Emotional Dashboard: Design for Affective Learning Also Needs to Support Teaching

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Abstract: In this paper we revisit our experience with creating and applying a framework for multimodal affective software design and evaluation for education. Our goal was to support the system designer, and indirectly also teachers and students. We describe how our evaluation techniques led us to improve our design techniques. In particular, we gained new insight about the role of the teacher, leading us to redesign a novel interactive visualization to allow teachers to retrieve and explore the emotional factors in multimedia and multimodal experiences.

Introduction and Background

Our recent work has involved the design and evaluation of multimodal software for *affective* education, where the software supports emotional aspects of the learning process. We reviewed interaction design and evaluation methods, adapted them, and then conducted several case studies.

We introduced the Multimodal Affect for Design and Evaluation (MADE) framework—our proposed structure for designing and evaluating affective multimodal education systems (GhasemAghaei, 2015). Our approach involves interaction design and techniques from human-computer interaction (HCI). We focus on how the interface and interaction should be designed to support and *help* a teacher's affective and multimodal strategies, rather than replace the teacher. Our framework therefore involves the system designer working to create a system that supports the teacher's affective strategy, to further support their learning objective for the student. We show this in Figure 1.
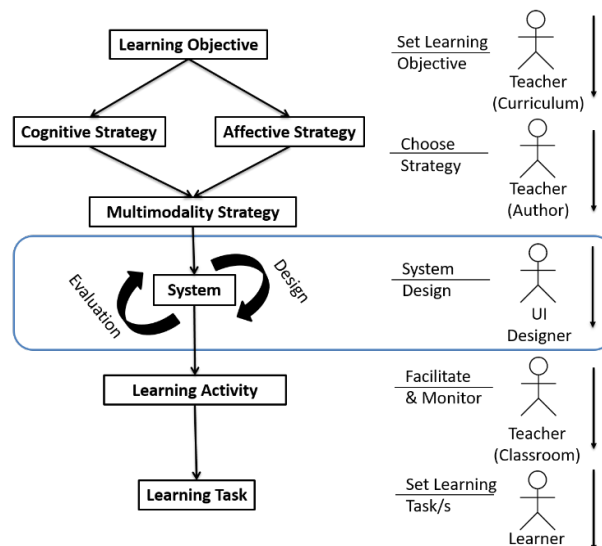

Figure 1: The MADE Framework showing the role of the system in relationship to the teacher.

Our approach to design was to adapt two well-known interaction design techniques, personas and essential use cases, to emphasize elements critical to affective learning, as well as multiple modalities. Our case study of this approach concerned mathematics: see Figure 2. We used the approach explored by education researchers on embodied

cognition to help learn the concept of a ratio (Abrahamson, 2011). The idea was to drive both the understanding and solving cognitive conflicts between the student's implicit assumptions and her/his own observable enactment, providing experiences that were recast in terms of emerging mathematical concepts. Overall, we were pleased that our design techniques drove the design in valuable ways we might not otherwise have considered.

Figure 2: A student moves the right hand higher from the desk searching for equivalent proportions 1 to 3 or 2 to 6; a LEAP Motion device detects this and the system provides affective feedback.

While conducting the studies on our evaluation techniques, we began to recognize some inconsistencies. In particular, our "affective walkthrough" evaluation method involved the emotional cycle in learning identified by Kort et al. (Kort, 2001). In our design methods, however, we had no equivalent approach. Therefore, we needed to go back and support that in the design methods as well. Moreover, these issues led us to recognize the need for better support for the teacher, as well as the student.
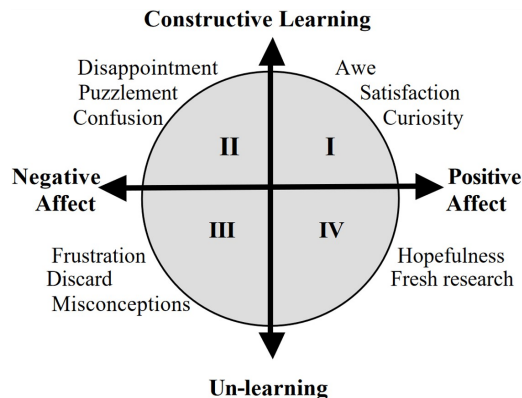

Figure 3: Kort et al.'s model relating phases of learning to emotions (Kort, 2001).

