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# Measuring Emotional Intelligence in Undergraduate Engineering Students

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**Abstract:** Engineering management, aside from the profound technical knowledge it requires, relies on the ability to influence, communicate, and manage emotions. Engineers and STEM students, however, are often criticized for having low emotional intelligence. This may affect future outcomes in interviews, job performance, and academic pursuits. With the goal of better understanding how emotional intelligence may affect engineering students, this research seeks to: 1) quantify the emotional intelligence quotients of undergraduate engineering students at the University of Puerto Rico-Mayagüez (UPRM); and 2) analyze the characteristics that industry recruiters focus on in job interviews for potential candidates. The Bar-On EQ-I assessment was used to create an online tool that will be distributed to all engineering students at UPRM. The assessment will provide information related to each student's academic and professional journey, which will be analyzed to identify correlations with emotional intelligence. Additionally, a questionnaire will be distributed to industry recruiters to assess the ideal emotional intelligence traits that they pursue for among job candidates. All together, these results will bring about greater importance to the subject of emotional intelligence within engineering students, as well as be an indicator for the UPRM faculty on where to invest resources to help students grow in their emotional intelligence.

*Keywords:* Engineering Management, Emotional Intelligence, Engineering Students, Leadership

## 1. Introduction

Ever since Goleman's 1996 best-selling Book *Emotional Intelligence: Why it can matter more than IQ,* the concept of emotional intelligence (EI) has grown in recognition and relevance (Goleman, 1996). EI is defined as the capacity to be aware of, control, and express one's emotions, and to handle interpersonal relationships judiciously and empathetically (Oxford Dictionary, 2010). Although it is a fairly new psychology-focused concept, there are studies correlating EI with physical and psychological health, social and self-actualization, performance at school and in the workplace, and leadership (Bar-On, R., 2006). To say that EI is important to the development of students and professionals is an understatement, for its impact and benefits go beyond those of work and school.

Within the engineering field, the fairly new engineering management discipline combines both technical and leadership skills. Engineering management is defined as the art and science of planning, organizing, allocating resources, and directing and controlling activities that have technological component (ASEM World Headquarters, 2018). It is the perfect combination between engineering knowledge and managerial practices, or in other words: technical and people skills, respectively. Engineering managers, students who are now training to become engineering managers, and engineering students in general are now required to have a set of skills that can be correlated to EI. With this in mind, the goal was to better understand and assess EI levels in undergraduate engineering students at the University of Puerto Rico-Mayagüez. It was also important to better understand what trends exist in the different industries that recruit engineers when it comes to EI. With better understanding of the current state of EI and where the industries and recruiters require the students to be, it will help the students to strive to be well-rounded professionals in a holistic manner and improve student's well-being and performance.

## 2. Literature Review

### 2.1 Emotional Intelligence Theory - History and Disputes

The study of EI has been a subject of disagreement in psychology and the social sciences because of differences in opinions and definitions. There are three main contributors to the field, these being Salovey & Mayer, Goleman, and Bar-On.

Salovey and Mayer are the main and first contributors to the branch of EI, dated back to 1990. Mayer and Salovey define EI as "the capacity to reason about emotions, and of emotions to enhance thinking. It includes the abilities to accurately perceive emotions, to access and generate emotions to assist thought, to understand emotions and emotional knowledge, and to reflectively regulate emotions so as to promote emotional and intellectual growth" (Mayer, J. D., Salovey, P., and Caruso, D. R., 2004). From their theoretical perspective, EI "refers specifically to the cooperative combination of intelligence and emotion". Salovey and Mayer categorized the skills and abilities of EI into a four-branch model, these being: perceiving emotion, using emotion to facilitate thought, understanding emotions, and managing emotions (Mayer, J. D., Salovey, P., and Caruso, D. R., 2004).

Following Salovey's and Mayer's contributions, Daniel Goleman's work is the main reason the concept of EI became widespread among academia and society. The publication of his book in 1996 titled *Emotional Intelligence: Why it can matter more than IQ* got the attention of many and led EI into the mainstream and corporate environments where it has grown. Since then, he has written several books on EI focusing on workplace environments and leadership. Daniel Goleman defines EI as "the ability to identify, assess and control one's own emotions, the emotion of others and that of groups" (Goleman, 2014). He also categorized EI into different categories and created a 5-branch model: Self-awareness, self-regulation, internal motive, empathy, and social skills (Goleman, 2014).

