Exploring the Role of Emotions in Foundational Electrical Engineering Courses

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WIP: Exploring the role of emotions in foundational electrical engineering courses

Introduction

In this Work In Progress, we present a pilot study to investigate how instructors see the role of emotions in their student's learning process and argue that instructors' emotional connections substantially impact teaching methods and practices, consequently influencing the students' learning process. Research conducted by educational psychologists and cognitive scientists has demonstrated the importance of emotional connections in the learning process. When information is tied to an emotional association for the student, it tends to be better retained and recalled over an extended period [1]. In fact, the complex and dynamic processes associated with learning cannot be dissociated from the crucial role that the emotions being experienced by the students play. Turner et al. [2] claim that emotion is a constant component in examining the incentives, support, and outcomes of instructional interactions that shape students' goals and, consequently, their motivation. Consequently, educators may support students' motivation and performance by creating an emotionally supportive learning environment where students feel safe and valued [3].

Little research has been done to understand emotions or affective experience; for example, of over 42,000 publications in engineering education between 1990 and 2007, approximately 0.2% investigate affective factors as a central component of research [4]. Between 2010 and 2020 there were only 25 peer-reviewed journal and conference papers research about emotions or affection in engineering education [5]. Furthermore, there is a tendency among faculty and professionals to prefer the idea of engineers as rational problems solvers, rather than engineers who also rely on their emotions and feelings in these processes [6]. Perhaps that is why Lönngren et al. (2023) [7] asserts that in order to reshape engineering education and empower students with the skills, capabilities, and assurance to address future sustainability challenges, research in engineering education needs to involve emotions in the processes of teaching and learning. Thus, this work in progress aims to serve as the foundation for future papers, where possible best practices can be provided for engineering faculty to learn how to incorporate emotional connections in their classes, thereby enhancing the learning process for their students. To achieve this, we will address the following research questions:
RQ1: How do instructors perceive the role of emotions in their student's learning process?
RQ2: How do instructors integrate emotional connections into course design and classroom teaching practices?

Emotions in Engineering Education

In the field of emotion research, emotions are commonly perceived as short-lived experiences triggered by various stimuli [8]. Researchers in this field widely concur that these emotional episodes are composed of multiple components: a subjective feeling component, a motor component, a physiological component, an action tendency component, and an appraisal component; and these components can be measured at different levels of analysis [8]. For this study, we will see emotions as a sociocultural phenomenon with a constructivism lens. This theoretical perspective suggests that our understanding of reality is shaped by our own experiences and interpretations. Constructivism focuses on the way individuals, both researchers and participants, make sense of their experiences [9], within this perspective, one assumes that

participants experience the world around them in different ways. Viewing emotions through this lens will help us better understand each instructor's perception of the role of emotions in teaching and learning. This is particularly important since prior studies have demonstrated that the emotional state of the instructor can have significant impact on the overall learning experience [10], [11], [12].

Theoretical Framework

The Control Value Theory framework (CVT) is a well know framework to study academic emotions. This framework views emotions as a combination of interconnected psychological processes, where all the components play essential roles. These components include affective (related to feelings), cognitive (related to thoughts and mental processes), motivational (related to goals and desires), and physiological (related to corporal responses) elements [10]. Furthermore, Pekrun (2006) established that academic emotions consist of two dimensions, each characterized by two factors (a) valence, which is the quality of emotions consisting of positive or negative factors, and (b) activation, which is composed of activating or deactivating energy [11]. For this study, we will employ the concept of academic emotions, along with its two dimensions and factors, as depicted in Figure 1.

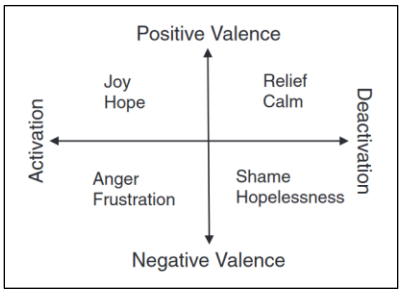

Figure 1. *Representation of the two dimensions of academic emotions and its two characterizing factors* [11]

Methods

The study was conducted during the spring semester of 2024 at a PWI (Predominantly White Institution) in the United States. As a case study and work in progress, we identified two instructors from the electrical engineering department who teach foundational EE courses. These instructors were selected because they are part of a larger NSF-funded study conducted by the authors, thus already familiar to them.

Participants and setting

One of the goals of the larger project in which this WIP is situated seeks to explore the instructional practices of instructors of foundational electrical engineering classes. Consequently, two instructors were invited to participate in this pilot study. One instructor is a female who teaches the Embedded Systems course, while the other is a male teaching Intro to ECE Concepts; both have more than 7 years of experience teaching these courses.

Data Collection

We conducted in-person interviews with the two instructors. The interviews were video recorded and lasted between 20 to 30 minutes. All interviews were conducted by the first author, and the video recordings of the interviews were transcribed by the first author. As part of the interview

protocol, the researcher explained to the participants the concepts of positive and negative emotions and activation and deactivation emotions and showed them Figure 1.
The interview questions were adapted from Lonngren et al. [5] using the concepts of academic emotions and their two dimensions and factors. The questionnaire can be seen in Appendix 1.

Data Analysis

For this work in progress (WIP), we aim to analyze both common and distinct themes between the two interviews. Additionally, we intend to highlight how instructors use positive and active emotions from the CVT framework in classroom teaching practices. The primary theme identified in both interviews is *connection*. Both instructors emphasized the significance of establishing a connection with students. They asserted that this connection fosters student engagement with the course, encouraging attendance and active participation in projects. Both instructors also acknowledged the role of emotions in building this connection. The first instructor in the interview explicitly stated:

> *I think if you don't have a connection, it's really difficult for them a) to get them to come to class, because they don't feel like there's a connection, they just don't come across. So, attendance is intimately tied with emotion. And, then the desire to do well. You know they'll never really have the desire to do well if they don't have a connection with the professor. So… I think that's one of the most important components, in being a good professor, is to develop that connection. And the easiest way to do that is just to be nice.*

As we can see in the paragraph, the instructor emphasizes the significance of the connection between the instructor and students for effective learning. He asserts that in order to form this connection, the instructor has to be nice and kind to the students. On the other hand, the second instructor also emphasizes the importance of the connection between the instructor and students. However, she states that to build this connection, it is necessary to establish a sense of community in the class. The students should feel a sense of belonging in the class. She said:

> *I hope that by feeling included and not being alone… they can do better today… that is more about having a connection. If we consider the class as a living organism, sort of, that includes the professor, and the TAs, and the other students. I like for the students to have a feeling that they are part of this. Not, not being part of it. And that is more of an emotional thing to me than a logical thing. Because logically they know they have registered for class and they are part of the class.*

We can observe that, although both professors coincide on the significant role of the instructor-student connection in the learning process, they differ in their approaches to establishing this connection. This is the first difference that we found in the interviews: the distinct techniques instructors employ to foster a strong instructor-student connection. Nonetheless, both instructors shared the belief that emotions are integral to this process. Another common theme that we found was *empathy*. The instructors mentioned that empathy is a key element in connecting with their students and that it can only be achieved on an emotional level, as one must understand and feel what the other person is experiencing. The first instructor recalled the importance of sharing his past feelings with students after being presented with the figure of academic emotions from the CVT framework. He emphasized that it is important to empathize with students by sharing personal anecdotes. He said:

> *I'll tell the students about the fact that I had a lot of trouble when I first learned circuits. Okay. So I share a personal experience. I was frustrated. Right. So, then they feel like it's okay if they get frustrated.*

On the other hand, the second instructor mentioned that she tries to empathize with the students by sharing stories of how previous classes have overcome the course and how many students before them have successfully finished it.

> *Giving them the sense that despite the fact that they may feel alone or that this is too hard … telling them that many students before you came and they had similar things and many other students in class are feeling the same way. So, you are not the only one who is experiencing all of these.*

Both instructors highlighted the importance of empathizing with students. One instructor demonstrated personal empathy, connecting with students on an individual and emotional level. The other instructor transmits empathy through the sharing of stories of various students who had previously successfully completed her class. Once again, the difference lies in the techniques that instructors use to empathize with their students.

Results and Future Work

In this pilot study, we wanted to explore how instructors see the role of emotions in their student's learning process. In this first approach, our findings indicate that instructors indeed recognize the significant role emotions play in their classrooms. We have identified two crucial abilities that instructors use to spark students' learning process through emotions: *connection and empathy*. Furthermore, we have identified specific techniques that instructors employ to establish emotional connections with their students, aiming to enhance student attendance and support them in achieving the expected learning outcomes. While there is still ample room to delve deeper into emotions in engineering education, we believe that this work in progress provides a solid foundation for asserting the significance of the attitudes, empathy, and connections that instructors cultivate in the classroom.

Therefore, the next steps for this work would be to analyze how the instructor-student connection facilitates student engagement with the course material and contributes to achieving the learning outcomes. It is also important to further investigate this topic to uncover best practices, assisting new instructors in effectively integrating these methods from the beginning.

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Appendix 1
Questionary for interviews

1. Do you believe that emotions play a role in learning within engineering classrooms? If so, what specific role do you think they play?
2. Based on your experience, what types of emotions do you believe students experience?
3. Have you found that students’ emotions influence your teaching methods? If so, how and in what kinds of situations?

We show the instructors Figure 1 from the paper, and then we ask them two more questions:

3. Based on your experience, have you used these positive and active emotions in course design and/or classroom teaching practices?
4. Based on your experience, have you encountered deactivation emotions from students when lecturing in a class? If so, did you use any strategies at that moment?