

## 4.4 Effects of a Pedagogical Agent's Emotional Expressiveness on Learner Perceptions

### Effects of a Pedagogical Agent's Emotional Expressiveness on Learner Perceptions

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**Abstract.** The use of animated pedagogical agents or avatars in instruction has lagged behind their use in entertainment. This is due in part to the cost and complexity of development and implementation of agents in educational settings, but also results from a lack of research to understand how emotions from animated agents influence instructional effectiveness. The phenomenological study presented here assesses the perceptions of eight learners interacting with low and high intensity emotionally expressive pedagogical agents in a computer-mediated environment. Research methods include maximum variation and snowball sampling with random assignment to treatment. The resulting themes incorporate perceptions of importance, agent humanness, enjoyment, implementation barriers, and suggested improvements. Design recommendations and implications for future research are presented.

#### 1.0 INTRODUCTION

Increased access to the Internet and widespread use of computers in the last decade has transformed computer-mediated instruction. Today there are a variety of different formats to support this type of educational setting such as web-based instruction, computer-based instruction, computer-based instructional simulations and serious games. In all of these formats the instructional content is presented in a combination of text, images, animations and/or audio representations. However, in an effort to increase human-computer interaction and to create the illusion of human to human interaction, these instructional environments have also seen an increase in the use of animated pedagogical agents.

Animated pedagogical agents are life-like computerized characters that facilitate learning in interactive environments [1, 2]. Some pedagogical agents are used as support tools like virtual tutors or help aids. Others are used to present the instructional content like a virtual instructor. Additionally, some animated pedagogical agents perform as virtual actors. An example of such function is CATHIE (Computer Agent

Teaching Helping Interactions Effectively), an animated pedagogical agent portraying the role of a student seeking advice from a human services employee [3].

In computer-mediated instructional environments, pedagogical agents can be represented as anthropomorphic characters (i.e., non-human like cartoon images) or human-like images or 3D figures. Overall, animated pedagogical agents should meet the basic interface agent characteristic of agency, responsiveness, competence, and accessibility as well as, the character building qualities of animations, gestures, communication, and personality [4]. Of course, in order for instructional designers to recreate the essence of life by developing characters that seem to think, live, and feel it is important to capture the essence of humanity by providing appropriately timed and clearly expressed emotions [4].

The focus of this investigation is to expand current knowledge on the role of animated pedagogical agents in computer-mediated instructional environments. Of particular concern are the effects of emotion (low versus high) intensity on learners' perceptions towards human-like emotionally expressive animated pedagogical agents.

## 2.0 LITERATURE REVIEW

Prior research on animated pedagogical agents has focused mainly on quantitative inquiries questioning the animated agents' effect on learning and the learners' perceptions of animated agents reported through survey instruments [3, 5, 6, 7, 1, 8, 9]. Some of these studies obtained positive results for both learning and learners' perception of the animated agent [9, 5]. However, other studies failed to obtain significant results for either variable [3, 1]. In the majority, the studies reported mix results in which learners' gained a positive perception of the animated agent but performed poorly on the learning tasks [6, 7, 8].

In the case of qualitative inquiries, research on animated pedagogical agents has been limited to a single phenomenological exploration that focused on the experiences individuals have when holding a dialogue with conversational pedagogical agent for educational purposes [10]. In this phenomenology, analysis from interviews and written reflections yielded five main themes (i.e., asking questions and trying to understand the pedagogical agent, the sense of time, body reactions, sense of place and humanizing the pedagogical agent). Overall, the findings support that individuals interact with virtual characters as if they were interacting with other humans [10]. Participants of this phenomenological exploration reported losing track of time, testing the knowledge of the animated agent, paying close attention to both utility and usability but also the interaction design related to aesthetics and emotion.

So far, only two studies utilized human-like emotionally expressive animated agents while measuring the agent's effect on learning and learners' perception [11, 12]. Kim et al. [11] used a quantitative approach to investigate learners' perception and learning outcomes using verbal and facial expression of emotion and gender in the interaction between an animated pedagogical agent and the learners.

