

Affective Pedagogical Agents and User Persuasion

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Abstract

The use of animated pedagogical agents with emotional capabilities in an interactive learning environment has been found to have a positive impact on learners. The Greek philosopher Aristotle contended that three elements; emotion, logic, and character are crucial for successful persuasion, i.e. in winning others over to one's way of thinking. We have designed a pedagogical agent, which acts in an interactive learning environment, using the Cognitive Structure of Emotion model [Ortony, et al 1988] and the five-factor model of personality [McCrae and John 1992] thus taking into consideration Aristotle's elements of a good persuader. In this paper we investigate the persuasive impact of this emotional pedagogical agent on a group of learners. The results show that while not contributing any significant performance gain in learning, the incorporation of emotion changes the way students perceive the learning process, and makes it more engaging. We also found out that there are some gender-based and individual differences in the user perception of an emotional agent, which need to be taken into account when designing a more adaptive and "intelligent" emotional pedagogical agents.

Keywords: Emotions, Persuasion, affective reasoning, pedagogical agent

1. Introduction

The use of personified agents in user interfaces has been a controversial issue in both the HCI and AI community. However, studies have continued to show that using personas in the interface significantly raises users perception of their experience with the system [Mulken, et al. 1998; Koda and Maes 1996]. The explanation for this is that these interfaces enriches the users interaction with the system by creating a two way face-to-face communication that increases the feeling of a personal and social interaction.

Researchers and interface designers are striving to enhance the credibility and believability of animated personas. They create an illusion of life by equipping the persona with qualities that would enable it communicate in a more human-like fashion. Traits such as affect in communication and distinct personality are believed to increase believability thereby significantly enhancing communication and user's total experience [Huang 1999; Bates 1994].

Emotional agents are believed to have advantages in the context of learning environments. It has been argued by a number of researchers [Elliott, et al. 1997; Rickel and Johnson 1997] that personification of the environment (e.g. by introducing an animated character/persona) positively affect the students' perception of their learning experience and that integrating emotional traits into these personas would result in more effective and motivating instruction. The belief is that these agents have the ability to change students' perception of learning from something that is dull and boring into a fun and engaging activity. Ultimately the student that enjoys a learning environment will undoubtedly spend more time there, which is likely to increase learning [Elliott, et al. 1997].

So far no empirical study has been carried out to determine how much impact integrating an emotional model into a pedagogical agent would have on the students' learning experience. We have conducted an empirical study to investigate the impact of integrating personified pedagogical agents with emotional model, personality traits and affective reasoning. Our interest is to find out the impact/effect of the emotional qualities on the learning experience. Our goal is to find answers to the following research questions:

- Do we really require an emotional engine in pedagogical agent?
- Does the integration of an emotional engine have any impact on user's learning experience?
- If there is an impact, how significant is it?
- What individual factors influence the impact of an emotional engine on the users (e.g. sex, knowledge-level, previous experience with educational software and with animated characters)?

We are investigating the impact of emotions on students' from two major directions.

- The impact on the users' perception of their learning experience
- The actual impact on the students' performance; i.e. do students who use such an agent actually perform better.

The paper is structured as follows: First we describe the pedagogical agent and the learning environment. Next we describe our experimental methodology. Finally we present our results, and try to answer the research questions we have outlined above.

2. The Learning Environment

We developed a simple learning environment, which takes the student through an introductory lesson on the structure of a C++ program. The training package contains a simulation, where students practice the coding skills they learned during the application and intermediate quizzes to ensure that the user is progressing along well. At the end of the training session students are presented with a set of questions that test their knowledge and understanding of the materials presented.

The application is designed using Visual Basic, while the materials for the training are delivered using audio output, the entire training lasts about 30 – 45mins.

3. The Affective Pedagogical Agent

For the study, we designed an emotional pedagogical agent called "Smiley" that delivers the training. Smiley exhibits verbal and facial expressions in response to users actions and progress during the learning process. The character is designed to appear as caring and considerate pedagogical agent that is concerned about its students' and their performance and progress throughout the training.

Smiley is a simple character made of 6 major emotional states: sad, surprised, angry, happy, pleased and neutral states. Figure 1 below shows the facial expressions associated with each emotional state.