Design Revisited

Like our design methods, our evaluation methods were adapted from two well-known usability inspection methods: cognitive walkthroughs and heuristic evaluation. We conducted a number of case studies of software, both academic and professional, to explore and refine our affective walkthrough, and our affective heuristic evaluation methods. It was during this process that we identified two weakness in our design approach, which we address below. In particular, they relate to our use of Kort et al.'s model of the emotional cycle in learning (Kort, 2001). This model involves first positive affect in exploration, then negative affect as challenges are met, more positive trends as they are overcome, and finally positive affect with affirmation of success (see Figure 3).

Personas

We realized our design techniques had a focus on learners, but did not address the teacher's role in a supporting way. For example, one issue we recognized was that while our design technique emphasized affective personas, we did not consider how they might be created or maintained.

Realization: Up until this point, our design techniques called for different personas to be accommodated, but no way for them to be easily created or maintained by teachers. Our software simply allowed students to control settings of affective messages or media.

Action: We decided that learner personas were properly the responsibly of teachers, and should be supported as such. We therefore created a teacher's dashboard element for this purpose (see Figure 4). The dashboard allows teachers to access learners and personas, and manage the affective settings. In particular, the teacher may link a learner's settings to that of a persona. Thus, creating a persona may be done once, and it can be reused for the students that match that persona, as several students might need the affective strategies from the affective persona model. For example, a teacher might create and reuse personas for students lacking confidence, students more interested in music, or students with who have trouble reading complex text.
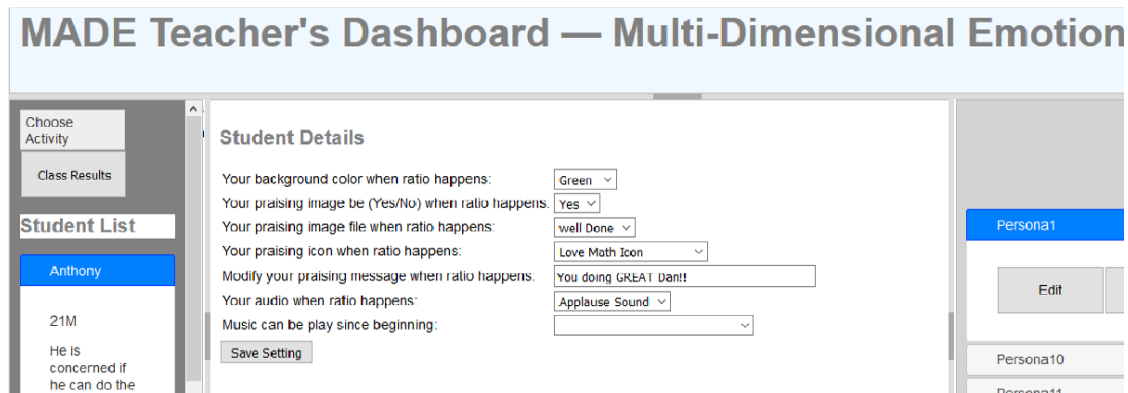

Figure 4: Teacher's Dashboard persona-learner edit settings.

Figure 4 illustrates the dashboard support for personas. This figure shows the class list on the left side, in the center are the detail settings, and on the right side, the list of personas. The teacher can change the settings and have a specific affective strategy for a specific learner or persona. While recognizing the need for this kind of support for teachers, our work on evaluation made us realize a more far-reaching kind of support was desirable. We address this below.

Task Sequencing

Realization: The problem was that Kort et al.'s model and phases proved valuable in our evaluation techniques, but were not considered in our design techniques. Our design did not support task sequences as well as we could have done.

Action: We returned to our learning software, and added new design elements. To support Kort et al.'s model, software might provide a sequence of tasks with difficulty and affective support that vary. We therefore changed our software to take the learner through a sequence of tasks, each presenting a goal for the learner, along with affective feedback. We also added support for the teacher to specify these sequences of tasks customized on the basis of the particular persona or user. The teacher can specify a sequence of tasks, where each task has a level of difficultly, and provides feedback for success or failure. In this way the teacher can follow Kort et al.'s model, beginning by encouraging exploration, and so on through the other phases.

