Users’ views of Facial Expressions and Body Gestures in E-Learning Interfaces: an Empirical Evaluation

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Abstract: - This paper introduces an experimental study performed to investigate the usability aspects of e-learning interfaces that incorporate the use of avatar as a virtual lecturer. A within-subject experiment has been conducted using three different e-learning interfaces which were developed from scratch and tested by a group of 48 users. Each of these three interfaces involved the use of a human-like avatar as a virtual lecturer to present one of three different lessons about class diagram notation usually used in the software engineering process. The scope of this paper is to report and discuss the experimental results related to users’ satisfaction and views in regard to a set of facial expressions and body gestures when used by a virtual lecturer in the presence and absence of interactive context in e-learning interfaces. These results highlighted that some facial expressions as well as some body gestures were perceived by the users more positively than other expressions and gestures. Consequently, it could be used to improve the attractiveness of virtual lecturers which in turn will be reflected in increasing users’ motivation and interest about the presented learning material.

Key-Words: - E-Learning, Avatar, Facial expressions, Body gestures, Usability, Multimodal metaphors

1 Introduction

E-Learning is a general term that is used to describe the learning process in which information and communication technology could be utilized in the learning process [1, 2]. Recently, most of e-learning interfaces largely depend on text and graphics as an information delivery means. Making use of multimodal interaction metaphors such as speech, sounds and avatars with facial expressions and body gestures is still limited and need to be investigated more. The experimental study described here is one of the main experiments in a research program that aims to explore usability aspects of multimodal e-learning systems. Previous experiment [3, 4] in this research indicated that the inclusion of avatar, earcons and recorded speech could be beneficial in e-learning interfaces. However, it highlighted the need for further research to explore the contributing role of each of these metaphors. This experiment, examined the role of avatar’s facial expressions and body gestures in an interactive e-learning interfaces. In this paper, results related to users’ evaluation of these expressions and gestures are presented.

2 E-Learning

The accelerated developments in computer networks and machines resulted in facilitating easier and faster access to a huge amount of educational content. Therefore, research in the field of e-learning as well as the technologies employed in the development of e-learning applications have been increased [5]. It is expected that there will be about five million online learners within the next ten years [6]. In comparison with traditional learning, e-learning offers more flexible learning in terms of time and location and allows better adaptation to individual needs [7]. Also, it enables online collaborative learning over the Internet [8], could be used to suit a variety of pedagogical teaching approaches [9] and could increase learners’ motivation and interest about the presented material [10]. Nevertheless, technology needed in e-learning is not always accessible [11]. Furthermore, it was found that students felt uncomfortable using computers and missed traditional face-to-face interaction with teacher. Therefore, users’ accessibility and their attitude in regard to e-learning should be enhanced [12].

Pedagogically, it is not always true that every e-learning virtual environment provide high-quality learning and so, fundamental pedagogical principles must be applied to insure successful e-learning solutions [13]. According to Govindasamy [13], development and evaluation of e-learning involves learner and task analysis, defining instructional
objectives and strategies, testing the environment with users and producing the initial version of the e-learning tool.

3 Multimodal Interaction

Multimodal interaction is a human computer interaction in which more than one of human senses are involved. It could be utilised to enhance the usability of user interfaces. Multimodality allows conveying different information using different channels [14]. Also, it enables users to employ the most suitable communication metaphor to their abilities [15]. So, Learning experience could be enhanced by the assistance of Information and Communication Technology (ICT) where visual, aural, haptic and other channels could be integrated in a multimodal approach to perceive and learn the communicated disciplines.

Sound and visual output are complement to each other and variety of information could be distributed across both. However, sound is more flexible because it can be heard from all sides without paying visual attention to the output device. Speech sounds could be used to convey auditory feedback to the users of the system [16]. It was found that the incorporation of recorded speech and short musical sounds (earcons) helped users to perform different learning tasks more successfully [17].

Avatar is another interface component through which both of auditory and visual human senses could be involved. It is a computer-based character that could be utilized to represent human-like or cartoon-like characters [18]. It has been used in interactive computer interfaces to communicate verbal and non-verbal information through facial expressions and body gestures [19]. Several studies have been carried out to evaluate the role of avatar as a pedagogical agent in e-learning. Results of these studies showed the positive contribution of avatars in terms of facilitating the learning process [20-22]. Furthermore, avatars could be employed in e-learning environments to enhance users’ attitude towards online courses [23]. Fabri et al. [24] suggested that facially expressive avatars could be used to teach users with special needs (i.e. autism). A study conducted by Theonas et al. [10] demonstrated that the use of facial expressions particularly the smiling resulted in a more interesting and motivating learning experience and improved students’ performance. In part of this research, we tried to find out which facial expressions and body gestures are more significant for the production of an expressive and attractive avatar to be used in multimodal interactive e-learning systems.

