

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. 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 that acts in an interactive learning environment, using Ortony's Cognitive Structure of Emotion model and McCrae and John's five-factor model of personality. We investigated 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.

1. Introduction

The use of personified agents in the interface has been a controversial issue in both the HCI and AI community. However, studies have continued to show that using personas significantly improves users' satisfaction with the system (Mulken, Andre and Muller 1998; Koda and Maes 1996). The explanation for this is that these interfaces create a two-way face-to-face communication that enriches the feeling of a personal and social interaction.

Researchers and interface designers are striving to enhance the believability of animated interfaces by equipping these personas with qualities that would enable them to communicate in a more human-like fashion. Traits such as distinct personality and expressing affect in communication are believed to increase believability thereby significantly enhancing the 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 that personification of the environment (e.g. by introducing an animated character/persona) positively affects the student's perception of their learning experience and integrating emotional traits into these personas would result in more effective and motivating instruction (Elliott, Rickel and Lester 1997; Rickel and Johnson 1997). 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 spend more time there, which is likely to increase learning (Elliott, Rickel and Lester 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 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 on the learning experience of students. Our goal is to find answers to the following questions:

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

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

2. The Learning Environment and the Affective Pedagogical Agent

We developed a simple courseware application, which takes the student through an introductory lesson on the structure of a C++ program. A simulated programming environment allows students to practice coding skills and

make intermediate quizzes. At the end of the training session users are presented with a set of questions testing 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 (using pre-recorded female voice). The entire training takes about 30 – 45mins depending on the user’s speed.

For the study, we designed “Smiley” - an emotional pedagogical agent that delivers the training. Smiley exhibits verbal and facial expressions in response to user actions and progress during the learning process. The character is designed to appear as a caring pedagogical agent that is concerned about the student’s progress and performance throughout the training. Smiley can display six major emotional states: sad, surprised, angry, happy, pleased and neutral (see Figure 1).

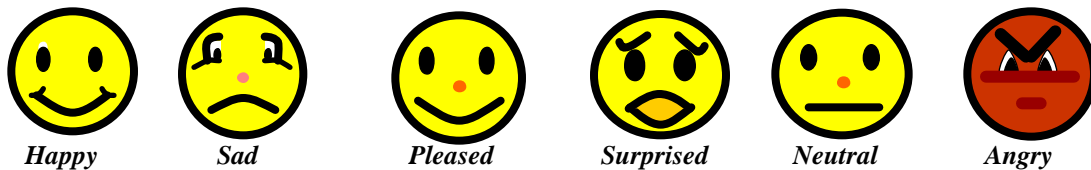


Figure 1: Smiley’s facial expression for the six major emotional states

We chose to keep the agent’s facial expressions simple by reducing the level of abstraction. Some studies (Bartneck, 2001) show that human beings tend to find the emotional expressions of a cartoon-like face more distinct and easily recognizable, in comparison with a real human face. An affective reasoning engine based on the student’s action, the agent’s preceding emotional state and the agent’s overall goal controls Smiley’s facial expression and emotional state. Smiley’s goal is to motivate the student by convincing him/her that it really cares about his/her performance. To achieve this, Smiley emits a sign of pride and joy whenever the student’s performance on a quiz or test item is positive and exhibits an expression of worry and concern (sometimes even disappointment and annoyance) when the student’s progress is less than desirable.

3. 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 ran on high-end Pentium PCs with color monitors. The experiment and data collection phase lasted two days, with each student going through the training and tests, after which they answered a questionnaire to evaluate the students’ perception of their learning experience.

3.1 Participants, Experimental Setting and Procedure

The participants 12 individuals, 6 male and 6 female, with an average age of 25 years, were enrolled as first year computer science students at the University of Saskatchewan with no previous experience in programming with C++. In order to encourage participation, the students were offered a free entry ticket to a movie. In order 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.

Each participant was given 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. The participants were then provided with consent forms assuring anonymity and confidentiality. The participants were then asked to fill out a pre-questionnaire that was used to gather information about their background; sex, age, computer skills, experience in C++, e with software training programs and with animated characters. Figure 2 shows the experimental design.