As an example in our ratio software, the user is able to learn ratios and proportions by following a customized task sequence with receiving feedback in each step. First, the system might start by encouraging the user to explore. Next, by giving a simple task and afterwards a complex task. Finally, providing an affirmation task that shows they have mastered the concept.
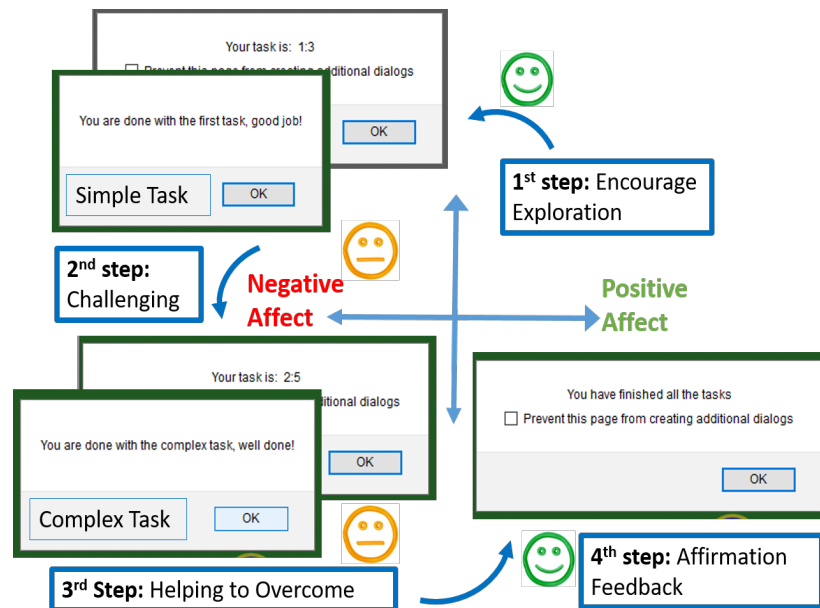

Figure 5: Simple-complex task model for a specific learner, based on the model of Kort et al.

We wanted the *teacher* to come up with the task sequences, and customize the feedback messages with affective strategies. The teacher customizes tasks for each user, e.g. for a specific user the ratio software might include the following task specifications:

- Ratio – First, there will be a simple task (e.g. ratio 2:3), and after the task completion there will be a more challenging task.
- Feedback success – The feedback that should be given to the learner, if the task has been completed successfully.
- MaxTime – Each user has a time period to complete a specific task.
- Feedback Failure – The feedback that should be given to the learner, when they are not able to complete a task in a time period. This feedback might be explanatory, yet encouraging.

We illustrate this sequence in Figure 5. The system (as specified by the teacher) provides each user a customized list of tasks from simple to challenging, when they are interacting with the system.

Visualizing Task Phases

In the earlier work, we introduced an affective e-learning data visualization dashboard for monitoring online learner emotions (GhasemAghaei, 2016). The application such as the ratio software were augmented with Clmtrackr

(Øygard, 2012) , an open source library that supports tracking of facial features and detection of emotions in real time, identifying six different emotions.

The intensity of these different emotions is recorded over time for inspection by the teacher. Figure 6 shows the visualization presented. This allows the teacher to retrieve and explore areas of interest in the student's emotional experience. On the top left we select the learning activity (e.g. the ratio software), on the lower left we show a list of students and their characteristics, and in the main window we have the data visualization graph, showing the time period, the major events (e.g. success and failure), and the emotion data overlaid. The emotion data consists six colored lines, one for each emotion. Positive emotions (happiness and surprise) are shown above the axis, and negative emotions (sadness, anger, disgust and fear) are shown below the axis. On the right we have a summary graph showing user proportions of emotions in specific time periods (which can be selected by moving the interactive "brush" at the bottom).
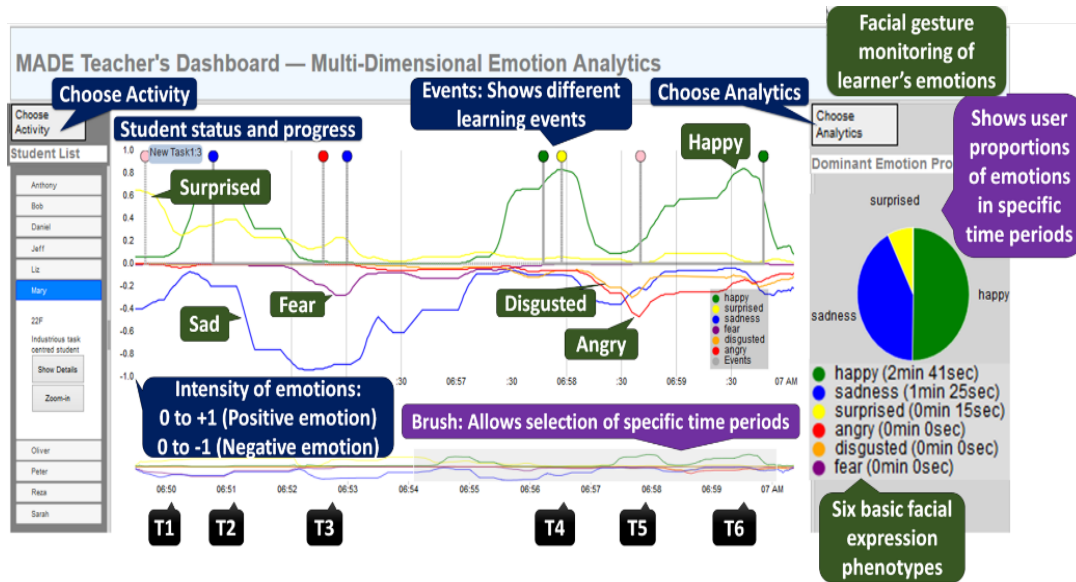