4 Experimental E-Learning Platforms

To serve as a basis for this empirical study, three different e-learning platforms were built from scratch. These platforms has been designed to utilise speaking avatars as virtual lecturers in addition to textual brief notes and graphics across three instances of a multimodal interaction that offers an audio-visual presentation of three different lessons about class diagram notation. These three lessons communicated information about (1) classes and objects, (2) class naming and drawing, and (3) associations and multiplicity. The content of these lessons were adapted from [25] and its duration was 3.24, 3.28 and 5.9 minutes respectively. Although the presentation of these lessons varied among the three platforms, the content and the format was the same.

The first platform (see Figure 1A) named Virtual Lecturer with Facial Expressions (VLFE) utilised an expressive avatar with facial expression while the second one (Figure 1B) provided an avatar with full body animation and gestures and called Virtual

![Fig.1. Screenshots of the three experimental platforms. A- Virtual Lecturer with Facial Expressions (VLFE), B- Virtual Lecturer with Body Gestures (VLBG), and C- Two Virtual Lecturers with Facial Expressions (TVLFE).](image-url)
Lecturer with Body Gestures (VLGB). Both of the first and second platforms allowed the user to textually ask two questions related to each lesson and get the answer by the virtual lecturer with textual and graphical explanations. In the third platform, TVLFE or Tow Virtual Lecturers with Facial Expressions (Figure 1C), two avatars, male and female, with facial expressions were included and shared the presentation of each lesson. Additionally, the last platform included two more avatars to represent male and female students. In contrast to the first and second platforms, the role of these tow avatars was to ask the questions vocally. Furthermore, all experimental platforms offered the pause/play functionalities in its interfaces. Figure 2 shows the facial expressions and body gestures used in the experiment. The same 6 facial expressions were used in both VLFE and TVLFE. According to [26] these expressions were grouped into positive (interested, amazed, happy and smiling) and neutral (neutral and thinking). Also, in addition to walking and neutral, a set of 8 body gestures were used in VLBG and categorised into positive (hands clenching – front and back, open palms, pointing, chin stroking and hands steepling) and negative(arms folded and legs grossed) groups [27].

5 Experiment
One of the main aims of this study was to obtain an overall feedback for the use of particular facial expressions and body gestures in the presence and absence of interactive e-learning context, and to explore whether these expressions and gestures could attract users, motivate them and increase their interest regarding the presented learning material. In order to fulfil this aim, a within-subject approach was employed in carrying out the experiment with 48 users participated in an individual basis. The majority of users were postgraduate students coming from a scientific background and their age ranged from 25 to 44 years. Also, most of them had no or limited experience in both of avatars and class diagram notation, and weekly used the computer ten or more hours. Seventy-three percent of those were male and the remaining were female.

The experiment was explained to each user and started by filling the pre-experimental questionnaire for user profiling. Then, four tasks were required from the user. In the first task, facial expressions were individually shown along with their titles assuming that these expressions will be used by a virtual lecturer. User had to give his/her rating (positive or negative) in regard to the usage of each expression in the absence of learning context. The second task was selecting two expressions that user did like and two that he/she did not like. The same procedure was implemented in the third and fourth tasks but this time body gestures were presented. Thereafter, 2-minute video recording was presented demonstrating the experimental platforms. Once this recording had finished, three lessons about class diagram notation were introduced in an interactive learning context. The order of these lessons was constant for all users but each experimental platform had to be used for the presentation of only one lesson. In order to enforce the learning effect and to make sure that all experimental platforms had been used equally for each lesson, these platforms were assigned to the three lessons on a systematic random rotation basis. Upon the completion of each lesson, user has been asked to answer 4 questions related to the delivered learning material and to rate positively or negatively each expression or gesture used by the virtual lecturer(s). Also, user has been informed to answer the post-condition satisfaction questionnaire regarding his/her experience with the applied interface.