Overall, results indicated that only the positive emotional expression (male and female) increased learners' social judgment of the agent and the interest of the learner. No significant learning outcomes were obtained in the study from any of the treatments.

Veletsianos [12] used a mixed method approach in a study in which learners interacted with either a verbally expressive or a non-verbally expressive animated pedagogical agent. The quantitative results of the study reported significant learning outcomes and positive learners' perception of the animated agent. Additionally, the qualitative data collected served as a method to gain a deeper understanding of the learners' experiences as they interacted with the animated agent. In total six main themes emerged from the data: expressiveness, multidimensional and contrasting agent perceptions, items of distraction, pedagogical agent affordances, use of 'human' as a measure of comparison, and agent focused with the lesson on the periphery. Overall, the comparison of qualitative data from both treatments revealed that change in verbal expressiveness qualities influences student perceptions and learning outcomes and that agent expressiveness is an important element of pedagogical agent design [12].

Due to the limitations of the past qualitative research on the topic of animated pedagogical agents, which only focused on dialogue experiences with a conversational agent and the verbal emotional expression of an agent, it is important to further explore in a qualitative manner the topic of animated pedagogical agents. Perhaps, the qualitative research on animated pedagogical agents can help understand the mixed results (positives and negatives) obtained by past quantitative inquiries. Or, it could also provide critical design feedback as experienced by the learners in their interactions with the animated pedagogical agents. Nonetheless, the qualitative research needs to center its attention on



animated pedagogical agents with both verbal and facial expressions of emotion.

### **3.0 PURPOSE STATEMENT AND RESEARCH QUESTIONS**

The purpose of this qualitative study was to describe the lived experiences of the learners as they interact with an emotionally expressive animated pedagogical agent in a computer-mediated instructional environment. Specifically, the researcher focused on the lived experiences between learners who interact with a low versus a high intensity emotionally expressive animated pedagogical agent. The main research questions that guided this study were: how do learners perceive low intensity emotionally expressive agents? (Research Question 1) And, how do learners perceive high intensity emotionally expressive agents? (Research Question 2)

### **4.0 OPERATIONALIZED VARIABLES**

Low and high intensity emotion variables were operationalized based on the programming of the facial and verbal expressions of the animated agent.

#### **4.1 Low Intensity Emotion**

The animated pedagogical agent had a soft emotional tone in the voice. Eye brown, mouth, and cheek movements were subtle and gentle. Head movement was limited and delicate.

#### **4.2 High Intensity Emotion**

The animated pedagogical agent had a strong emotional tone in the voice, with very high pitch and intonation. Eye brown, mouth, and cheek movements were exaggerated and excitement-like. The animated agent experienced a significant amount of head movement.

### **5.0 RESEARCH TRADITION**

For this research study, a phenomenology tradition was utilized. Phenomenology is a qualitative research paradigm focused on

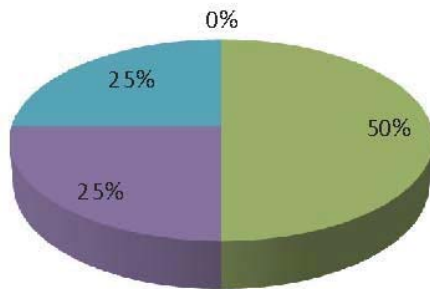
capturing the essence of the phenomenon under study. It descriptively captures the invariant characteristics of the phenomenon; and clarifies its significance and organization [13]. Under phenomenology, researchers participate in intentional analysis, in which the phenomenon under study is experienced by the participants as it normally occurs and it is reflectively explored to truly understand the experiential process through which the phenomenon is lived [13]. In addition to exploring the essence and intentional analysis of an experience, phenomenology encourages researchers to abstain from integrating theories, explanations, and hypotheses about the phenomenon under investigation [13]. Instead, the researcher learns about the phenomenon subjectively without any naive or irrelevant beliefs.