Figure 6: The Emotion Visualization.

Affective Learning Phases

Now that we allow teachers to specify tasks and phases (according to Kort et al.'s model) as described earlier, we can identify these on the visualization.

Realization: While we had displayed the student emotions to the teacher, we had not previously helped associate the emotional impact intended with the emotional impact that resulted.

Action: Now that we allow the teacher to specify tasks and their intent using the model of Kort et al., we can use this information to improve the visualization. We therefore show the phases prescribed by the teacher on the visualization. Specifically, we show different phases in the graph area background with different colors for each phase. Each phase starts when a new task is assigned, and ends when the student succeeds or fails. In this way, the teacher can see their intent, and compare with the emotion data indicated by the six lines.

Figure 7 shows the result. This figure shows two of the phases (overcome and affirm), which the teacher is using for a particular learner. An overcoming phase is shown with a yellow color background and an affirmation phase with a green color background. This will enable the teacher to monitor the emotional impact that was intended. For example, in the figure, the teacher can see the yellow background for an overcome phase, and compare it with the actual emotions of the student. They can see happiness (green line) decreasing as the student is frustrated, and increasing as they overcome and succeed. Sadness (blue line) increases as happiness decreases, but diminishes as the student overcomes their difficulties. This pattern shows that the teacher's intent was successful.
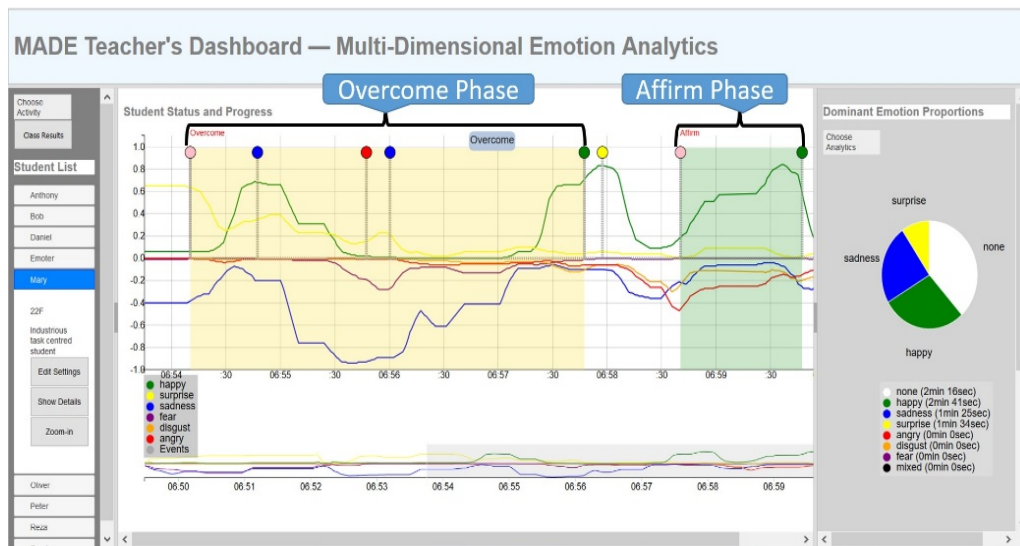
Figure 7: The Emotion Visualization Dashboard showing Kort et al.'s phases specified by the teacher.

Conclusions and Future Work

This paper revisited our previous work exploring support for affective educational software, identifying ways to better support the teacher. For example, there was a need for the teacher to specify personas, and to specify and monitor task sequences for the natural emotional cycle in learning. Our interactive emotional visualization supports the teacher in retrieving and exploring details in the student's experience. We believe that these experiences can help inform the design and evaluation of affective educational applications, and may also be applicable to other types of learning systems. We now plan to conduct user testing of our improved software with teachers and learners.

Acknowledgements

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