An Affective Computing Platform for Investigating the Role of Pedagogical Feedback in Computer-mediated Collaboration

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Classroom technologies can help increase the quantity and variety of feedback dialogues about an individual student's performance. In this paper, we summarize the dimensions and challenges of pedagogical feedback. We then present our platform combining several affective computing devices and modules which enables to investigate the role of various pedagogical feedbacks in computer-mediated collaboration. Feedback used in educational contexts is generally regarded as crucial for improving knowledge and skill acquisition (Kulik, Kulik, & Bangert-Drowns, 1985). Shute (2008) uses the term 'formative feedback' which she defines as ''information communicated to the learner that is intended to modify his or her thinking or behavior for the purpose of improving learning'' (p.154). Gibbs and Simpson (2004) describe several conditions under which feedback has a positive influence on learning. Feedback is significantly more effective when it provides *specific* details on how to improve the answer, rather than when it just indicates whether the student's work is correct or not (Bangert-Drowns et al., 1991). The *source* of feedback is also an important feature of feedback. Peer feedback is provided by equal status learners and can be regarded as a form of formative assessment plus a form of collaborative learning. Student's trust about peer feedback might nevertheless be limited. Students' reservations prompted them to search for confirmation by checking instruction manuals, asking the teacher, and/or performing more self-corrections. Peers' comments request more clarification and elaboration. As a result, students might acquire a deeper understanding (Yang et al., 2006). Feedback can vary according to several other dimensions, including *valence* and *style* (e.g., positive vs. negative), *timing*. Researchers examined the impact of providing feedback in two contrasting ways to people attempting to solve one insight problem (Roxburgh 2004). Their system provided feedback in either positive (i.e., telling users what they should do) or negative formats (i.e., telling them what they should not do). The results revealed that users receiving feedback in a positive style were more likely to follow it than users who received it in a negative style. Noticing relevant feedback is also known to be of importance and was observed to improve learning in an intelligent tutoring system for peer tutoring (Walker et al. 2012).

Emotional feedbacks (vocal and facial expressions of emotion) are often used in computer-supported collaborative learning environments. Baylor & Kim (2009) showed that the presence of some facial expressions facilitates learning. They observed a positive impact of emotional facial expressions on the perception of the virtual agent and the performance of the task. For example, a facial expression of "seriousness" encourages students to be more concentrated. An expression of "joy / satisfaction" improved learning when it follows a good response from the student. With these emotional feedbacks, interaction becomes more attractive, increasing student engagement and motivation (Afzal & Robinson, 2011; D'Mello, 2007). Recent studies showed that emotional feedbacks can also reduce stress during interactions and increase the efficacy. Kim, Baylor and Shen (2007) observed that a pedagogical agent's empathetic response had a positive impact on learners' interest and self-efficacy. Their results indicated a positive impact of a male pedagogical agent on judgments and interest in the task. When the facial expressions of virtual agent were positive, the male pedagogical agents were judged more favorably than the female pedagogical agents. Baylor and Kim (2009) observed in an experiment about attitudinal instruction that participants learnt more when the agent's facial expression was present and deictic gesture was absent.

A platform for investigating the role of feedback

Such experimental studies about the affective impact of feedback in pedagogical situations involving virtual peers requires multiple components and measuring tools. We hereby describe the different components of our platform.

<u>Expressive virtual agents : the MARC framework.</u> MARC is a platform of virtual expressive virtual agents with several levels of realism (Courgeon 2011). Computer models of emotions inspired from theories of emotions in psychology are used to control the behavior of the agent in real time. Several 3D models exists and the virtual character can be used for different roles (eg. Virtual peer, self avatar, teacher, …) and represent either a distant user (eg his avatar) or an autonomous agent simulating a student. When pretending to be autonomous, the agent can be indeed controlled by a hidden experimenter following the well-known Wizard of Oz protocol. Using the virtual agent as an self avatar of the user might also be useful to make the user aware of his/her own emotions.

<u>Physiological Measures</u>. In real social interactions, we perceive others' emotional facial expressions. We have then a tendency to reproduce them (Hess, Philippot & Blairy, 1999). This matching is commonly called mimicry. Facial electromyography (EMG) can be used to study the user's rapid facial reactions (RFRs) when interacting with others. These very fast facial reactions occur in

less than one second after the social stimulus. Moreover Facial EMG provides information about the valence of user's emotions and can be considered as an objective measure of user's emotional experience. Facial EMG has already been used in experimental paradigm based on virtual expressive characters (Schrammel et al., 2009), but very few studies use facial EMG during real-time interaction with a virtual agent. Our MARC platform was used in a study about social phobia using facial EMG for controlling the approaching behavior of our agents in real-time (Vanhala et al. 2012). In face-to-face virtual interaction, we hypothesize that RFRs are modulated by the type of virtual agent (peer or teacher), the quality of interaction, and virtual character's facial expressions. Studying facial reactions of students is a good way to understand their emotional experience. Electrodermal activity (RED) provides other physiological cues about emotional experience. Several studies showed that arousal is related to variations of RED. It can also inform about the intensity of user's emotion. Recent devices enable to collect such data in a non intrusive way (eg. such as the wireless QSensor).

Eyetracker. The gaze of the users is quite important for studying which areas of the virtual character or of the environment the user is looking at (see our previous study with autistic users looking at virtual agents embedded in social scenes (Grynszpan et al. 2012)). We have two eyetrackers, one on a destop PC and one mobile version.

Video manual and automatic annotations. We already collected video corpora of students interacting with a virtual agent in a previous study using part of the platform. Our platform includes automatic recognition tools such as FaceReader for recognition of basic emotion and a few basic facial movements, the EyesWeb software for studying movements and the Anvil tool for manual annotation of videos (Kipp 2003).

Ontologies for reasoning about student's emotions. Cognitive theories of emotions suggest that the situation and its evaluation by someone is key to emotions (Scherer 2010). Our platform includes an ontology for predicting student's emotion depending on the situation. It was applied to a quiz game (Eyharabide et al. 2010).

Future directions

We recently used part of our platform in a study in which a virtual peer asks questions to a student, assesses the student's answer and provides a positive or a negative feedback. Two conditions were tested. In the first condition, the virtual peer displayed facial expressions corresponding to the feedback. In the second condition, the virtual peer did not display any facial expressions. Analyses are currently being conducted on the collected data.

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