Mayer and Salovey criticize Goleman for his work because they believe that EI should not be correlated with personality. Under Mayer and Salovey's definition of EI there is no mention of interpersonal skills or traits that can be related to charisma or character. They view EI as a "member of a class of intelligences including the social, practical, and personal intelligences" that they call the "hot intelligences" (Mayer, J. D., Salovey, P., and Caruso, D. R., 2004). Goleman took the theoretical concept of EI and transformed it into an understandable and mainstream concept, which included optimism, leadership, team capabilities, and others.

Within the field there are other ways EI can be classified and defined, and a common one is Bar-On's. Reuven Bar-On is an important figure in the study of EI, for he created the EQ-i, an EI assessment. The EQ-i holds so much importance because it is a pioneering assessment of its kind to be published by a psychological test publisher and one of the most widely used measures of emotional-social intelligence to date (Bar-On, R., 2006). Bar-On defines EI as the "array of noncognitive capabilities, competencies, and skills that influence one's ability to succeed in coping with environmental demands and pressures" (Bar-On, R., 2006). Bar-On also created a 5-scale model that was divided into fifteen (15) subscales to classify EI. The five (5) major scales are: Intrapersonal, Interpersonal, Stress Management, Adaptability, and General Mood (Bar-On, R., 2006). Bar-On's definition and classification is more similar to Goleman's vision of EI. To better visualize the types of EI theory, differences and similarities of these methods are found in Table 1.

Table 1. Differences between mayor contributors to the field (Riemer, M. J., 2003)

| *Mayer and Salovey* | *Goleman* | *Bar-On* |
|---|---|---|
| 1. Perceiving emotion | 1. Self-awareness | 1. Intrapersonal |
| 2. Using emotion to facilitate thought | 2. Self-Regulation | 2. Interpersonal |
| 3. Understanding emotions | 3. Internal Motive | 3. Adaptability |
| 4. Managing emotion | 4. Empathy | 4. Stress Management |
| | 5. Social Skills | 5. General Mood |

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## 2.2 Emotional Intelligence in Engineering Education

Student's emotional intelligence can have a significant impact on learning, creativity, and performance. With that said, in no way it is said that EI should be considered a replacement for technical knowledge, instead, EI should be used as an enhancer of teamwork, work skills, and self-awareness. Since it is known that being able to monitor and control your own emotions is part of EI, it can help to understand that emotions and EI affect school performance. Marc J. Riemer lays out the important elements to consider when utilizing EI in education:

- "Individuals differ in their ability to harness their own emotions in order to solve problems.
- Emotions and moods can subtly (but systematically) influence certain components and strategies affecting problem solving.
- Positive emotion can affect memory organization so that cognitive material is actually better integrated and diverse ideas are seen as being more inter-related.
- Emotions and moods may be used to motivate and assist in improved performance at complex intellectual tasks.
- Emotional processes can refocus attention and help to reprioritize demands on the person's attention and the reallocation of resources.
- Emotionally intelligent individuals will be able to solve problems adaptively and will be more competent in integrating emotional considerations when considering alternatives" (Riemer, M. J., 2003)

## 2.3 Emotional Intelligence in Engineering Management

EI skills can be applied across different work environments and roles. EI can improve teamworking skills, communication skills (written, non-verbal, oral), conflict resolution, leadership, and more. Goleman states that "careers where professional selection focuses almost exclusively on intellectual abilities, emotional intelligence carries much more weight than intellect in determining who emerges as a leader" (Goleman, 2014). With newer technology and human resources practices, recruiters and companies hire, promote, and develop with EI in mind. A famous study done by Cavallo, K., PsyD, and Brienza at Johnson and Johnson called "The emotional intelligence and leadership study" gave us an insight on how EI affects workplace and leadership (Cavallo, K. and Brienza, D., 2002). The study was conducted on 358 managers across the *Consumer & Personal Care Group* internationally to identify if there were any specific skills or traits that distinguished high performers from average performers (Cavallo, K. and Brienza, D., 2002). The results indicated that "the highest performing managers had significantly more "emotional competence" than other managers". It also found "that in divisions around the world, those identified at mid-career as having high leadership potential were far stronger in EI competencies" (Cavallo, K. and Brienza, D., 2002)

With high levels of EI, engineering managers can be prepared for when setbacks occur; when projects don't follow the project plan, when things are not running routinely, when machinery breaks, when employees have discussions. It is then that the capabilities of engineers are tested, and their needs to be the right balance between technical skills and EI (Zhou 2010).

