# WIP: *Understanding Emotional and Transformative Journeys in a First Year Engineering Program*

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***Abstract*—First year engineering experiences provide unique cognitive and emotional challenges, that help first year students to venture outside their comfort zones. These challenges act as "disorienting dilemmas" which help in initiating transformative learning by compelling students to critically self-reflect and reassess their assumptions, beliefs, and values. This self-introspection may trigger emotional responses or discomfort in students during their first-year experience. The study is motivated to explore the unique interplay between students' emotional journey and transformative journey during first year experiences. Hence, this research to practice paper aims to explore the role of emotions in a first-year engineering program using Mezirow's transformative learning theory (1990) and Russell's Circumplex model of affect (1980) as our guiding theoretical frameworks. Data was collected through surveys from first-year engineering students in *an Engineering Design Thinking* course at the end of their second semester. The study utilizes quantitative methods to analyze the data, and preliminary results show that students who attained a transformed perspective and were more likely to take reflective actions, were less likely to feel bored and more likely to feel engaged in their first-year experience.**

**Keywords—first year engineering experience, emotions, transformative learning**

## I. INTRODUCTION

Literature have extensively used the Tinto's model of retention to understand the various risks and challenges first year students face in their college journey [1]. Tinto's model considers the degree of academic and social integration the student has, to predict their risk of attrition [2]. Studies have explored the academic factors such as performance and GPA, and social factors such as faculty support, peer support and college support to understand students' engagement and success [2].

First year students face a higher risk of attrition [3-4]. This is due to the unique set of challenges they face in their first year of engineering. Most of the challenges stem from their transition from high school to college. However, studies have mostly focused on the cognitive factors that affect students' experiences as compared to the non-cognitive factors [5]. Both cognitive and non-cognitive factors have a dimension related to emotions [6]. An important learning theory that takes into account the emotional component of learning process is the transformative learning theory. According to the theory, when learners come across a situation that does not fit well with their existing meaning schemes and belief systems, it challenges the learners to reassess their assumptions, perspectives and belief systems. This leads to the process of critical self-reflection and help the learners gain transformed perspectives and worldviews [7]. The situations which start the transformative learning process are called "disorienting dilemmas". The process of critical self-reflection on such disorienting dilemmas is often accompanied with strong emotions such as guilt and confusion.

First year engineering experiences are recognized for presenting students with unique cognitive and emotional challenges, pushing them beyond their comfort zones. These challenges act as disorienting dilemmas which help in initiating transformative learning by compelling students to critically reflect upon and reassess their self-assumptions, beliefs, and values. The process of self-introspection might trigger emotional responses or discomfort in students during their first-year experience. Thus, to comprehensively understand the factors that affect student's experiences, we should focus on student's emotional journeys along with their academic journeys. This study is motivated to understand first year students' emotional journeys and how they interact with their transformative learning process. The study aims to explore the role of emotions in a first-year engineering program using Mezirow's transformative learning theory [7] and Russell's Circumplex model of affect [8] as our guiding theoretical frameworks.

Research Question: What is the relationship between first year engineering students' transformative learning experiences and emotional experiences?

## II. THEORETICAL FRAMEWORKS

### *A. Mezirow's Transformative Learning Theory*

Mezirow's Transformative Learning Theory states that thought-provoking experiential activities or scenarios (also referred to as disorienting dilemmas) that challenges students' "meaning perspectives"- uncritically assimilated assumptions through the process of socialization [9], leads to the development of new frames of reference through a transformation of perspectives [10]. Transformative learning helps in examining the changes experienced by learners in the cognitive, affective, and conative dimensions [9]. Mezirow conceptualized a ten-stage framework for the transformative learning process [11] described below.

Stage 1. A disorienting dilemma
Stage 2. Self-examination with feelings of guilt or shame,
Stage 3. A critical assessment of epistemic, sociocultural, or psychic assumptions,
Stage 4. Recognition that one's discontent and the process of transformation are shared and

that others have negotiated a similar change,

Stage 5. Exploration of options for new roles, relationships, and actions,

Stage 6. Planning a course of action,

Stage 7. Acquisition of knowledge and skills for implementing one's plans,

Stage 8. Provisional trying of new roles,

Stage 9. Building of competence and self-confidence in new roles and relationships; and

Stage 10. A reintegration into one's life based on conditions dictated by one's new perspective.

