Virtual pedagogical agents – design guidelines regarding visual appearance and pedagogical roles

A. Gulz [*,1], and **M. Haake** [2]

[1] LUCS (Lund University Cognitive Science), Lund University, Sweden
[2] Dept. of Design Sciences, LTH, Lund University, Sweden

Following a brief discussion on aspects of visual appearance and roles respectively, two user studies are presented and discussed. Both focus on learner experiences and explore the reciprocal relation between visual appearance of virtual agents and their pedagogical roles. The paper concludes with some preliminary guidelines for the early stages of the design process of virtual pedagogical agents.

Keywords visual appearance; virtual pedagogical agent; pedagogical role; gender; design guideline

1. Introduction

Virtual pedagogical agents, i.e. computer generated characters in pedagogical roles, populate the digital society in increasing numbers. They are found in educational programs from preschool to university. They are also found in broader educational contexts as virtual medical counsellors, physical exercise coaches and guides on city homepages, and they appear in edutainment and infotainment settings. In the development of any virtual pedagogical agent (VPA), a number of design decisions must be taken – consciously or otherwise. One group of design decisions concern the *visual appearance* of the character: its gender, skin colour, age, facial features, body, hairstyle, clothing and attributes. Another visual design decision regards the *visual style* and the *degree of visual naturalism* by which the agent is depicted [1].

Recently, those visual design decisions, or decisions on the *appearance* of agents, have been recognized as *important* from a pedagogical perspective [2]. No matter how adequate and well-designed the behaviour, dialogue and 'intelligence' is in a pedagogical agent – if its visual appearance is inadequate, the pedagogical benefits from the agent may decrease considerably, since the visual appearance of an agent affects learner expectations, attitudes, understanding and motivation. For instance, a well-chosen visual design of a VPA may influence self-confidence in learners, in terms of their belief in their own competence in approaching a certain subject matter [3]. In other words, visual design has a definite impact on learner experiences.

But *what* is an adequate visual appearance for a given VPA, and how do we support designers in attaining this? First of all, there is no hope for overall and general guidelines in this area. Visual appearance is complex, and whether a visual design decision is adequate and appropriate will depend both on the learning context as such and, not least, on the group of learners in question. The design of visual appearance is certainly a process where user involvement and user evaluation is strongly recommended. Nevertheless, in order to delimit the visual design space when generating initial design alternatives, support and guidelines are both possible and desirable – and are what the research presented in this article intends to contribute to. The article presents two studies that both focus on *learner experiences* and explore the reciprocal relationship between the *visual appearance* of VPAs and their pedagogical *roles*. The first study concerns visual style and the degree of visual naturalism; the second deals with gender and representations of femininity–masculinity.

[*] Corresponding author: e-mail: agneta.gulz@lucs.lu.se, Phone: +46 (0)46 2223269

2. Roles and visual appearance as variables in the two studies

2.1 Roles of virtual pedagogical agents

Pedagogical roles may be broadly divided into two categories: authoritative roles such as teachers, instructors or mentors; and non-authoritative roles such as learning companions, study partners and other kinds of co-learners [c.f. 4]. The first study presented makes use of this classification, with two different versions of an educational program being compared: one involves a VPA that is an instructor and chief, the other a VPA that is a learning companion and colleague.

The roles mentioned thus far – teachers, instructors, mentors, co-learners, etc. – are prototypical *pedagogical roles*. But there are also roles that are less pronouncedly pedagogical but yet impact learning. As an example, someone who is lecturing on a certain medical topic may be a practicing physician, a nurse or a researcher. Likewise, a young student's co-learner in an assignment may be another young student or a much older person, new to the field in question but with a long professional life in other areas. Such roles also influence learners and learning. The relationship between these kinds of roles and issues of visualization, with respect to learner experiences, is highlighted in the second study.

2.2 Visual appearance of virtual pedagogical agents

Visual appearance, as used in this paper, refers to the design of a VPA in terms of its body and face shape, gender, ethnicity, age, clothes, and attributes – as well as in terms of the graphical style and the degree of visual naturalism with which it is represented. That is, the concept does not designate visual dynamics such as gestures and facial expressions but the static figure that is being animated [1]. The visual appearance dimension involved in the first study is the degree of visual naturalism (Figure 1). The second study focuses on visual representations of gender and of masculinity–femininity in VPAs.

3. Study I: Visualization and authoritativeness in VPAs

3.1 Method

Ninety 12-16 year-olds, 48 girls and 42 boys from a Swedish secondary school, participated in the study, which was organized in the context of their regular art lessons. The study is described in more detail in [5, 6]. For the study, two dummy versions of a scenario-based multimedia program for elementary school were developed. In both versions the student is to take the role of a journalist at a magazine, being sent to European countries to carry out article research. In the 'Instructor version' the student is guided by a virtual instructor and in the 'Companion version' accompanied by a virtual companion. Both dummies include: (i) an introduction where the program and a first mission is presented, and (ii) a module where the student is to choose a chief editor (instructor) or companion journalist (companion) from eight different VPAs, four more stylized and four more naturalistic (Figure 1), with randomized placements.

3.2 Result and interpretation

Relating the choice of visual style (stylized vs. naturalistic) to the pedagogical role of the agent (instructor vs. learning companion) the following was found: Participants who were presented with the instructor version showed a slight tendency ($p(\chi^2) = 0{,}11$) to chose a stylized agent, whereas participants presented with the companion version of the pedagogical system, showed a significant ($p(\chi^2) = 0{,}05$) preference to chose an stylized agent (Figure 2).

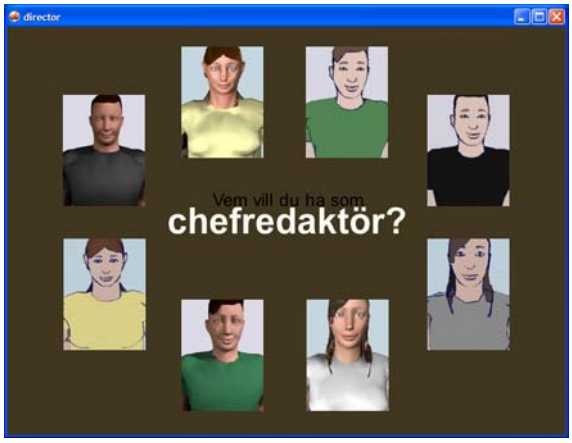

Fig. 1 Screen shot from the agent selection module in Study I.

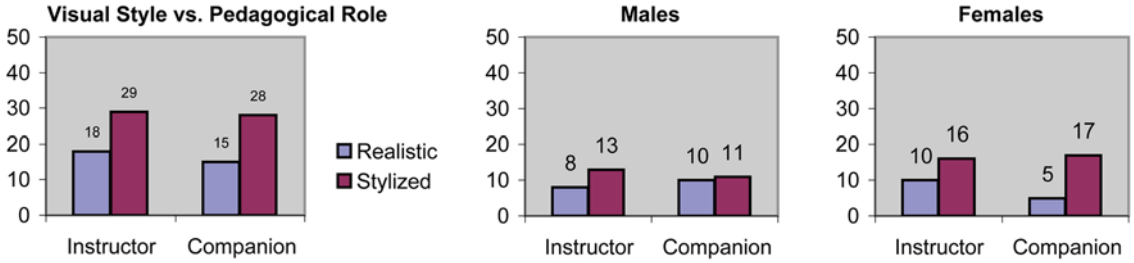

Fig. 2 The distribution of visual style choices for instructor role vs. companion role.

$p(\chi^2)_{total} = 0.74$; $p(\chi^2)_{instr} = 0.11$; $p(\chi^2)_{comp} = \mathbf{0.05}$
$p_{male}(\chi^2)_{total} = 0.53$; $p_{male}(\chi^2)_{instr} = 0.28$; $p_{male}(\chi^2)_{comp} = 0.83$
$p_{female}(\chi^2)_{total} = 0.24$; $p_{female}(\chi^2)_{instr} = 0.24$; $p_{female}(\chi^2)_{comp} = \mathbf{0.01}$

Separating the participants with respect to gender, the significant result for the 'Visual style preference' in the 'Companion version', is seen to originate from the female group. ($p_{female}(\chi^2)_{comp} = 0.01$). That is, moving from the 'instructor condition' to the 'learning companion condition' brings about a shift in the preference distribution in favour of stylized visualisation, and significantly so for the female participants. A starting point for an attempt to interpret this result is to consider the long tradition in comics to use stylized characters to facilitate the subjective identification and immersion into the characters and story [7]. If participants associate a learning companion with a 'real friend' to have a personal relationship with (in contrast to a strictly task-oriented, authoritative boss or instructor) it may be close at hand for them to select a stylized character in contrast to a naturalistic character. Since the significant visual style preference arises from the 'female' group, we may furthermore interpret the result as one where gender specific behaviours and social strategies are reproduced in the virtual world – girls/females being more competent in using subjective relational strategies, and boys/males relying more on formal, objective strategies for social interaction.

4. Study II: Gender, visual appearance and roles

4.1 Method

Whereas gender issues *emerged* from the results of the first study, the second study had an explicit gender focus in the issues explored. At large the study parallels a study by [8] carried out with 35 participants aged 18-23. The study showed that the degree of femininity and masculinity in voices in computer

interfaces, obtained through modulations of the volume and the frequency spectrum, evokes the same gender stereotypes as in real life with corresponding expectations and judgements. For instance, the more masculine voice was rated significantly higher in terms of will-power, reasoning skills and persuasive ability than the more feminine voice.

Our study replaced *voice* with *visual appearance* as a carrier of masculinity and femininity. Four VPAs – a masculine male, a neutral male, a neutral female and a feminine female – were designed (and pre-validated). The two male characters spoke in one and the same, neither particularly masculine nor feminine, voice and correspondingly for the two female characters. Furthermore, all characters were designed as physicians, lecturing on the topic of shift work and health (Figure 3).

Fig. 3 Screen shots of the four different pysicians used in Study II.

Each of the 90 participants (18-65 years old), encountered one female character and one male character (randomized as to order and character). They lectured on the same topic but on different sub-parts. The two linguistic scripts were pre-tested for being as equivalent as possible in terms of affirmativeness, objectivity, difficulty, and neutrality of language (nor a prototypically female or male way of expressing oneself). After each encounter with a VPA, participants evaluated aspects such as credibility, trustworthiness, intelligence, knowledge, objectivity, and emotionality, by the means of Likert scales.

The most relevant differences between the original study and our study were: (i) the kind of interface: a voice interface versus an agent interface that in addition to voice involves a visual representation of a humanlike agent; (ii) the visual representation versus the voice as carrier of femininity–masculinity; (iii) late 1990s versus 2006; (iv) cultures: US versus Swedish participants; and (v) the role of the VPAs: 'anyone in the street' versus a physician.

4.2 Results and interpretation

Gender stereotypes had some, but considerably weaker, impact than in the original study. Possible explanations that we regard as *less* likely are: (i) that visual cues are much weaker in carrying gender stereotypes than voice cues, and (ii) that time has brought by a difference so that people are less susceptible to gender cues and gender stereotypes. Both these proposals are largely contradicted in several studies by A. Baylor and her group at RITL [9]. Thus, the parameters of culture and agent role remain – and the interviews that followed the questionnaire indeed point towards these. In the interviews, a common and quite strong conception of *physicians* as being credible, intelligent, knowledgeable, and objective, emerged. As a consequence expectations or stereotypes due to perceptions of gender and mas-culinity–femininity may be superimposed by even stronger expectations or stereotypes of *a physician* (in Sweden a high status profession with equal number males and females). In order to better separate *role* and *culture* (to the extent that it is possible) we will, however, have to repeat the study with another VPA role – one (in Sweden) less strongly associated with expectations on credibility, intelligence, objectivity, etc. This way it could be found out to what extent *gender stereotypes overall* have less impact on Swedes than Americans (as groups).