This qualitative inquiry captured the essence of the experience using the learners' perspectives of the agent and this type of instruction. The goal was to recognize commonalities and differences among the learners' experiences between the two treatments (i.e., low intensity and high intensity emotion).

### **6.0 METHODOLOGY**

#### **6.1 Participants**

The participants of the study were eight university students, both undergraduate (i.e., six students) and graduate level (i.e., two students), from a public university in southeastern United States. Five of the participants were females and three were male students. Six participants were within the 18 to 25 age group and two were in the 25 to 35 age group. Most of the participants were full time students; only one participant was a part time student.



According to the responses in the demographic questionnaires, all participants were either competent, proficient, or expert users of computers. Also, they were very familiar with desktop and laptop computers and knew how to use Windows and Mac operating systems. On average, the participants spend 18 hours using the computers at home and 17 hours of computer usage at works in a weekly basis. Typically, the participants used the computer for word processing (15%), email (17%), reading the news (13%), research (11%), and social networking (15%).

## 6.2 Sampling Strategies

For this phenomenological inquiry the researcher utilized a purposive sampling method, this form of sampling method provided information rich cases that yield insightful and in – depth understanding of the phenomenon under study [14]. Of the different strategies that can be used for purposively selecting information rich cases two specific sampling strategies were used: maximum variation sampling and snowball sampling. The aim of using maximum variation sampling is to capture and describe the central themes that cut across a great deal of variation [14]. In this manner the common patterns that emerged from

both undergraduate and graduate student participants are of particular interest and value in capturing the core experience and central, shared dimensions of emotionally expressive animated pedagogical agents in computer – mediated instruction.

In the case of snowball sampling, the process begins by asking well-situated people who the researcher should speak with [14]. In this phenomenology, snowball sampling was used to locate information– rich participants. This was done by asking the initial participants in the study to pass on information of the study to other undergraduate and graduate classmates.

In order to obtain participants that fit the characteristics of both purposive sampling strategies, recruitment notices were send out through university and departmental listserv, university social networking sites, and university bulletin board fliers. No specific age, gender, sexual orientation or ethnic/racial group restriction were set for selection of the participants. As compensation, participants received a five dollar gift card to a local coffee shop.

## 6.3 Materials

### 6.3.1 Instructional Environment

The instructional environment consisted of a linearly sequenced set of web pages that provided an overview on the topic of African history. Participants were first presented with an introduction and learning objectives for the lesson. Then, they progressed through thirteen pages of instructional content. After the instructional content, learners advanced to the conclusion. In order to move forward and backwards, participants used the “Previous” and “Next” buttons on the top left and right corners of the web pages. Participants used the progression menu, located on the left side of the web page, to track how far they had advanced through the lesson content.





Figure 1. Instructional Environment



Figure 2. Animated Pedagogical Agent

In each instructional content page, the participant would see the title of the lesson (i.e., “African History: An Overview”), the progression menu, the title for the content of the page (e.g., “Kingdom of Mutapa,” “Great Zimbabwe,” “Zanzibar Island,” etc.), an image related to the content of the page and the animated pedagogical agent.

The instructional environment was developed using Adobe Dreamweaver. The instructional content was prepared by a subject matter expert on the topic of African history.

### 6.3.2 Animated Pedagogical Agent

The animated agent presented in the instructional environment consisted of a young (25 – 30 years old) male with African American physical attributes. The agent wore a white shirt with a gray sports jacket. It used semi-formal language and spoke with a voice relatable to the age range. The background of the animated agent video presented of a hillside green area with bushes and flowers.

## 6.4 Data Sources

Data was collected through individual interviews, guided reflection journals, and a demographic questionnaire.

### 6.4.1 Individual Interviews

The interviews lasted 20 – 35 minutes each and occurred immediately after the participants interacted with the emotionally expressive animated pedagogical agent. They had a guided format and consisted of open ended questions. Participants were asked to describe their experiences as they interacted with the computer-mediated environment. The aim was to gain a deep understanding of the participant’s perceptions of the emotionally expressive animated agent. In order to have complete accuracy during the transcription process, the interviews were video recorded.