### B. *Circumplex of Emotions Model*

In order to provide innovative changes to an individual's learning experience, observations must first be made. One way to make such observations is to track a user's engagement level depending on their emotions [12]. To more accurately understand if a student is learning or not, Altuwairiqi et al. [12] proposed a new affective model, which is an adaptation of Russel's circumplex model of affect [8], to detect a student's engagement level. According to their model, Altuwairiqi et al. [12] outlined five levels of engagement, ranging from Strong, High, Medium, Low, and Disengaged, can be tracked by understanding one's emotions. Each level contains a varying amount of specifying emotions which are then mapped to a circumplex plane with engagement level on the Y-axis and levels of pleasantness and unpleasantness on the X-axis. The proposed model can be seen in Figure 1. This model guided the emotional engagement items in our survey.

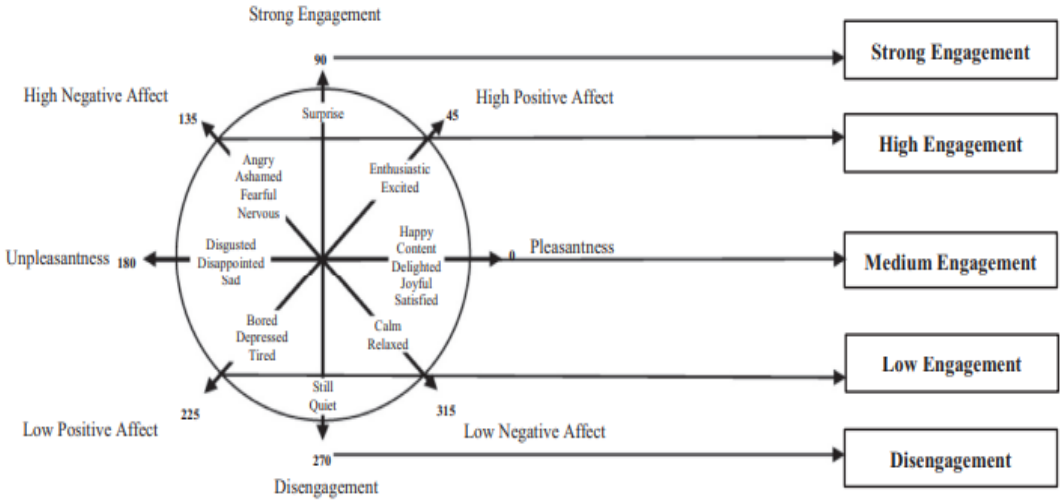


Fig. 1. Altuwairqi et al. (2021) circumplex of emotions model

## III. METHODS

### A. *Setting*

The study took place at a midwestern U.S. University in the year 2024. The participants were recruited from a first year "engineering design" course, Engineering Design Thinking, in their second semester. Throughout this course students were challenged to learn the engineering design process which would help them promote "engineering thinking". To implement what they have learned, each student had to complete a semester long engineering project which tested their problem defining, brainstorming, problem testing, and project communication/marketing.

### B. *Data Collection*

Data was collected through an online survey from first year engineering college students. The students were notified of the survey at the end of the semester and were invited to participate via email and QR code. Participation in the survey was voluntary with there being no financial incentive.

The survey was administered using Qualtrics Online Survey Tool and was made up of 3 major sections, containing both quantitative items (fixed-answer multiple-choice questions) and qualitative items (open-ended free-response questions). Part one of the survey was based on the learning activity survey questionnaire [13] and was used to determine a student's transformative learning stage as outlined in Mezirow's ten stage framework for the transformational learning process [7]. Each question was Likert-scale item answered on a scale of one to six; six and one being equal to a strong level of agreement or disagreement respectively, five and two being equal to moderate levels of agreement and disagreement respectively, and four and three being equal to slight levels of agreement or disagreement respectively. These transformative learning stage-wise Likert items were followed by six open ended questions regarding students' transformative learning experiences during their first-year engineering courses. Section two was a habit of mind survey that consisted of fixed-multiple choice answers which held the purpose of determining to what extent the first-year engineering experience was influential in the six dimensions of a student's habits of mind [14]; with those 6 dimensions being philosophical, moral and ethics, psychological, sociological, epistemic, and aesthetics. Each question asked students how much their habit of mind regarding each dimension was influenced due to their engineering experience on a scale of one (not at all influential) to five (extremely influential). This was followed by asking students to identify factors that influenced their habits of mind. The checklist of factors included classmate support, instructor support, an encounter during the program, team project,

college support and any other factor. Section three included items related to students' emotional engagement collected on a 6-point Likert scale (1=highly disagree, 6=highly agree). Examples include: i) *I felt disappointed, ii) I felt bored.* Section four was then used to collect demographic data from each participant. Of these demographic questions, gender, race, ethnicity, international status, first generation status, engineering majors and information about a student's college pathway was collected.