5. Discussion and conclusion

5.1 Making use of results like these – contributing to a visual design guidelines project

Step-by-step recipes on 'how to visually design a VPA' is a futile objective, since learning contexts, learning goals and groups of learners are such important and divergent parameters. However, in order to delimit the visual design space when generating initial alternatives, support and guidelines are both possible and desirable. Designers, we believe, may be helped by guidelines in form of pointers such as: 'these variables relate to each other' and 'this is a question that needs to be answered before making a choice on this or that visual parameter'. Such guidelines could be highly useful for navigating the immense visual design space of VPAs and to generate adequate initial alternatives. Research results on VPAs should, we hold, be used as a basis for the development of such design guidelines, and simultaneously be a means to ensure that research results do not only stay with researchers but are also communicated to the wider business domain.

5.2 Preliminary guidelines

A shared result from the two presented studies is that the role of a VPA is in certain, non-obvious, ways, related to visual design – and visual design decisions. From study I, we can extract some relatively straightforward guidelines. If one is interested in creating a non-authoritative pedagogical agent, it may be favourable to design it as a stylized character. However, the study also shows divergence in preferences, which is something to consider with respect to potential benefits in *offering a choice*.

From study 2, one take-away is the proposal to attend not only to prototypically *pedagogical* roles but also to other roles that may even superimpose the formers. This can be exploited, for example, if one wants to avoid a reconstruction of existing gender patterns in the educational area. The inclusion of different kinds of roles, in a broad sense, may open alternative ways for navigating in the complexity around cultural stereotypes on gender. In this context it is also useful to look back at the parameters in first study and the option of decreased visual naturalism: Stylized representations of *androgynity* are likely to be less controversial and conspicuous than androgynity appearing in naturalistic (or real human) agents.

In conclusion we have pointed at some relations between roles and appearance and derived some visual design guidelines from these. This is also an example that it is possible to sort out design aspects that can be relevant in specific design contexts. The long-term goal is to establish more extensive sets of design guidelines to be used as check-lists and references while designing virtual (pedagogical) agents.

References

[1] M. Haake and A. Gulz, Visual design of virtual pedagogical agents: Naturalism versus stylization in static appearance, Proc. of the 3rd Int. Conf. on Design for Engagement @ NordiCHI 2006, Oslo, Norway, 2006.
[2] A. Gulz and M. Haake, Design of animated pedagogical agents – a look at their look, Int. Journal of Human-Computer Studies, **64** (2006), pp. 281-394.
[3] A. Baylor and A. Plant, Artificial Intelligence in Education: Supporting Learning through Intelligent and Socially Informed Technology, **125** (2005), pp. 65-72.
[4] C-Y. Chou, T-W. Chan and C-J. Lin, Redefining the learning companion: the past, present, and future of educational agents. Computers & Education, **40** (2000), pp. 255-269.
[5] A. Gulz and M. Haake, Social and visual style in virtual pedagogical agents, Workshop Proc. Adapting the Interaction Style to Affective Factors, 10th Int. Conf. on User Modelling, Edinburgh, Scotland, 2005.
[6] M. Haake and A. Gulz, A look at the roles of look & roles in virtual pedagogical agents, Conf. on Intelligent User Interfaces (IUI), 2006.
[7] S. McCloud, Understanding Comics: The Invisible Art, HarperPerennial (1993).
[8] D. Voelker, The effects of image size and voice volume on the evaluation of represented faces, Doctoral dissertation (1994), Stanford University, Stanford, CA.
[9] RITL (Center for Research of Innovative Technologies for Learning), Florida State University, http://ritl.fsu.edu