### 6.4.2 Guided Reflection Journals

Similar to individual interviews, guided reflection journals were completed after the participant interacted with the animated agent in the computer-mediated instructional environment. The journals were written electronically. Specifically, the researcher provided an electronic form with comment/essay boxes in which participants typed their reflections on the experience. The reflections of each participant were

guided by a series of questions. Participants had 40 – 50 minutes to type their guided reflection journals.

### **6.4.3 Demographic Questionnaire**

Lastly, participants were asked to complete a demographic questionnaire. The questionnaire was provided in paper format and consisted of a single sided page with eight questions. Some of the data collected through the demographic questionnaire were: gender, age group, college education level, type of student (full-time or part -time), computer experience, computer usage (amount of time), and type of computer usage (e.g., social networking, gaming, research)

## **6.5 Procedures**

After initial contact with the participants, the researcher sent an email to the participant with a link to register for the study and select a specific time slot for participation. The day of the session, the participants were asked to sit comfortably in front of a computer monitor with a wireless keyboard and mouse. The researcher proceeded to brief the participant on the purpose of the study and the structure of their participation. Various consent forms (i.e., participation and video consent forms) were provided to the participant. The researcher gave the participant time to read over the consent forms and sign if they felt comfortable with their participation in the study.

Once the participants had signed the consent form, the researcher randomly assigned the participant to a computer-mediated environment (i.e., low intensity emotionally animated agent or high intensity emotionally expressive animated agent). At this point, the researcher left the room and asked the participants to open the door once they had completed the interaction. After the researcher re-entered the research room, the participant was randomly selected to complete either a guided reflection journal or an interview protocol.

Before leaving the research room, the participants completed the demographic questionnaire and the gift card receipt form. In total, four participants were randomly assigned to the high intensity emotionally expressive animated agent and four to the low emotionally expressive animated agent.

## **6.6 Data Analysis**

### **6.6.1 Individual Interviews**

As each interview occurred, they were transcribed and analyzed. Video and voice recording of the interviews was used to transcribe the dialogue between the participant and the researcher. The transcriptions consisted of exact verbatim.

In addition to the interview transcripts, a contact sheet was filled after each interview. The sheet was filled by the researcher and it included four main questions. The questions were used to make the researcher reflect on the interviewee, the interviewee's responses, important issues or themes that emerged during the interview, and to compare the interview with other interviews.

### **6.6.2 Guided Reflection Journals**

To analyze the guided reflective journals, each participant's journal copied from the electronic format to a MS Word format. Exact verbatim was copied. Then, for each journal a contact sheet was completed.

The contact sheet used to analyze the guided reflection journal was the exact same format and questions as the contact sheet used for the individual interviews.

### **6.6.3 Demographic Questionnaire**

To analyze the demographic questionnaires, an MS Excel file was created. Responses to each question were coded in the columns/rows of the spreadsheet (i.e., gender, age group, education level, type of student, computer experience, computer usage, and type of computer usage). Totals were calculated



for each response option and graphic pie charts were created for each question category.

After all the interviews, guided reflection journals and demographic questionnaires were analyzed, two members of the research team conducted a phenomenological analysis of the data. The intent was to grasp the meaning, structure and essence of the lived experiences of the participants [14] as they interacted with the emotionally expressive animated pedagogical agent in the computer – mediated environment. To start the process, the researchers Epoche. This means that the researchers bracketed or restrained from judgment, personal bias, or eliminated any involvement with the subject material [14].

The next step was the phenomenological reduction of the data. To reduce the data, all interviews and reflection journals were coded separately by two researchers. During the coding process, key words and phrases were pulled from the data to develop initial codes. Code lists from both of the researchers were then compared against each other for any similarities or discrepancies. All the codes were entered into a codebook. The final version of the codebook included 19 keywords and phrases that were grouped into five coding categories.

Following the reduction of the data, the horizontalization process occurred. The purpose of horizontalization was to spread out the data and to organize it into meaningful clusters, in which irrelevant, repetitive or overlapping data are eliminated [14]. Five main themes were identified from the horizontalization process. A MS Excel spreadsheet was created to enter textual and structural descriptions for each of the five main themes.

## **7.0 RESULTS**

Five themes emerged from the individual interviews and guided reflections journal. It

is important to mention that these themes are mutually supporting and overlapping. They will be described in turn.

### **7.1 Perceived Importance**

Participants in both treatments, low and high intensity emotion, described reasons why emotionally expressive animated pedagogical agents are important in computer – mediated environments. Participant B, assigned to the low intensity emotion treatment, mentioned that “it is kind of nice to have a face because you can pick up some cues if something is a little bit more important, that needs to be paid close attention to.” Similarly, a participant in the high intensity treatment provided an example of how emotionally expressive animated agents could be implemented to support the learning experience of the students. Participant E felt that “emotions are a huge part of people and that if you take that out of a teacher it would be harder for the students to relate and they will get bored. There is just not enough stimulation for the student [without emotion].”

However, one participant mentioned that they could not see the difference between using an emotionally expressive agent and just videotaping a real person. This participant did not consider emotionally expressive animated agents necessary or important to computer-mediated instruction.

### **7.2 Perceived Enjoyment**

Regardless of agent expressiveness, low or high intensity, participants were both critical and complimentary regarding their perceived enjoyment of the animated agent.

Some of the complimentary comments from the participants in low intensity treatment were related the facial expressions of the agent. Participant D mentioned that “he likes that sometimes the avatar would stop and smile. Also, raising the eyebrows every once in a while was a nice touch.” Similar complimentary comments were reported by the participants in the high intensity emotion

treatment. Participant G mentioned that he liked the sharpness of the agent's appearance. And, just like participant D, he enjoyed the fact that while speaking the avatar's facial expressions and head movements were interacting simultaneously with the talk.

Some of the participants in the high intensity treatment did not enjoy interacting with the agent. Participant E mentioned that "the agent didn't have much to look at" and, similarly, participant F stated that "she found herself looking at the pictures more than looking at the avatar." Participant F also mentioned that although she found the topic of lecture interesting she did not enjoy looking at the agent emotional expression.

### **7.3 Perceived Humanness of the Agent**

All participants (both treatments) perceived the agent as "professional looking", "sharp dresser," "very modern" and someone that "looked like a professor."

However, participants in both treatments also revealed that the humanness of the agent was easily discredited by lack of proper facial expression of emotion or lack of synchronization between audio and mouth movements. Participant C, a participant in the low intensity emotion treatment, mentioned in her interview that "although he was talking about an upsetting subject, I did not recall any sad facial expression from him. I saw that he was smiling briefly." In the high intensity emotion treatment participant F mentioned there was a lack of synchronization, "I noticed that sometimes the voice and the movement of the mouth did not quite line up. For a second it discredited the avatar."

### **7.4 Perceived Barriers for Implementation**

For the participants in the low intensity emotion treatment, as well as one participant from the high intensity emotion treatment, the main barrier for the

implementation of emotionally expressive animated agents was the fact that they are too distracting. One participant stated, "I had to focus on what it (the agent) was saying because his face distracted me from his voice." Participant D, who was assigned to the low intensity emotion treatment, also mentioned how distracting the agent was for him. The participant said, "The funny faces he made with the smile and moving eyebrows distracted me into watching them instead of listening to what he had to say." Participant C too agreed with the level of distraction related to the avatar, he mentioned "I focused more on what his face was doing than what was coming through the speakers." Participant E, who interacted with the high intensity emotion agent, mentioned "this could be extremely distracting to students because they would spend more time focusing on why the avatar's expression was a certain way rather than the lesson." Participant G felt that "because avatars are not actually people, their emotions aren't displayed as smoothly as ours are; therefore, glitching and delays can lead to student distraction, which could ultimately cause a barrier in learning."

