Editorial

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Biographical notes: Dr. Scotty D. Craig is a Research Scientist at the University of Memphis, USA with the Institute for Intelligent Systems/ Department of Psychology. To date, he has worked on projects in such areas as affect and learning, discourse processing, multimedia learning, vicarious learning environments and intelligent tutoring systems in both laboratory and applied classroom settings. His contributions to the field to date consist of 13 journal articles, 1 book chapter, 3 manuscripts in press, 30 published conference proceedings, 32 non-published conference presentations, and 2 manuscripts submitted/in progress. Dr. Craig has served as an ad hoc reviewer for ten academic journals and conferences. He has organised two individual workshops and served as workshop chair for AIED 2009. He is currently on the editorial board of the *International Journal of Learning Technology*.

Genaro Rebolledo-Mendez is a Senior Lecturer and Researcher in the Faculty of Informatics, University of Veracruz, Mexico. Previously, he was a Senior Researcher at the Serious Games Institute, University of Coventry, UK. He has also been a Research Fellow at the London Knowledge Lab, University of London and the IDEAS Lab, Sussex University, UK. Rebolledo-Mendez's interest is the design and evaluation of educational technology that adapts sensitively to affective and cognitive differences among students. To do so he studies how cognitive and affective differences impact students' behaviour while interacting with educational technology and how, in turn, technology impacts students' learning and affect. To that end he uses techniques from artificial intelligence, computer science, education and psychology.

Learning is accompanied by episodes of success and failure which inevitably invoke a host of associated affective responses. Interest driven content exploration (curiosity), being encouraged by success (happiness), making mistakes (feeling confused), recovering from them (overcoming frustration), diagnosing what went wrong (not becoming dispirited), and starting over again (with hope, determination, and maybe even

enthusiasm) are the natural phases involved in the mastery of deep-level concepts. While there have been theories that convey general links between cognition and emotions (Lepper and Chabay, 1988; Picard, 1997; Stein and Levine, 1991), they do not directly explain and predict the sort of emotions that occur during deeper-level learning (Pekrun *et al.*, 2002), such as attempts to master science, technology, engineering, and mathematics. Some emotions presumably have a more salient role in learning than others.

To date there are several open challenges that face researchers investigating the interplay between emotions and learning. These include empirical and theoretical questions such as:

1 What are the emotions that are important to learning?

2 How are they linked with cognition and meta-cognitive processes such as self-regulation and goal orientation?

3 How do they get recognised by tutors, peers, and the learners themselves?

4 Do relationships between cognition and affect generalise above and beyond individual differences in experiencing and manifesting affect?

This special issue emerged from the Modelling and Scaffolding Affective Experiences to Impact Learning workshop[1] held in collaboration with *13th International Conference on Artificial Intelligence in Education* which focused on the four questions posed above. The workshop engaged researchers interested in the role of affect and learning from a large range of multiple disciplines associated with the learning sciences such as psychology, education, cognitive science, computer science, artificial intelligence, and neuroscience. This special issue can be viewed as a follow up on select projects. It includes five articles out of the ten workshop presentation that made it through the review process.

A large majority of our manuscripts deal with affect sensitive intelligent tutoring systems. The widely acknowledged effectiveness of one-on-one tutoring in promoting active knowledge construction has extended the role of affective modelling beyond traditional classroom environments and into the arena of integrated learning environments. The next generation of educational technologies needs to be more than mere cognitive machines. Their educational strategies should be tailored in order to restore the balance between cognition and affect (Picard, 1997). This transition into the affective domain requires innovative approaches to construct online models of the emotion dynamics of a learner and efficiently utilise these models to optimise learning. In addition to the questions raised above, this endeavour brings to light additional computational issues:

- How can we develop and evaluate systems to automatically detect learner centric emotions in real-time?
- How should intelligent learning environments modify their dialogue planners to be responsive and reactive to the learner's affect?
- What social rules should our embodied conversational agents that serve as artificial tutors or peer learning companions employ in order to synthesise affective expressions so as to yield more naturalistic communication?

The papers in this special issue touch on theoretical, empirical, and technological questions that were raised above, but many of these are still open questions that should guide research in the field for years to come. Three of our five papers overview attempts to incorporate the detection of emotions by intelligent tutoring systems. Our fourth paper looks into way that technology can assist affective communication between humans during the learning process. Our last paper in this special issue addresses potential interactions between specific learner characteristics such as self efficacy and the affective agent.

In our opening article, Woolf and colleagues provide a discussion of the theories and technologies needed to understand and integrate knowledge of student affect such as frustration, motivation, and self-confidence) into models of learning. In their paper they provide their model for affect recognition, interventions to respond to student affect and describe their animated agents which express emotional responses to the user.

Our second article provides the pros and cons of online and offline research methodologies when determining the user's affect while using technology, specifically an intelligent tutoring system. In this article, D'Mello, Craig, and Graesser demonstrate that the link between affect and learning require robust methodologies to measure the learner's affective states. Two studies are described that utilise either an online or an offline methodology to detect the affective states of a learner during a tutorial session with AutoTutor. The online study relied on self reports for affect judgments while the offline study considered judgments by the learner, a peer, and two trained judges. The studies also investigated relationships between facial features, conversational cues and emotional expressions in an attempt to scaffold the development of computer algorithms to automatically detect the learners' emotions. Both methodologies showed that boredom, confusion, and frustration are the prominent affective states during learning with AutoTutor.

In our third paper, Balaam furthers our look at methodologies for detecting the learner's affective state in real classroom settings using a technology called the *Subtle Stone* that the student can modify the colour of the stone to indicate their current affective state to the teacher. In two studies, this paper highlights the difficulties intrinsic to gauging a student's affective state. In their first study, they present low levels of correlations between possible physical expressions of emotion and the emotional experiences reported by the students themselves. These low levels of physical expression in turn impact on the abilities of observers (whether the class teacher or an observer unknown to the students) to interpret those emotional experiences. The results from the first study were used in the design the Subtle Stone in an effort to facilitate emotional communication between the teacher and the students. The predominantly qualitative analysis presented in this paper focuses on the Subtle Stone as a flexible new tool for capturing self reports of emotional experience in real time throughout learning experiences. As such we examine the extent to which the Subtle Stone meets the design requirements and needs of the users. We show that the Subtle Stones engendered a sense of private communication between student and teacher within the classroom, enabling the student to communicate her emotional experiences in real time to her teacher. In addition preliminary results suggest that the Subtle Stone is able to make the concept of emotions within learning more accessible to the teenage student.

In McQuiggan and Lester's paper, we turn back to methods of detecting the affective states of the user in an intelligent tutoring system. This paper displays another solution to the puzzle by investigating the role of biofeedback data and context for determining a user's affective state. This inductive approach is examined for the task of modelling student self-efficacy and empathy for companion agents.

In two studies, Kim's article focuses more on the relationship between attitudes towards learning, self-efficacy and learning when learning with an animated agent and demonstrates how this relationship might be more complicated than it first appears. In her first study, she found that when low ability female high school students interacted with an agent based system their math attitudes and to a lesser extent self-efficacy increased. However, this did not hold for high ability students. In a second study, she showed this effect folding across gender. She also determined that how sociable the student was play a significant role in how effective the agent system was at impacting the learner's views. In that, students with lower sociability showed significantly more gains in math attitudes scores and self-efficacy towards math than low social students that did not receive an agent. If this finding holds, it could have implications on who affective sensitive systems target since more of our systems involve agent based systems.

References

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Note

1 http://www.informatics.sussex.ac.uk/users/gr20/aied07/index.html