### C. Sample

Of the 300 students invited to complete the survey, the analysis was based on 166 viable responses. Out of the workable data, according to the survey responses, 73.5% were males (n = 122), 24.7% were females (n = 41), 1.8% (n = 3) of the responses reported they did not identify as male or female or preferred not to answer the question. White/Caucasian students made up 74.1% (n = 123) of the responses, while 13.3% (n = 22) were Asian, and 9% (n = 15) were Black/African American. International students made up 13.3% (n = 22) of the responses, 11.4% (n = 19) were reported to be first generation college students. Approximately 93.4% (n = 155) of students reported that they enrolled in college directly from high school without any delay. Students were made up of multiple engineering disciplines including mechanical, electrical, chemical, biomedical, civil, aerospace, computer, architectural, and environmental.

### D. Data Analysis

Descriptive statistics were used to calculate frequencies, means, and standard deviations for all responses and were analyzed using IBM SPSS Statistics. Nonparametric tests such as a Mann-Whitney U test, and a Kruskal Wallace Test were utilized to search for significant differences between correlations of gender, race, transformative learning scores, and habits of minds.

This paper provides the preliminary results for the transformative learning stages (measured through learning activity survey items) and emotional engagement of students (measured through engagement items). The qualitative items and habit of mind items and their related factors are not presented in this work in progress paper.

## IV. Preliminary Results

Mezirow's stage wise transformative learning scores obtained from the learning activity survey are tabulated in Table 1. It was found that stage 6 (development of an action plan) had the highest agreement scores, followed by stage 7 (acquisition of skills and knowledge for implementing action plan) and stage 9 (development of self-confidence and competence in new roles). Stage 5 (exploration of new actions and roles) and Stage 2 (self-Examination) received the lowest agreement scores.

TABLE I. MEZIROW'S 10 STAGE OF TRANSFORMATIVE LEARNING

| Stage# | Mezirow's Stages of Transformation | Learning Activity Survey Items | Mean | SD |
|---|---|---|---|---|
| 1 | Disorienting Dilemma | *i) I had an experience that caused me to question the way I normally act.*<br>*ii) I had an experience that caused me to question my ideas about social roles.* | *3.66*<br>*3.63* | *1.35*<br>*1.36* |
| 2 | Self- Examination | *iii) As I questioned my ideas through the experience, I realized I no longer agreed with my previous beliefs or role expectations.* | *3.27* | *1.21* |
| 3 | Critical Assessment of Assumptions | *iv) I realized that other people also questioned their beliefs.* | *3.92* | *1.12* |
| 4 | Recognition that others shared a similar transformation | *v) I thought about acting in a different way from my usual beliefs and roles.* | *3.66* | *1.23* |
| 5 | Exploration of new actions and roles | *vi) I felt uncomfortable with traditional societal expectations.* | *3.10* | *1.27* |
| 6 | Development of an action plan | *vii) I tried out new roles so that I would become more comfortable or confident in them.* | *4.07* | *1.11* |
| 7 | Acquisition of skills and knowledge for implementing the action plan | *viii) I tried to figure out a way to adopt these new ways of acting.* | *4.01* | *1.30* |
| 8 | Implementing the plan | *ix) I gathered the information I needed to adopt these new ways of acting.* | *3.95* | *1.20* |
| 9 | Development of self-confidence and competence in new roles | *x) I began to think about the reaction and feedback from my new behavior.* | *3.99* | *1.24* |
| 10 | Reintegration into life based on new perspectives | *xi) Through my FYEE experience, I took action and adopted these new ways of acting.* | *3.98* | *1.16* |

Table II shows the agreement scores for the emotion related items. Students recorded the highest agreement scores for feeling nervous and engaged. The lowest agreement scores were recorded for feeling relaxed. It can be observed that higher agreement scores were mostly recorded for high arousal emotions and lower agreement scores for low arousal emotions.

TABLE II. CIRCUMPLEX OF EMOTION

| Items | Nature of Emotion | Mean | Std Dev | Interpretation of Mean Value |
|---|---|---|---|---|
| I felt disappointed. | HA-NV | 3.21 | 1.25 | Somewhat Disagree |
| I felt bored. | LA-NV | 2.91 | 1.26 | Somewhat Disagree |
| I felt quiet. | LA-PV | 3.11 | 1.23 | Somewhat Disagree |
| I felt relaxed. | LA-PV | 2.44 | 1.30 | Somewhat Disagree |
| I felt nervous. | HA-NV | 4.11 | 1.33 | Somewhat Agree |
| I felt surprised. | HA-PV | 3.83 | 1.19 | Somewhat Agree |
| I felt excited. | HA-PV | 3.74 | 1.23 | Somewhat Agree |
| I felt satisfied. | LA-PV | 3.76 | 1.15 | Somewhat Agree |
| I felt engaged. | HA-PV | 4.19 | 1.13 | Somewhat Agree |

a. We denote Low Arousal-Negative Valence as LA-NV, Low Arousal-Positive Valence as LA-PV, High Arousal-Positive Valence HA-PV and High Arousal-Negative Valence as HA-NV