# 3. Methodology

## 3.1 Bar-On EQ-i Method

As previously mentioned, Reuven Bar-On created the EQ-i, which is a self-report assessment of emotional behavior which can estimate the level of emotional intelligence, named the emotional quotient (EQ). The assessment contains 133 items comprised of short sentences which can be answered using a Likert scale from 1 to 5, 1 meaning *not true of me* and 5 meaning *very true of me*. Scores are tabulated and converted into standard scores (T-scores) with a mean of 100 and a standard deviation of 15 (Bar-On, R., 2006). The assessment has a correction factor comprised of validity indices, which are positive and negative impressions of different items. The EQ score is directly proportional to the level of emotional intelligence, and the level of emotional intelligence is directly proportional to "effective functioning in meeting daily demands and challenges" (Bar-On, R., 2006). The development of the Bar-On model and EQ-i took a time period of seventeen (17) years and went through six (6) major stages. The EQ-i has also gone through numerous reliability and validity studies conducted around the world over the past three decades (Bar-On, R., 2006).

### 3.2 Dr. Emir Rivera-Castillo's Work

Emir Rivera-Castillo, PhD, is a Puerto Rican psychologist who has worked with the Bar-On EQ-I model since the early 2000's in his master's thesis at the Ibero-American University Puebla in Mexico (Rivera, 2000). In his work, he translated the assessment to Spanish in order to be accurately employed within the Mexican population. In 2008, he published a revised translation that was adapted to the Puerto Rican population and studied with over 200 Puerto Rican citizens to conclude that this version met all the major psychometric criteria of reliability and validity (Rivera, 2008). Rivera's work was used in this research because it is scientific, appropriate, and able to provide a clear translation of the EI levels among engineering students at the University of Puerto Rico-Mayagüez.

### 3.3 ANOVA

After the data samples were collected, one way ANOVA was used to interpret the results. The focus was on looking at the relationships between different factors and the level of emotional intelligence in students. The objective is to identify which factors contribute to high emotional intelligence scores. The factors that were considered are:

- GPA scores
- Engineering Department
- College years
- Gender
- Extracurricular activities (COOP, Summer Internship, Research, Student organizations)

## 4. Tool creation

### 4.1 Questionnaire Tools

After Dr. Emir Rivera-Castillo's revised Bar-On EQ-i assessment was received, it was deployed into a Microsoft Form to be able to mass distribute it, taking into consideration its efficiency and within this new virtual world caused by the COVID-19 pandemic. Two Microsoft Forms were created, one using Dr. Emir Rivera-Castillo's assessment and another to assess what companies and recruiters are looking for in candidates pertaining to EI. In this assessment, recruiters were asked to order in their or their companies' preference which EI branch or subbranch is preferred. Even though the mission is to recollect data to understand the current EI state at the UPRM, it will also help to gather information on demographics to try to identify trends withing gender, age groups, engineering departments, and past experiences of students. The analysis of the recruiters' questionnaires is not included in this article due to space limitations.

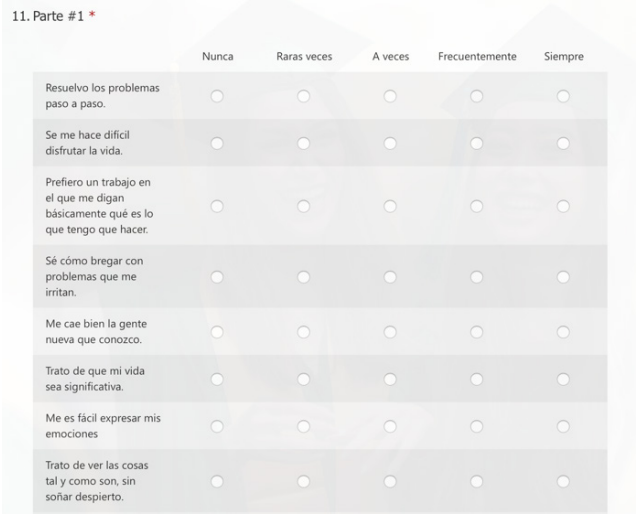


Figure 1. Student Questionnaire tool

### 4.2 Excel Tool

After creating the questionnaires, a Microsoft Excel tool was programmed to automate the analysis process from the Microsoft Forms answers. There are a series of steps that need to be taken to calculate the end result, including validating positive and negative impressions, standardizing scores, and organizing these calculated scores in their different EI branches. Additionally, the Excel tool created visualizations of the scores to show trends and simplify data understanding.