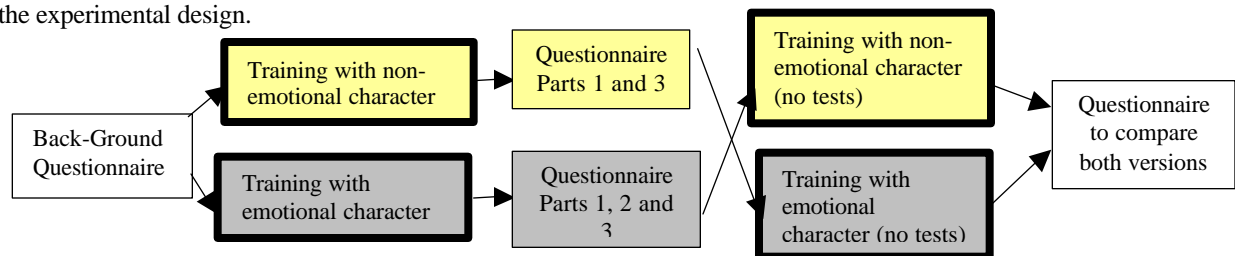


Figure 2: Experimental design (arrows show the groups of participants)

After the information gathering phase, each student proceeded through the training program. Headphones were provided for each participant to avoid any distractions. Each participant completed the training and tests. The tests were aimed at assessing the knowledge acquired during the lesson. Users actions and responses were tracked and recorded as they went through the entire experiment.

<p>PART ONE</p> <ol style="list-style-type: none">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? <p>PART TWO</p> <ol style="list-style-type: none">9. Where 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? <p>PART THREE</p> <ol style="list-style-type: none">15. What did you like or dislike about the training?16. How would you summarize your experience?
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Figure 3: Assessment Questionnaire 1

On completion of the training module, participants were then asked to complete a questionnaire aimed at eliciting responses to be used to assess their perception of the learning experience. The questionnaire consisted of 3 parts (Fig. 3). The first part contained questions which all participants where 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 where 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. The third part of the questionnaire consisted of open-ended questions, which asked all the participants to comment 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.

Each participant then went through the training again under the alternate persona condition. Those participants who first used the persona with the emotional engine set to “off” where asked to undergo 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 where given a final questionnaire (Fig. 4).

<ol style="list-style-type: none">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

4. 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.

4.1 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 student's 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.

Table 1: Summary of participant's test scores

Participant	Non-Emotional	Emotional
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

Table 2: Mean and t-values for questions in Part 1

Question	Mean Emotional	Mean Non-emotional	t-value
1	4.17	3.83	+0.95
2	3.67	3.67	0.00
3	3.67	3.33	-0.85
4	3.67	1.83	-2.36
5	4.83	4.17	+1.32
6	3.00	1.50	-3.00
7	1.83	3.67	-4.04
8	3.50	3.33	-0.25

Table 3: Mean scores for questions in Part 2

Q	Mean
9	4.8
10	4.8
11	4.8
12	2.3
13	4.8
14	3.7

For the subjective assessment, the data from the first part of the questionnaire were subjected to t-tests. For all questions besides question 4, 6 and 7, the analysis showed no significant effects. For question 4 (see Figure 3), a significant effect was discovered ($t(10) = -2.36; p = 0.04$). For question 6, also significant impact was also discovered ($t(10) = -3; p = 0.01$). For question 7, the data also showed a significant effect ($t(10) = -4.04; p = 0.00$).

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 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 training, while 3 participants were indifferent. Table 2 shows the mean and t-values obtained for the questions in part 1.

For the questions in part 2 of the questionnaire, which were related to the impact of the personality and emotion displayed by the pedagogical agent on users' perception, the following results were obtained; For questions 9, 10, 11 and 13, five participants gave a value of 5 points, and 1 participant gave 4 points; thus indicating that they felt that the persona was very concerned about their progress, its emotional responses were adequate and convincing, and that they were able to clearly distinguish between the agent's responses. On question 12, there were mixed answers. These users who felt that the persona was irritated commented that this was the case only when they continually failed answer a question correctly.