### **7.5 Suggestions for Improvement**

Data from the interview transcripts and guided reflections journals indicated that some participants would be glad to interact with an emotionally expressive animated pedagogical agent if given the opportunity. However, they would like to see some improvements and changes to the animated agent. For example, participant D who was also assigned to the low intensity emotion treatment suggested additional work on the facial expression component of the animated agent. He stated, "I could easily spot the same pattern of movements and expression from the avatar. A richer library of expressions would make a great difference."

One participant assigned to the high intensity emotion treatment recommended



having more emotional inflection in the voice of the animated pedagogical agent. Participant G said, "Sometimes I imagined a person reading a script."

## 8.0 DISCUSSION

Across all themes, the results indicated that participants in both treatments have similar perceptions of animated pedagogical agents. In fact, there are more similarities in perception than there are differences. Overall, the learners in the low emotion intensity treatment perceived the emotionally expressive animated agent as an important element of the computer mediated environment because it used emotion to provide subtle cues that highlighted important content in the lecture. The learners also perceived this agent as friendly and professional looking. However, there were some negative perceptions regarding the fidelity of the agent. The learners did not perceive this agent as human because it lacked proper synchronization between the topic of the dialogue and the expression of emotion (i.e., wrong emotion for the context). Another negative perception regarding the low emotion intensity animated agent was that learners felt it distracted them from focusing on the audio/voice component of the lecture.

Similar to the low emotion intensity agent, the learners that interacted with the high emotion intensity agent also perceived the agent as an important element to the instructional environment because the emotion contributed to their character as instructors of a lecture (similar to instructors in real life). On the other hand, there were positive and negative perceptions regarding the enjoyment of interaction. While some learners enjoyed the emotion and movement of the agent, others felt the agent was not visually pleasant. The perceptions of humanness of the high emotion intensity agent were mostly negative because of glitches in the synchronization of mouth movement and the audio. Finally, the learners in this treatment also perceived the

agent as distracting to the content of the lecture due to the facial emotion expression.

Even though, these findings mixed (i.e., positive and negative perceptions, they serve as a good source of design recommendations that could aid the design and development of agents in future projects. The first design recommendation is to utilize animated agents in circumstances in which humans would not be able to perform the same task or they could not perform the task with the same level of detail as an agent. For example, it is good to utilize animated agents in a computer mediated environment in which the agent has to perform a task that could be dangerous for humans (e.g., explaining how to deactivate an explosive). By doing so, the designer of the instruction highlights why it is important to utilize animated agents in that specific context. Another recommendation is to design the agent in a manner that it is visually pleasant to the learner. This can be done by utilizing an agent that the learner can relate to (i.e., relate in age or physical appearance) It might also be important to utilize an agent that the learners would find physically attractive and that seems relevant to the tasks they are performing in the computer-mediated environment. One more recommendation, specifically related to emotion representation, is to develop the agent in a manner that there it presents a good synchronization between the dialogue of the agent, the movement of the mouth, the motional inflection of the voice, and the emotional facial movement. This will prevent the learner from getting distracted and it will also further enhance the level of fidelity of the agent. One final design recommendation is to present facial expression of emotion in a manner that is as natural and subtle as the emotion express in humans, with emotional patterns that vary significantly throughout the interaction with the learner.

## 9.0 CONCLUSION

To summarize, this qualitative research found that participants in both treatments, low and high intensity emotion, perceived emotionally expressive animated pedagogical agents in a similar manner. Nonetheless, there are few limitations in this study. One of the major limitations of this study is the number of participants. In future research, a larger sample of participants should be recruited. In addition, the topic presented by the animated agent was one that focused mainly on negative aspects of African history. This content limited the facial and verbal expressions of the agent to mostly negative emotions (i.e., angry, sad, scared). It did not allow the implementation of a larger sample of emotional expression. Future researchers of animated agents should consider a topic that has a broader range of emotions (i.e., happy, surprise, disgusted, angry, sad, scared).

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