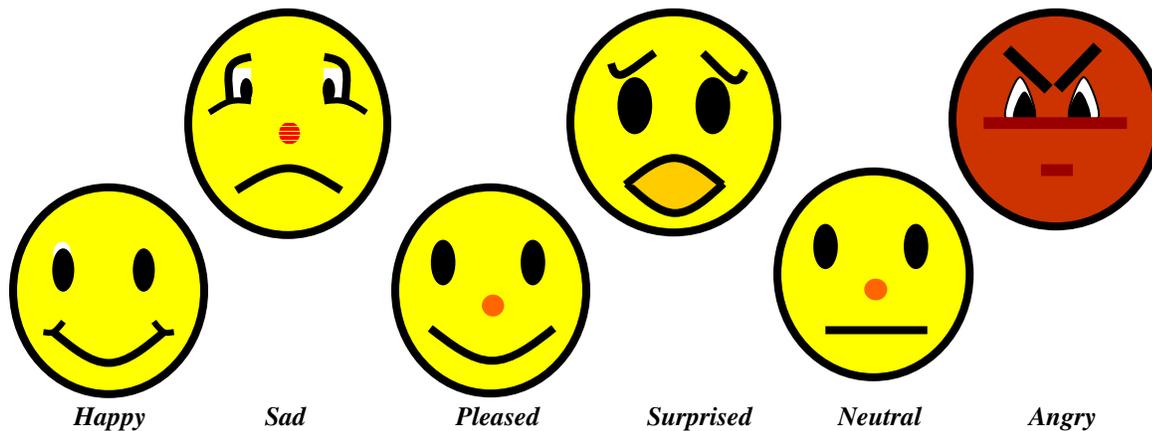


Figure 1: Smiley's facial expression for the six major emotional states

We tried to keep the agent's facial expressions simple by reducing the level of abstraction. Studies [Bartneck 2001] show that human beings tend to find the emotional expression from a simple caricature such as smiley more distinct and easily recognizable, in comparison to a real human face. Smiley's facial expression and emotional state is controlled by an affective reasoning engine that is based on the student's action, the agent's preceding emotional state and the agent overall goal. Smiley's goal is to motivate the student by convincing him/her that it really cares about his/her performance hoping that in this way the student's learning experience becomes more enjoyable. To achieve this, Smiley emits a sign of pride and joy whenever the student's performance and attention on the training is positive and exhibits an expression of worry and concern (sometimes even disappointment and annoyance) when the student's progress is less than desirable.

Throughout the training, Smiley tries to encourage the student; it stands on the screen delivering the training and providing advice and guidance to the student during the simulation, tests and quizzes. The agent presents multimedia material to the student following a pre-recorded script.

4. Methodology

The students were exposed to two versions of the application in a controlled learning environment; one with the emotional engine switched off and the other with the engine switched on. The experiment and data collection phase lasted about two days, with each student going through the training and tests, after which they answered a questionnaire, designed to investigate the impact of the affective pedagogical agent on the student's performance and the students' perception of their learning experience.

4.1 Participants and Setting

The participant group consisted of currently enrolled first year students at the University of Saskatchewan with no experience in programming with C++. In order to encourage participation, participants were offered a free entry ticket to a movie worth \$2.50. 12 individuals, 6 male and 6 female, with an average age of 25 years were selected as test subjects. To ensure uniformity and to account for all systematic differences in the groups, participants were randomly assigned to the two test groups. There were an equal number of males and females in each of the groups.

The study was conducted in the MADMUC lab at the University of Saskatchewan. The experiment ran on high-end Pentium PC's with color monitors. Pre-recorded speech was used for the persona's audio output.

4.2 Procedure

Each participant was welcomed by the researcher and seated at the workstation where the experiment would be conducted. The researcher then gave the participant an overview of what was expected of him/her and what to

expect during the experiment. Care was taken not to give out information that may bias the user’s perception of the animated character. The participants were assured that they were not under evaluation and that they could quit the experiment at any point, if they felt uncomfortable.