Interestingly, on question 14 (on whether they felt a need to perform well on the test in order not to disappoint the persona), three participants, all female, gave a value of 5 points indicating that they felt a need to do well so as not to disappoint the persona. From the other three male participants, one gave 1 point while the other two awarded 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. Table 3 shows the mean values obtained for the questions in part 2.

When asked to choose between having between the two versions of the persona all participants voted that they would rather have the persona with the emotional engine switched on. Most participants felt that the emotional version made the training more interesting and motivational and prevents them from quitting the application altogether.

5. Discussion and Conclusions

The results showed that the participants found the persona motivating and all of them said they enjoyed the training with the emotional persona more. Participants 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, Rickel and Lester, 1997). 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 as they all rated the questions on concentration and encouragement very highly. The persuasive impact that the emotional agent had on these participants' perception of their learning experience was clearly evident.

There also seems to be 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.

However, our findings showed that an emotional pedagogical agent had no impact on the learning performance of users. This is in agreement with findings of other authors. For example, (Mulken, Andre and Muller, 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 whom stated that they paid little attention to the agent since they were busy trying to grasp the material 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.

One possible explanation is that our study didn't account for the user's personality and preferences. A good tutor takes the student preferences and behavior into account. Incorporating user-modeling capability in the agent will help to generate an adaptive affective pedagogical agent that is more suited for a particular student. Further work is required to see if incorporating user modeling of the affective preferences of the user as well as adapting to the user's emotional response will help to influence learning.

Finally, it would be interesting to investigate the effect of a longer-term exposure to an emotional persona on the user. If, as suggested by our results, the persona makes learning more entertaining and fun, the students may spend more time in the environment and some of them may actually strive to perform better in order to please the persona, which will eventually tie up in better performance results. However, a long-term experiment has to account for the effect of novelty that an animated persona introduces in the interface. It is possible that the motivating effect of the agent in our study was due only to the entertainment effect of the first encounter. Defining the threshold of the user's "saturation" to the point of getting bored and annoyed with the agent is an important task for future work, not only for animated personas in learning environments, but in general.

References

- Bartneck C. Affective Expressions of Machines, Proceedings CHI2001 Conference, Seattle, 2001.
- Bates J. The role of emotions in believable agents. *Communication of the ACM*, 37(7): 122-125, 1994.
- Elliott C., J. Rickel, and J.C. Lester. Integrating affective computing into animated tutoring agents. Proceedings IJCAI Workshop on Animated Interface Agents: Making Them Intelligent, Nagoya, Japan, 1997, 113-121.
- Huang H.-Y.. The persuasion, memory and social presence effects of believable agents in human-agent communication. Proceedings Third International Cognitive Technology Conference, CT'99 (San Francisco/Silicon Valley, 1999).
- Koda T. and P. Maes. Agents with faces: The effect of personification. Proceedings 5th IEEE International Workshop on Robot and Human Communication (RO-MAN'96), Tsukuba, Japan 1996.
- Lester, J.C., Converse, S., Kahler, S, Barlow, T., Stone, B., & Bhogal, R. (1997). The Persona Effect: affective impact of animated pedagogical agents. Proceedings CHI'97 (Conference on Human Factors in Computing Systems). (Atlanta GA, 1997), ACM Press, 359-366
- McCrae R.R., and John O.P.: An introduction to the five-factor model and its applications. Special Issue: The five-factor model: Issues and applications. *Journal of Personality*, 60: 175-215, 1992.
- Ortony, A., G.Clore, A.Collins "The Cognitive Structure of Emotions." Cambridge, MA: Cambridge University Press. 1986
- Rickel J. and Johnson L. Integrating pedagogical capabilities in a virtual environment agent. Proceedings First International Conference on Autonomous Agents, 1997.
- Rist T., E. Andre, and J. Muller. Adding Animated Presentation Agents to the Interface. In J. Moore, E. Edmonds, and A. Puerta, (Eds), Proceedings International Conference on Intelligent User Interfaces, pages 79--86, Orlando, Florida, 1997.
- van Mulken S., E. Andre, and J. Muller, "The Persona Effect: How Substantial Is It?" In H. Johnson, L. Nigay, and C. Roast, (Eds), *People and Computers XIII: Proceedings HCI '98*, Springer-Verlag, London (1998).