## 5. Results

### 5.1 Demographics

There were a total of 220 samples within seven (7) different engineering majors, with at least fifteen (15) samples for each branch of engineering. There is a nearly perfect split between genders, with 105 males, 112 females, and 3 who wished to not identify themselves as neither male nor female. Regarding the academic year, there are twenty-three (23) freshmen students, twenty-five (25) in their second year, thirty-six (36) in their third year, forty-two (42) in their fourth year, twenty-nine (29) in their fifth year, and sixty-five (65) in a sixth or higher year. Many of the samples were from students who had extracurricular activities. Sixty-seven (67) students had participated in summer internships, fifty-nine (59) had participated in semester long COOP experiences, and ninety-three (93) had participated in research projects within the UPRM or through Summer Research.

### 5.2 ANOVA Results

When the analysis was performed on the different factors and how they affected the level of EQ, very interesting results were found. The one-way Anova results show no statistical differences between the means of EQ scores based on the different hypothesis, with one exception. The different engineering departments appear to exhibit different levels of EQ scores. There is sufficient evidence to conclude that at least one of the mean EQ totals for the seven (7) departments was not the same. When looking at the results, software engineering is the lowest scoring department when it comes to EQ scores. Refer to Figure 1.

**Analysis of Variance**

| Source | DF | Seq SS | Contribution | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|---|---|
| Departamento de Ingeniería | 6 | 704.5 | 8.92% | 704.5 | 117.42 | 3.43 | 0.003 |
| Error | 210 | 7189.9 | 91.08% | 7189.9 | 34.24 | | |
| Total | 216 | 7894.5 | 100.00% | | | | |

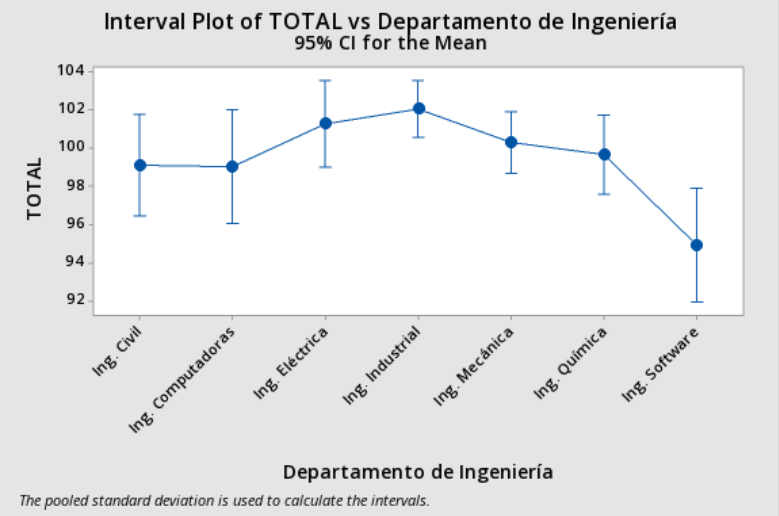


Figure 2. Minitab Results

## 6. Conclusion

While seeking to better understand EI, its effects on students and leadership, and how they can be improved, it is possible to start understanding its importance and relevance to people's everyday lives. As companies seek to create more diverse and welcoming environments, EI will be more thoroughly searched for within candidates. It was interesting to see that there were no significant differences between EQ scores when you compared factors like gender, academic year, and extracurricular activity participation. Believing that there is more that can be done in this field, it is recommended to recollect more data samples, specifically in those engineering branches with the lowest participation. Something that would also be interesting to see in the future is how each different factor contributes to the EQ score in students. This research effort represents a pioneering project, focusing on student's EI and engineering management research within the University of Puerto Rico – Mayagüez.

There are opportunities to continue this research in the future, using this initial assessment as a basis. In particular, it will be appropriate to understand the differences in the EQ scores among the different engineering disciplines.

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