

## Work in Progress: A Multi-Modal Method for Assessing Student Emotions During Programming Tasks

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Zahra Atiq is a Ph.D. candidate at the School of Engineering Education at Purdue University. She is interested in learning about the non-cognitive/affective and individual/demographic factors that impact students in STEM courses. Specifically, she is interested in understanding the emotions students' experience while learning computer programming. She is also interested in understanding women's participation in computer science and engineering.

# **WIP - A Multi-Modal Method for Assessing Student Emotions During Programming Tasks**

## **1. Introduction**

Computer programming is considered a necessary skill for engineering students [1]. As a consequence, programming courses are introduced to undergraduates early in their engineering education. However, learning programming is difficult [2]: it requires patience and persistence [3]. It is also challenging because novice students may not have accurate mental models of computer programs [2]. Hence, students in a programming course may experience a wide array of emotions that may positively or negatively impact their performance and learning [4]. Students' backgrounds and cultural factors may also influence their performance and persistence in engineering courses and engineering in general. For instance, women engineering students who struggle in a programming course may leave engineering [5], [6], but little is known about the role of emotions in student retention in engineering. A few researchers are beginning to investigate student emotions in the context of engineering education [7], [8].

The purpose of this research is to investigate the emotions that first-year engineering students experience during programming tasks. I am using inter-disciplinary and multi-modal methods to understand emotions [9], [10]. I aim to use the control-value theory (CVT) of academic emotions, which has been extensively used to understand student emotions in other STEM fields [11]. However, this theory has not been used extensively in the context of computer programming. A better understanding of student emotions may help educators design curriculum and pedagogy to mitigate the effects of negative emotions, and to promote positive emotions. This improved curriculum and pedagogy may eventually help students maximize their learning and performance in programming courses.

## **2. Research Questions**

The overarching objective of this study is to understand the emotions experienced by first-year engineering students as they work on programming problems. Specifically, I ask the following research questions:

1. What emotions do first-year engineering students experience as they work on a computer programming task? How do student emotions change as a result of working on programming problems?
2. What reasons do students describe for experiencing the different emotions?
3. What self-regulation strategies do students use to deal with these emotions?

## **3. Research Methodology**

### **3.1. Context and Participants**

For this study, I recruited 18 participants from ENGR 132 (Transforming Ideas to Innovation II) during Spring 2018. ENGR 132 is a two-credit course that introduces programming skills in MATLAB to first-year engineering students at Purdue University. For this study, I considered

only novices, taking ENGR 132 for the first time, because novices may experience a range of emotions while taking a programming course [1].

### 3.2. Research Design

I collected quantitative and qualitative data, both concurrently and retrospectively. Each selected student participated in two sessions: 1) *programming task* and 2) *retrospective think-aloud interview*.

#### 3.2.1. First Session – Programming Task

In the first session (up to 75 minutes), the participant worked on a set of programming problems using MATLAB. The workstation used by the participant was equipped with a frontal camera to capture facial expressions and an eye-gaze tracker to capture eye-gaze data. The participant wore a noninvasive “shimmer” device on one foot [Figure 1(a)]. This device captured electrodermal activity (EDA), which consists of autonomic changes in the electrical properties of the skin. Data from all these devices were synchronized using a software package called imotions, a platform used to do biometric research [Figure 1(b)]. imotions also recorded screen capture while the participant worked on the workstation. Before the task started, the participant was prompted to fill out the before-task Achievement Emotions Questionnaire (AEQ), which is a validated self-report instrument based on CVT that assesses student emotions in academic settings [12].

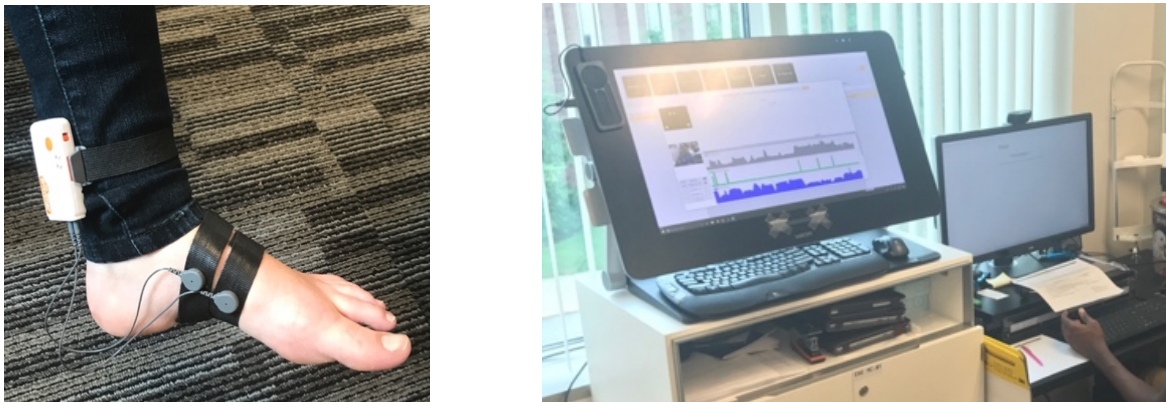


Figure 1: (a) Shimmer device attached to participant's foot, (b) Workstation with frontal camera, keyboard, and mouse

The participant then worked on the programming problems for thirty minutes. Once completed, the participant filled out two questionnaires: 1) the after-task AEQ (self-report emotions they may be experiencing upon completion), and 2) the Neuroticism sub-scale of the Big-Five personality trait inventory. This sub-scale asked participants about their tendency to experience unpleasant emotions (anger, anxiety, depression, and vulnerability). Collecting these data will help differentiate between participants who have a neurotic predisposition and participants who might experience a change in emotions when they worked on programming problems. Finally, I conducted a short post-task interview, in which the participant answer questions about their experience of completing the programming task. The interview was audio recorded.

### 3.2.2. Second Session - Retrospective Think-Aloud Interview

The second session (retrospective think-aloud interview) took place approximately three to five days after the programming task. I replayed the video of the programming task session. The screen capture and eye-gaze data helped participants recall what they did during the programming session [13], [14]. While the participants viewed the segments, I paused the replay of the programming task after every 30 seconds, and asked these questions: a) What emotion do you think you were experiencing here? b) What do you think are some reasons for experiencing these emotions? and c) What strategies did you adopt to deal with the emotion? The retrospective think-aloud interview was audio recorded.

Since I am using CVT as a framework for various stages of my study, I will use a theoretical thematic analysis [15] to analyze the transcripts of the interviews (both the follow-up and retrospective think-aloud) using a codebook that I have designed [16]. As I analyze the data, the sample codebook will evolve by adding new codes.

## 4. Current Status and Future Directions

This research study has been designed for the purpose of a PhD dissertation. The immediate future directions include conducting the analysis in the summer and fall of 2018, and defending the dissertation in the spring of 2019.

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