The participants were then provided with consent forms to read and sign. The consent form basically outlines everything the researcher had earlier explained and assures the anonymity and confidentiality of the student’s responses. The participants were then asked to fill out a pre-questionnaire that was used to gather information about their background; sex, age, computer knowledge/skill level, experience in programming with C++, experience with software training program and previous experience with animated characters. Figure 2 below shows a representation of the experimental design.

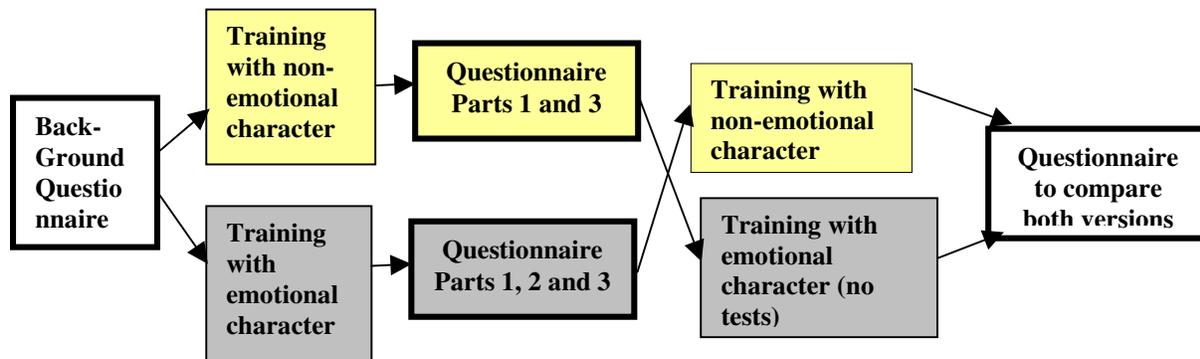


Figure 2: Experimental design (arrows show the groups of participants)

After the information gathering phase, each student proceeded through the training program; headphones were provided for each participant to avoid any distractions. The researcher observed the student as they went through the training without any interruptions. Each participant completed the training and tests. The tests were aimed at assessing the knowledge acquired on the just concluded lesson. Users actions and responses were tracked and recorded as they went through the entire experiment.

On completion of the training module, participants were asked to complete a questionnaire aimed at eliciting responses to assess their perception of the learning experience. The questionnaire consisted of 3 parts [Fig. 3]. The first part contained 10 questions which all participants were required to complete. This part contained questions that concerned the general difficulty of the training material/tests, how entertaining the experience was and whether or not the persona helped the participant concentrate on the training.

The second part consisted of 6 questions, which were specific to participants who had undergone the training with the emotional engine switched on. This part was concerned with the possible impact of the emotional responses. It contained questions such as: “Were the facial expressions distinguishable? Were they appropriate for the situation? Did the persona appear caring and sympathetic? Did you feel a need to perform better in order to please the persona?” The third part of the questionnaire consisted of open-ended questions, which asked all the participants to give some free-form comments on how they felt about the training. The questions on part one and two were answered on a five-point scale, users were also asked to comment on why they selected a particular option

After going through the training and answering the questionnaire, each participant went through the training again under the alternate persona condition. Those participants who first used the persona with the emotional engine set to “off” underwent the training with the engine switched “on” and vice-versa. No test was administered during this second round of the experiment (since otherwise it would have been unclear if the students have gained knowledge during this or the previous session). On completion they were given a final questionnaire [Fig. 4] to comment on the difference observed between both version (if any), and which of the two versions would they prefer for future trainings.

PART ONE

1. Did you find the training entertaining?
2. Was the training difficult?
3. How easy/difficult were the tests?
4. Did you find the persona sympathetic?
5. Did you find the persona distracting?
6. Did the persona help you concentrate on the training?
7. Did the persona motivate/encourage you to further pay attention to the training?
8. Would you choose to have a persona present in your future trainings?

PART TWO

9. Were you able to distinguish between the varying emotional responses of the persona?
10. Did you feel that the persona behavior / responses were appropriate for the situations?
11. Whenever you made a mistake, was the persona concerned?
12. Whenever you made a mistake, was the persona irritated?
13. Did you find the emotions displayed by the agent convincing?
14. Did you feel a need to perform well on the test because you didn't want to disappoint the persona?

