistency of each factor indicated high reliabilities of 0.94, 0.92, 0.86, 0.87, and 0.86 for *Facilitating Learning*, *Credible*, *Human-like*, *Mentor-like*, and *Engaging* respectively.

### Confirmatory Factor Analysis: Model estimation and evaluation

To estimate validity of the above factor structure, a confirmatory factor analysis was conducted for the second sample ( $n=133$ ) by using maximum likelihood method. First, the five factors were reviewed to build an initial model with two latent variables. One latent variable was a content-oriented variable for the three factors of *Credible*, *Facilitating Learning*, and *Mentor-like*, which addressed student's perception of instructional help from the agent. The second latent variable represented affective features of the agent: *Engaging* and *Human-like*, which measured the agent's human-like behavior, including emotional expression. However, a test of the initially-hypothesized model revealed that it did not fit the data ( $\chi^2[4]=27.02$ ,  $p<0.001$ ).

### Model Revision

Since the initial model failed to fit the data, a model revision was performed by a) reviewing the correlation coefficients from the initial model and b) analysing the contextual meaning of the items. First, in terms of correlation coefficients, *Mentor-like* showed the lowest correlation coefficients and was considered to be likely to have contributed to the initial model's lack of fit to the data. Second, through analysis of contextual meaning of the items it was found, interestingly, that half of the items of *Mentor-like* were originally revised from a scale used for a *human* tutor and focused on individualized feedback to students. It was determined that these items were more appropriate for a human teacher or a more adaptive agent system rather than general pedagogical agents. Based on both of these results, *Mentor-like* was dropped from the initial model.

After removing *Mentor-like*, a revised model was tested as shown in Figure 1. A confirmatory factor analysis was conducted and it was concluded that the revision process led a much improved model fit, as indicated by model fit indices, including the root mean square error of approximation (RMSEA), the adjusted goodness-of-fit index (AGFI), the normed fit index (NFI), and the comparative fit index (CFI).

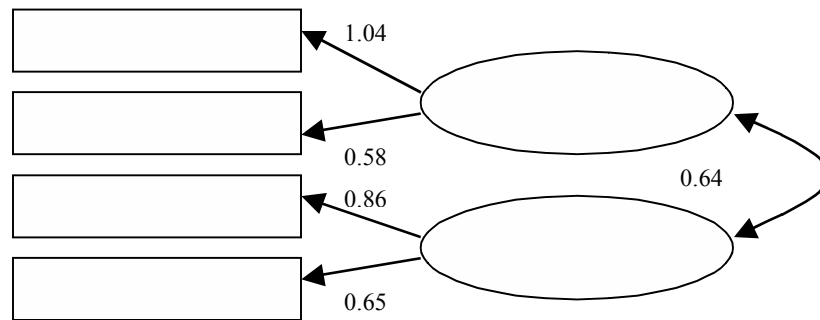


Figure 1: The correlation coefficients of the revised model.

### Latent variables

After specifying the revised model, the latent variables were labeled as Informational Usefulness (comprised of *Facilitating Learning* and *Credible* factors) and Emotive Interaction (comprised of *Human-like* and *Engaging* factors). The Informational Usefulness latent variable is related to the agent's instructional advice and information, with *Facilitating Learning* having a higher correlation at 1.04 (versus *Credible* at .58). The Emotive Interaction latent variable pertains to the motivational and entertaining features of the agent, as represented by the *Human-like* and *Engaging* factors, and thus contributes to student motivation and friendliness of agent.

### Discussion

Based on exploratory and confirmatory factor analyses, this validated instrument for assessing pedagogical agent persona – the API (Agent Persona Instrument), as listed in Table 1 -- presents four key factors for agents to be perceived as person-like: credibility, engaging, human-like, and the capacity to facilitate learning as listed below:

- *Facilitating Learning*: These 10 items are related to how well the agent helps the student through the learning process, e.g., by promoting reflection and learning support.
- *Credible*: This factor consists of 5 questions related to the credibility and believability of the agent and its advice for helping the learner understand the learning content.
- *Human-like*: These 5 items address the agent's behaviour and emotional expression in terms of its naturalness and personality.
- *Engaging*: This factor consists of 5 questions that related to how entertaining and enjoyable it was for the learner to work with the agent.

Future research needs to test the API with different content domains, agents, and types of learners.

<b><i>Facilitating Learning</i></b>	<b><i>Credible</i></b>	<b><i>Engaging</i></b>
<ol style="list-style-type: none"> <li>1. The agent led me to think more deeply about the presentation.</li> <li>2. The agent made the instruction interesting.</li> <li>3. The agent encouraged me to reflect what I was learning.</li> <li>4. The agent kept my attention.</li> <li>5. The agent presented the material effectively.</li> <li>6. The agent helped me to concentrate on the presentation.</li> <li>7. The agent focused me on the relevant information.</li> <li>8. The agent improved my knowledge of the content.</li> <li>9. The agent was interesting.</li> <li>10. The agent was enjoyable.</li> </ol>	<ol style="list-style-type: none"> <li>1. The agent was knowledgeable.</li> <li>2. The agent was intelligent.</li> <li>3. The agent was useful.</li> <li>4. The agent was helpful.</li> <li>5. The agent was instructor-like.</li> </ol> <p style="text-align: center;"><b><i>Human-like</i></b></p> <ol style="list-style-type: none"> <li>1. The agent has a personality</li> <li>2. The agent's emotion was natural.</li> <li>3. The agent was human-like.</li> <li>4. The agent's movement was natural.</li> <li>5. The agent showed emotion.</li> </ol>	<ol style="list-style-type: none"> <li>1. The agent was expressive.</li> <li>2. The agent was enthusiastic.</li> <li>3. The agent was entertaining.</li> <li>4. The agent was motivating.</li> <li>5. The agent was friendly.</li> </ol>

**Table 1: The API (Agent Persona Instrument)**

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