Table III below shows the correlations of the ten stages of transformative learning with the various emotions experienced by the students in their first-year engineering experience. It was found that feeling excited had a positive

correlation with all the stages of transformative learning whereas feeling quiet and relaxed did not have any correlation with any of the ten stages of transformative learning. Both the items related to the disorienting dilemma phase (items 1 and 2) were correlated with the feeling of surprise and excitement. Stage 10 (integration of transformed perspective) was negatively correlated with the feeling of disappointment and boredom.

TABLE III. CORRELATION MATTRIX OF TRANSFORMATIVE LEARNING STAGE AGREEMENT SCORES AND EMOTIONAL ENGAGEMENT AGREEMENT SCORES

| Emotions | LAS S1a | LAS S1b | LAS S2 | LAS S3 | LAS S4 | LAS S5 | LAS S6 | LAS S7 | LAS S8 | LAS S9 | LAS S10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Disappointed | -0.124 | -0.106 | -0.086 | -.164* | -.168* | -0.093 | -.236** | -0.137 | -.229** | -.261** | -.235** |
| Bored | -.211** | -0.108 | 0.001 | -.201** | -0.077 | 0.041 | -.250** | -.194* | -.225** | -.211** | -.302** |
| Quiet | 0.008 | -0.02 | 0.005 | -0.066 | 0.027 | 0.025 | -0.006 | -0.101 | -0.004 | -0.001 | -0.028 |
| Relaxed | -0.034 | 0.103 | 0.085 | 0.106 | 0.002 | 0.105 | 0.11 | 0.015 | 0.027 | 0.135 | 0.005 |
| Nervous | .164* | 0.149 | 0.093 | 0.074 | .167* | 0.097 | 0.13 | 0.15 | .167* | 0.086 | 0.105 |
| Surprised | .237** | .281** | .168* | .284** | .207** | 0.145 | 0.141 | .210** | .174* | .258** | .170* |
| Excited | .217** | .215** | .160* | .306** | .257** | .235** | .235** | .280** | .338** | **.416**** | .254** |
| Satisfied | 0.12 | .182* | 0.114 | 0.13 | 0.145 | 0.095 | .307** | .207** | .298** | .364** | .222** |
| Engaged | .193* | 0.106 | 0.004 | .240** | .159* | 0.133 | .347** | .259** | .314** | .370** | .266** |

a. LAS S1a and LAS S1b refers to LAS item referring to stage 1 as shown in Table 1, LAS S2 refers to LAS item referring to stage 2 as shown in Table 1, and so on

We performed a Mann Whitney U test for comparing the mean responses of male and female students for the emotion related items. We found that female students were more likely to feel nervous in their first-year engineering experience than their male counterparts (Z=2.780, p=0.005). Another Mann Whitney U test was performed for comparing the mean responses of emotion related items for white and non-white students. We found that non-white students were more likely to report feeling surprised than white students (Z=2.686, p= 0.007). We did not find any statistically significant mean differences in the emotion related items between international and domestic students, and first generation and non-first-generation students.

## V. DISCUSSION

The study aimed at understanding the relationship between first-year engineering students' transformative learning experiences and their emotional experiences. Our preliminary findings suggest that first year engineering student experiences consisted of a mix of pleasurable and unpleasurable emotions, but most emotions were associated with high alertness or arousal. The students experienced all transformative learning stages to a moderate extent. Transformative learning process is triggered by experiencing disorienting dilemmas. This explains why students in our study associate feelings of excitement and surprise with the disorienting dilemma phase of transformative learning. Further, transformative learning leads to changes in prior perspectives and habits of mind, transforming learner's frame of refences to be more inclusive and reflective. We found that the students who attained a transformed perspective and were more likely to take reflective actions, were less likely to feel bored and more likely to feel engaged in their first-year experience.

## VI. FUTURE PLANS & CONCLUSION

Since emotions are subjective and understanding emotions is a complex task, we plan to analyze the qualitative data regarding student's emotional and transformative experiences in their first-year engineering experience. Future work will include the exploration of the relationship between the habit of mind changes experienced by students and their emotional journeys in their first-year engineering experience. The qualitative data analysis will also help in triangulating the results obtained from the quantitative analysis. By understanding students' emotional journeys in their first-year engineering courses, faculties and instructors can provide targeted emotional support and foster a safer and more inclusive learning environment.

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