PART THREE

15. What did you like or dislike about the training?
16. How would you summarize your experience?

Figure 3: Assessment Questionnaire 1

1. Did you notice any difference between the two versions of the training?
2. If yes which of the two versions do you prefer and why?

Figure 4: Assessment Questionnaire 2

5. OBSERVATIONS

To aid in the analysis, we defined the following metrics. The independent variable is the persona, with emotional engine switched on and off, while the dependent variables are the users performance on the test and their subjective responses on the questionnaires. The persona variable was manipulated between participants and the results were analyzed using t-test with an α level of 0.05.

Our null hypothesis was that there was no difference between the two groups; i.e. whether the emotional engine was switched to on or off, performance was the same. Also for each of the individual responses in the questionnaire, we state a null hypothesis suggesting that there is no difference between the two groups for each of the effects of interest.

5.1 Analysis

To determine the impact of the persona on the *performance* of participants, the test scores for the participants were analyzed using a two-tailed t-test. Each correct answer in the test was awarded a score of 12.5, leading to a maximum score of 100. The analysis revealed that there was no real effect of emotional persona on the students' performance as there was no significant difference between the means of the emotional and non-emotional condition ($t(10) = -0.24$; $p = 0.82$). See Table 1 below for a summary of the test scores obtained by all 12 participants as well as the mean scores of the two test groups.

Table 1: Participant's test scores and the mean scores of the two test groups

Participant #	Non-Emotional (Scores)	Emotional (Scores)
1	37.5	62.5
2	75	87.5
3	87.5	62.5
4	75	62.5
5	50	75
6	75	62.5
MEAN	66.67	68.75

For the *subjective assessment*, the responses from the users were rated on a five-point scale, ranging from 1 (negative answer, indicating disagreement) to 5 (positive answer, indicating agreement). The data from the first part of the questionnaire were subjected to t-tests. Table 2 shows the mean and t-values obtained for the questions in part 1. For all questions besides question 4, 6 and 7, the analysis showed no significant effects indicating that the emotional persona had no significant impact on these factors when compared to the none emotional persona. However, for question 4, where the participants were asked if they found the agent to be sympathetic, a significant effect was discovered ($t(10) = -2.36$; $p = 0.04$). For question 6, where the participants were asked if the persona helped them concentrate on the training, a significant impact was also discovered ($t(10) = -3$; $p = 0.01$). For question 7, where the participants where asked if the persona motivated/encouraged them to do well in the training and test, also showed a significant effect ($t(10) = -2.36$; $p = 0.00$). These results show that for these three factors there was a significant positive impact of the emotional persona condition on user's perception of their learning experience.

Questions 1, 2, and 3, asked about the degree of entertainment and the difficulty of the training/test. All participants found the training to be entertaining. Participants from both groups did not find the persona to be distracting, however participants under the non-emotional condition said they didn't pay much attention to the persona.

On question 8, 9 participants commented that they would like to have an agent present during their trainings while 3 participants were indifferent.

Table 2: Mean and t-values obtained for each assessment question in Part 1 (on a 5-point scale)

	Questions	Mean Emotional	Mean Non-emotional	t-value
1	Did you find the training entertaining?	4.17	3.83	+0.95
2	Was the training difficult?	3.67	3.67	0.00
3	How easy/difficult were the tests?	3.67	3.33	-0.85
4	Did you find the persona sympathetic?	3.67	1.83	-2.36
5	Did you find the persona distracting?	4.83	4.17	+1.32
6	Did the persona help you concentrate on the training?	3.00	1.50	-3.00
7	Did the persona motivate/encourage you to further pay attention to the training?	3.67	1.83	-2.36
8	Would you choose to have a persona present in your future trainings?	3.50	3.33	-0.25

Questions in part 2 of the questionnaire were administered only to student's who went through the training under the emotional condition, the questions were used to assess the impact of the personality and emotion displayed by the pedagogical agent on these student's perception of their overall learning experience. Table 3 below shows the mean values obtained for the questions in part 2. For questions 9, 10, 11 and 13 which related to whether the participant's could distinguish between the various emotional behavior / response displayed by the persona, if the personas' responses/behavior were convincing / tuned with the materials presented in the training and if the persona appeared to be concerned about their progress, five participants awarded the three questions 5 points, while 1 participant awarded the question 4 points; indicating that they felt that the persona was very concerned about their progress, its emotional responses to be very adequate and convincing, and were able to clearly distinguish between the agent's responses.