6 Results and Discussion
Figure 3A shows how users evaluated each facial expression used in this study in the absence of any e-learning context and prior to experimenting any of the three experimental platforms. It could be noticed that more than 65% of the participants believed that the positive expressions such as smiling, happy, interested and amazed could be used positively by the virtual lecturer. The percentage for smiling
expression reached about 85% and dropped down for the happy, interested and amazed expression to about 81%, 77% and 68% respectively. For the thinking, the results were less significant with 60% positive views. On contrast, the neutral expression had about 37% of users’ positive views which means that they had a negative impression about it. Figures 3B and 3C demonstrated that users’ feeling becomes more positive in regards to the majority of facial expressions after the implementation of VLFE and TVLFE platforms which incorporates virtual lecturers with the same set of facial expression. This is, in particular, for the neutral expression were the percentage of positive views improved from 37% to about 55% in both VLFE and TVLFE conditions. All other expressions were positively rated by higher percentages with some differences. Comparing to post-VLFE, the interested, thinking and happy expressions obtained better results in post-TVLFE with 18%, 12% and 8% increments respectively. On the other hand, smiling scored the highest positive percentage in post-VLFE. Lastly, users’ rating was the same for amazed expression after experimentation of both VLFE and TVLFE.

Figure 4A shows users’ evaluation of body gestures when presented to them individually in the absence of any interactive e-learning context. For the positive group, it could be seen that these body animations were evaluated positively. The pointing posture obtained 93% positive score, followed by 89% for the open palms and 85% for the hands steepling. A less significant positive score was found for the chin stroking (64%) and front clenching of the hands (62%). However, the back clenching of hands which has been supposed to be positive gesture was perceived negatively by 41% of the users. For the negative gestures, about 75% of the users showed a negative feeling regarding the legs crossed. This percentage dropped down to about 56% for folding the arms. What is more, 60% of the users believed that neutral situation gives a negative impression, and another 81% of them found that the use of walking could be positive.

As it can be seen in figure 4B, results of the experiment revealed that including specific body gestures in interactive e-learning interfaces could be attractive for users. In comparison with the pre-experimental results, users’ positive feeling was improved in regards to all positive gestures as well as the neutral and walking when these gestures have been used by the virtual lecturer. Particularly, the positive score of neutral and walking raised by about 17%. Also, the pointing was positively rated by all users and 93% to approximately 96% of them found hands steepling and open palms positive. For the other gestures in the positive group, users’ positive rating was 75% and 68% for front hands clenching and chin stroking respectively. Concerning the negative gestures, participants of the experiment confirmed their evaluation of both legs crossed and arms folded were the negative score for these gestures increased 10%.

Figure 5 presents users’ selections of the facial expressions and body gestures when shown to them individually in the absence of any interactive e-learning interface. Users were asked to choose two expressions that they mostly liked and another two that they did not like. It could be observed from figure 5A that the positive expressions were liked by more than about 55% of those users who select it especially the smiling (86%) and happy (81%) expression, whereas the neutral and thinking
expressions were selected to be strongly disliked. This means that users were satisfied only with positive facial expressions. Figure 5B shows users’ choices of the 2 gestures they liked and the 2 gestures they didn’t like. The open palms gesture was liked by all users who selected it, followed by the pointing with 91% liked percentage. This percentage was ranged between 68% and 88% for the remaining positive gestures excluding the back clenching of the hands. In spite the fact that this gesture (i.e. hands clenching-back) has been regarded as a positive one, results showed that it was the most disliked among all gestures. In addition, the gestures legs crossed, neutral and arms folded were not satisfactory because these gestures were strongly disliked by users.

7 Conclusion

The conducted empirical study reported in this paper aimed at investigating users’ evaluation of facial expressions and body gestures when shown in the presence and absence of interactive e-learning interfaces. This investigation was carried out by employing a within-subject testing of three experimental platforms. These platforms incorporated avatars as virtual lecturers with facial expressions and body gestures to present three different lessons about class diagram notation. The obtained results demonstrated that the expressions interested, happy, smile and amazed were the most satisfactory for users. As far as the body gestures are concerned, the pointing, walking, open palms, hands...
steepling and front clenching of hands were the most positively perceived by the users. We believe that the results of this research will contribute in the design and production of a more attractive avatar to be used as a virtual pedagogical agent in e-learning applications. However, there is a need for further research to examine more expressions and gestures.

References: