
AC 2011-2764: UNCOVERING THE ROLE OF EMOTION IN ENGINEERING EDUCATION WITHIN AN INTEGRATED CURRICULAR EXPERIENCE

Nadia N. Kellam, University of Georgia

Nadia Kellam is an Assistant Professor and engineering educational researcher in the Department of Biological and Agricultural Engineering at the University of Georgia. She is co-director of the CLUSTER research group. Her research interests include interdisciplinarity, creativity, identity formation, and the role of emotion in cognition.

Tracie Costantino, University of Georgia

Joachim Walther, University of Georgia

Joachim is an assistant professor of engineering education research at the University of Georgia (UGA). He is one of the leaders of the Collaborative Lounge for Understanding Society and Technology through Educational Research (CLUSTER), an interdisciplinary research group with members from engineering, art, and educational psychology.

His research interests span the formation of students' professional identity, the role of reflection in engineering learning, and interpretive research methods in engineering education.

He was the first international recipient of the ASEE Educational Research Methods Division's "Apprentice Faculty Award", was selected as a 2010 Frontiers in Education "New Faculty Fellow", and is currently a UGA "Lilly Teaching Fellow".

His teaching focuses on innovative approaches to introducing systems thinking and creativity into the environmental engineering program. In this context, he is involved in the development and implementation of the Synthesis and Design Studio series at UGA.

Nicki Wendy Sochacka, University of Georgia

Nicki Sochacka is completing her doctorate at the University of Queensland. Her research interests span socio-technical transitions, with a particular focus on sustainable urban water management, and integrating socio-technical methods of inquiry into engineering practice and education. She currently holds a research and teaching position at the University of Georgia.

Uncovering the Role of Emotion in Engineering Education within an Integrated Curricular Experience

Abstract

The purpose of this paper is to uncover the role of emotion within an interdisciplinary, project-based design studio as implemented in 2009 and 2010. This qualitative research study involves a narrative analysis of data collected over two semesters of the design studios to identify the types of emotions described, the change in these emotions over the semester, and the interaction of these emotions with learning. This analysis is conducted on students' written reflections, as it is important to understand emotions from the perspective of the student and within the desired context. More specifically, the research study consisted of a narrative analysis of individual reflection reports written by students after participating in multiple reflective activities over the course of one semester. Two student narratives are highlighted in this analysis. The analysis of this data indicates that emotions at the high end of the activation spectrum, for example angry, tense, and excited, were described by the students as leading to critical learning incidents. The students described how their emotions changed over time as participating in the overall class or an individual project. The presence of high-activation emotions within the student narratives indicates that higher order thinking strategies were present. Additionally, the presence of negative emotions at the beginning of projects and positive emotions later in the project suggests a need for more scaffolding of projects and activities at the beginning of the time period and less later in the project or activity.

Introduction

Recently there has been an increase in the amount of research exploring emotions in education.^[1] Furthermore, there have been recent developments in neuroscience that point to the critical role of emotion in learning and decision-making.^[2-5] We have often considered emotion as a by-product of learning, but recent developments demonstrate that emotion is an integral part of learning.^[6]

There has been some discussion within engineering education concerning how intellectual development is influenced by a student's emotional state^[7] and the importance of the Empathy Quotient (EQ).^[8] However, both of these examples are considering emotion as separate from learning, not how emotion is an integral part of learning as the educational psychologists and neurologists have shown more recently.^[1-6] As engineering educators this recent research on the integral role of emotion in education is very relevant to us as we are preparing engineering graduates to make decisions and face some of the world's most pressing problems. A deeper understanding of the integral role of emotion in cognition within engineering education promises to have implications for critical thinking, life-long learning, and motivation.

The purpose of this paper is to uncover the role of emotion in learning within an integrated curricular experience^[9-12] and to further understand the interaction of emotion and student learning. This qualitative research study involves a phenomenological, narrative analysis of data collected over two semesters of an interdisciplinary design studio to identify the types of

emotions described, how the emotions evolved over time, and the relationship between emotions and learning.

Literature review

The engineering classroom is often associated with negative affect. Commonly the engineering classroom is a high stress environment with strenuous tests, a lot of homework, and difficult projects. Elizabeth Linnenbrink explains that an unpleasant affect is beneficial when one is working in a detail-oriented, analytical environment.^[13] She also explains that a pleasant affect is beneficial when one is working in a broader, more complex environment. Traditionally, engineering has been a more detail-oriented, analytical environment; however, the discipline of engineering is increasingly being called upon to approach more complex, broader issues such as global warming and energy shortages. When dealing with more complex and broad situations a pleasant affect is beneficial and therefore may be even more critical in the current engineering climate.^[13] Moreover, unpleasant affect is associated with external regulation of learning while positive affect is associated with self-regulated learning. For examples of positive and negative emotions see Figure 1, the right side of the figure includes examples of positive emotions (enjoyment, hope, pride, and relief) while the left side includes examples of negative emotions (anger, anxiety, shame, boredom, and hopelessness). In engineering the importance of lifelong learning is paramount, which could provide further support for positive affect that has been demonstrated to support self-regulated learning.

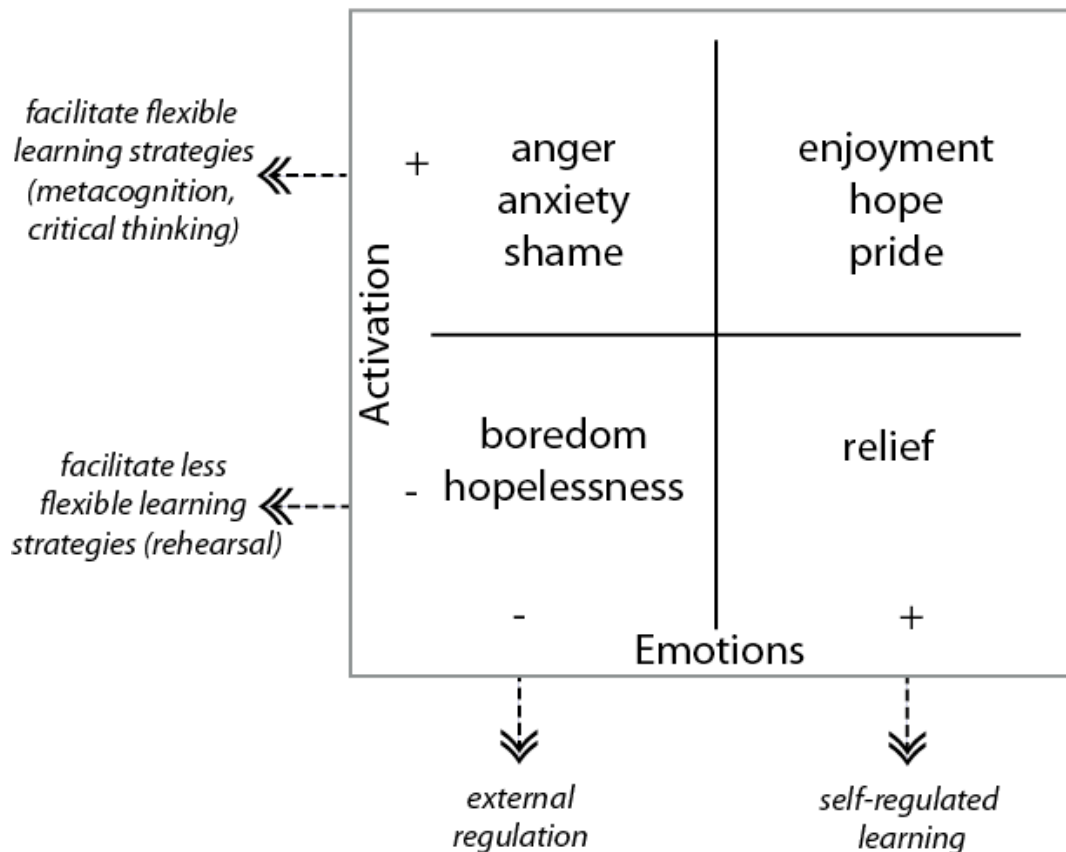


Figure 1: Representation of the relationships and examples of positive and negative affect (emotion) and high and low level of activation^[13-15]

In addition to positive and negative affect, emotions are described as being high or low activation emotions.^[15] For example a high activation emotion would be anxiety while a low activation emotion would be boredom. High activation emotions have been shown through research to be associated with flexible and higher order learning strategies such as metacognitive, elaborative, organizational, and critical thinking.^[16] Low activation emotions were associated with less flexible learning strategies such as memorization, strategies, and rehearsal.

Mark Johnson, a philosopher of embodied cognition, informed by the work of neuroscientists Antonio Damasio and Joseph LeDoux, provides clear definitions of emotion and feeling, and their relationship in cognition. He defines emotions as “complex neural, chemical, and behavioral responses to various types of stimuli that typically have positive or negative value for us”.^[17] Johnson explains that emotions are categorized as background, such as energy or calmness; primary, such as joy, sorrow, anger; and social such as pride or shame.^{[18][17]} In Figure 1 there is a combination of background, primary, and social emotions in each quadrant.

Johnson defines feelings as “a qualitative awareness of our sensations and emotional responses.”^[17] In the narratives described below, students’ feelings made them aware of the emotions they were having in relation to different aspects of the trigger, which may have been collaborative

work, or some other aspect related to the project. This trigger may be considered an emotionally competent stimulus, as theorized by neuroscientist Antonio Damasio^[5], which starts the cognitive process of emotional response, awareness through feeling states, and eventually reasoning to make a decision on how to act.

Context

This study involves examining emotion and triggers from the student perspective within the context of an interdisciplinary, project-based design studio as implemented in 2009 and 2010.^[9-12] The design studio occurs annually throughout the four-year environmental engineering undergraduate degree. The studio, its attributes, its curricular design, and research concerning student creativity is explored in more depth in other papers,^[9-12] but for the purposes of this short paper it has the following attributes: 1) project-based, 2) deliberate reflective activities, 3) distributed cognition, and 4) studio environment with two, three hour sessions per week. To provide the context needed for this paper, below we briefly describe deliberate reflective activities as these are used as the narrative data in this research study.

In each design studio students participate in multiple, deliberate reflective activities. These include journaling, minute papers, focus groups (2-3 times per semester), written reflections after each focus group, and a process reflection report at the end of each semester. In the written reflections after each focus group, the students are instructed to follow the SAID framework in which they describe specific situations (S), their reaction (affect) to that situation (A), their interpretation of the incident (I), and their decision making as a result of the incident (D).^[19-21] For the process reflection report, students are instructed to look back at their progress over the semester by referring to their journals and their written reflections. They then write a process reflection report that describes their learning and development over the semester. This report provides a synthesis of each student's learning over the course of the semester and is based on multiple forms of reflection.

Narrative Research

This phenomenological study used narrative analysis^[22, 23] of student reflections written by each student after participating in multiple reflective activities over the course of one semester. In the initial research design we planned to conduct an interpretive, phenomenological study in which we planned to code the students' process reflections as emotions and triggers. However, after the first iteration of coding the data as emotions and triggers in NVivo (a qualitative research software that allows for highlighting and coding text electronically) the researchers noticed something unexpected. In the students' process reflections the students described their emotions through telling a story. Their emotions were often described as changing through the course of a project or a specific activity within the course. By looking at discrete events (triggers and emotions) within the process reflections the researchers would have missed the richness of the emotions being portrayed through the students' experiences within the context of this design studio.

This narrative research method allows us to capture the students' stories, which describe rich accounts of student emotions throughout their semester of participation in the design studio. For this paper we analyze two student narratives in which emotions are present.

This research approach is not in alignment with many researchers studying emotion in education as it does not involve a quantitative, survey-based methodology. This research approach is in alignment with Op't Eynde and Turner's recent argument in which they describe a need to study the student within the context of a classroom and to take the perspective of the student.^[6] They argue that the researcher's observation of their activities or environment are not important, instead, it is important how the student interprets and makes meaning of their environment and experiences. Schutz and Decuir also argue that emotions should be studied from a holistic perspective and within the appropriate context.^[24] This is well suited for the narrative analysis as proposed here.

The participants in this study include students enrolled in the transdisciplinary (involving art and engineering students and ways of thinking) design studio that was offered in the Fall of 2009 (N=19) and the interdisciplinary (artistic ways of thinking were employed with all engineering students) design studio that was offered in the Spring of 2010 (N=45). Each student submitted a process reflection at the end of the semester. The authors reviewed these reflections using NVivo 8 software and first coded for emotions and triggers (see ^[25] for details about using NVivo to code qualitative data). After deciding to use a narrative analysis framework, we reviewed the process reflections again from a narrative approach. This involved highlighting stories told by the students in which they specifically discuss emotions. The following research questions were used to guide this study:

1. In what ways did students describe their emotions through engagement and participation in the design studio?
2. Did these emotions change or remain the same throughout the students' narratives?
3. How do these emotions interact with student learning?

The following two student narratives describe two common triggers that students discussed within their process reflections. The first focuses on the trigger of the ambiguity of projects and the second focuses on team roles and relations. After each narrative we discuss the specific excerpt and the categories of emotions that emerged from this narrative. In the discussion section we discuss the interaction of emotions with student learning.

Narrative 1: Reflecting back over the class I feel that I have come to enjoy the way that the class is designed much more now than when I began. Coming from the typical class where everything is very rigid and structured, I was frustrated with the first project and its uncertainty. However, by the third project I was completely excited with the fact that we just had the topic of sustainability and that the direction of the project was completely up to us. Also the strategies and tools that we used at first frustrated me and I was not motivated at all to use them. But after using them this semester I have come to see how useful they are.

This narrative describes the change in emotions toward projects throughout the course of the semester. The design studio is a project-based learning course that focuses the projects on open-ended and ill-structured projects. This learning environment is different from most educational environments that these students have experienced in their K-12 or higher education experiences.

This student, a female, environmental-engineering freshman, describes her emotions as she engaged in the projects throughout the design studio. During the first project she was frustrated (a high-activation, negative emotion) and at the launch of the third project she was excited (a high-activation, positive emotion). A similar trigger, an ambiguous project, provided two different emotional responses in this student after experience engaging in this project-based, ambiguous course. Over time she became familiar with project-based learning and ambiguous projects and then had a positive emotional response to a similar project.

Also, this student explains frustration (a high-activation, negative emotion) and a low level of motivation when discussing the strategies and tools that were introduced early in this class. These were project management strategies and tools that focused on the following aspects: scope, time, team, and performance. After engaging in using these project management strategies and tools, this student explains that she began to have a more positive emotional response when she began to understand the usefulness of these strategies and tools. She seems to have become more motivated towards the end of the semester when she describes being “completely excited” about the direction of the third project.

Narrative 2: After the first day of group work, we were asked to reflect on how we worked with the group members and what we learned about how to work with each other. We were working well together, and our ideas were fitting together well. I was apprehensive about having random group members; I wanted to work with people I knew and have worked with before. After the first meeting with the group, I remember feeling relieved that we were able to work together well. We began to divide the work up amongst ourselves and it all worked out that we got the part of the project we were best at and enjoyed doing the most. ...

About halfway through the project, we were asked again how we felt our group was going and how the project was coming along. This time, I was a little less pleased with the progress our group had made. I think that it was asked at a time when a couple of things we had planned to put into our report fell through, including an interview with a grocery store manager. This interview was going to be key to our video. I wrote on March 1 that "I don't have the camera...and I should call to find the camera. I don't have my group members' phone numbers because they are in my visual journal." ...

After the project was finished and we had turned it in, we were asked one more time to reflect on the group and the progress that was made. I remember being happy with the project that was turned in because I knew that our group had worked hard on it and had done the best with what we had. I was relieved that everything had been completed and turned in on time. On March 17 I said that "it felt good looking at the finished products online. Knowing we did a good job with it makes me happy that it is done." I learned that working in a group can be rewarding, especially if the group members all work together well and do their fair share of work. Working with these people helped me understand better how I work with other people. Learning this will be valuable in later endeavors with engineering problems that have to be resolved among a team of engineers. If I see that the members of a group are working in this manner, I know that the final product will most likely be much better than if the group tends to follow the ideas of just one person.

This narrative describes a journey that the student took during the course of a single project. Before the project he was anxious (a high-activation, negative emotion). After the first team meeting he was relieved (a low-activation, negative emotion). During the project he became anxious again about the team's progress. After submitting the project he became both happy and proud of the team's accomplishment (a high-activation, positive emotion). During this single team project this student describes both high and low activation emotions as well as positive and negative emotions.

This student, a male, environmental engineering junior describes his emotions as engaging in team projects. He cycled from negative to positive emotions as he moved from apprehension to relief to frustration and to relief and pride. This narrative describes the complex emotions that can be experienced while participating in a single project within one course.

Discussion

In the emotion in cognition literature described in the literature review section there was discussion of prior research that connects the type of emotion experienced with external and self-regulated learning, and with flexible and rigid learning strategies. This is an interesting lens to use when analyzing the student narratives presented in this paper. This lens can give rise to implications for teaching and learning.

At the beginning of the class and a project both students described being anxious and frustrated. These negative emotions have been shown to correlate with external regulation.^[15] This could have implications for the degree of scaffolding of a project or activity within a classroom. When the student is first given a project this suggests that it may be beneficial to provide more scaffolding through early deadlines or in-class activities to encourage the team or student to begin work on a project. Later, when the students have more positive emotions they will engage in self-regulated learning and will not need as much scaffolding of the project. This connection between negative and positive emotions with external and self-regulated learning can have implications of the curriculum design as the instructor considers how much to scaffold an activity.

It is encouraging that in both of these student narratives high-activation emotions are present. The only low-activation emotion described was relief after the project was submitted. Pekrun et al. have found that high activation emotions are associated with flexible and higher order thinking strategies such as metacognition, critical thinking, and creativity.^[15, 26] One of the main objectives of this course is to increase these flexible and higher order thinking strategies. It makes sense intuitively that a project-based course would encourage higher order thinking and this research supports that claim. In addition, other research conducted within this design studio shows that students' creativity is increased as a result of participating in the design studio.^[9, 12, 27] The implications for this are that when observing for indicators of whether the students are using critical thinking strategies, instructors can determine whether the students are experiencing high or low activation emotions. If boredom and relief are common emotions observed this might suggest that students are employing less flexible learning strategies such as rehearsal.

Conclusion

This paper begins to uncover the role of emotion in engineering education. With a deeper understanding of the integral role of emotion in cognition within neurology and educational psychology there is a demonstrated need to explore further the role of emotion in engineering education. This is especially critical as the discipline of engineering is increasingly being called upon to deal with large-scale, complex problems such as global warming and energy shortages.

This exploratory research study demonstrates that emotions are expressed in the context of this design studio and suggests the implications of this for developing a deeper understanding of student learning which will, in turn, impact teaching. This paper can serve as a catalyst for more research and a deeper understanding of the role of emotion in engineering education.

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