On the question of whether the persona appeared irritated when they didn't perform well, 3 participants awarded the question 2 points, 1 participant gave a value of 1 while the remaining two participant's gave a value of 3 and 4, indicating that sometimes the persona was perceived to be irritated about the user's performance during the test. However, these users commented that this was the case only when they continually failed to answer a question correctly.

On the last question on whether they felt a need to perform well on the test in order not to disappoint the persona, 3 participants', all female awarded the question 5 points indicating that they felt a need to do well so as not to disappoint the persona. From the other 3 male participants, one awarded the question 1 point while the other two awarded the question 3 points. So the male participants didn't seem to feel pressured to perform better in order to please the persona. This suggests that females are influenced differently from males by the persona. However, more research is needed to support this statement

The results obtained from questionnaire 2 showed that the emotional persona was preferred over the non-emotional one. When asked to choose between having the two versions of the persona all participants voted that they would rather have the persona with the emotional engine switched on. Participants commented that the emotional version made the training more interesting and motivational and prevents them from quitting the application altogether.

Table 3: Mean scores for each assessment question in Part 2 (on a 5 point scale)

	Questions	Mean
9	Where you able to distinguish between the varying emotional responses of the persona?	4.8
10	Did you feel that the persona behavior/responses were appropriate for the situations?	4.8
11	Whenever you made a mistake, was the persona concerned?	4.8
12	Whenever you made a mistake, was the persona irritated?	2.3
13	Did you find the emotions displayed by the agent convincing?	4.8
14	Did you feel a need to perform well on the test because you didn't want to disappoint the persona?	3.7

6. Discussion and Conclusions

The findings show that objectively an emotional pedagogical agent had no impact on the performance of users, however there are a number of possible reasons for this. Participants under the emotional condition found the persona to be motivating while all participants said they enjoyed the training with the emotional persona more.

However, there was a difference in the subjective perception of the persona by the participants, which shows advantages in the emotional version. Those who worked with the emotional persona commented that they could tell what their progress on the training was by simply looking at the facial expression displayed by the persona or noting the joy or disappointment it displayed. This observation supports the speculated impact of affective pedagogical agents discussed in literature [Elliott, et al. 1997] "pedagogical agents will be more effective teachers if they display emotions". On completion of the experiment, a number of participants under the emotional condition commented that they were surprised that they were not bored and were actually able to go through the whole training twice, as they have never viewed going through a training as a fun experience.

Participants under the emotional condition believed that the persona acted as a motivational factor, which is obvious from their responses to the questions evaluating the impact of the persona on their concentration and encouragement. The persuasive impact that the emotional agent had on the perception of the learning experience of these participants was clearly evident.

There also seems to a difference in the way the female participants viewed the persona when compared to the male participants. While the women felt the need to do well so as to elicit a smile from the agent, the men felt no such compulsion but merely used it as a tool to determine their progress on the training. However, all the participants under the emotional condition felt that the persona was truly concerned about their progress.

We expected that persuasive effect achieved by our emotional persona might eventually tie into student's performance on tests. However, our experiment did not show such an effect. This is in agreement with findings of other authors. For example studies conducted by [Mulken, et al. 1998] show that the presence of a +persona has no significant impact on the users' understanding when technical explanations were being presented. This finding is also consistent with the comments made by participants, 80% of them commented that they paid little attention to

the agent since they were busy trying to grasp the materials being presented and paid more attention to the audio output and the visual reading material.

Though most of the students reported that they did not find the persona distracting, there is still a possibility that the persona while entertaining had some negative impact on the student's concentration during the training.

A third possible explanation is that in our study the agent reacted to students' behavior/ performance during the tests and didn't account for the user's personality and preferences. A good tutor takes the student behavior, personality and preferences into account. Incorporating user-modeling capability in the agent will help to generate an adaptive affective pedagogical behavior that is more suited for motivating students.

Further work is required to see if incorporating user modeling of the affective preferences of the user as well as the user's emotional response to the agent and trying to tailor the personality and affective responses of the agent to the individual user will help to influence learning performance.

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