

Academic success of first year engineering students: emotional intelligence a predictor?

**M.F. (Frankie) Stewart (fstewart@ryerson.ca), Colin Chisholm (c.chisholm@gcu.ac.uk)
& Malcolm Allen (m.allan@gcu.ac.uk)**

Ryerson University, Canada & Glasgow Caledonian University, Scotland

***Abstract:** Emotional Intelligence (EI) refers to a set of emotional and social competencies that can underpin a student's success in their university education as well as their professional career afterwards in the global marketplace. This paper discusses research that demonstrates the importance of these emotional and social competencies as a key non-technical skill set not only for university students but equally for underpinning sustainable success in the graduated engineer's professional career development.*

To obtain a better understanding of the EI skills of engineering students, a study was undertaken at Ryerson University, Toronto, Ontario, Canada. This paper reports on the findings into the level of EI skills of first year engineering students (n=243) and an investigation into correlation between student EI subscale valuations and their academic success, as measured by GPA (Grade Point Average). The results suggest that specific EI subscales may provide indication of future academic success. Also briefly discussed is the converse idea, in effect could EI skill scores be used proactively to identify early on (in first semester) those students who might benefit from intervention programs (e.g. student mentoring) thereby resulting in a decrease in student disengagement with the program as well as attrition.

Introduction

Engineering education quality has gained prominence across the global university system in recent years, and efforts are being made to evaluate and improve the educational experience of undergraduates, through the US-based National Survey of Student Engagement (NSSE) which includes many Canadian universities as well as through the Henley Report –“Educating Engineers for the 21st Century” (2006). These reports conclude that higher education institutions need to focus on many varied areas from student engagement to student attrition to employability after graduation. Specific skill set development may address these topics.

The authors believe there is one skill set which can assist a student's successful navigation of their university experience, Emotional Intelligence (EI). In his pivotal book “Emotional Intelligence: Why it can matter more than IQ” (1996), Daniel Goleman described EI as possessing “abilities such as being able to motivate oneself and persist in the face of frustrations; to control impulse and delay gratification; to regulate one's moods and keep distress from swamping the ability to think; to empathize and to hope.” It appears obvious that such skills are the individually held competencies that ensure a person can deal effectively and successfully with events and obstacles in one's daily life

and, more pertinently, the academic demands and resulting achievement in one's post secondary education.

Emotional Competence and Engineering Formation

As present and future engineering graduates operate in a global environment, strong EI skills are an essential personal skill set required to support the development of sustainable emotional competence in the context of a global society where social responsibility and ethical behaviour are key components needed to address the creation of the global professional engineer.

“Most employers today expect workers to demonstrate and excel in many ‘softer’ skills such as teamwork and group development. They are keen to tap into these vital soft skills obtained during study and periods of work experience, rather than just degree-specific knowledge”. (Pant & Baroudi, 2008, p.124-128)

In addition, the need for emotional competence in the context of intercultural awareness is highlighted by Andreason who indicates that,

“...research evidence suggests that many management skills do not transfer from one culture to another and that the major contributing factor to expatriate failure is the inability to adjust to foreign culture rather than lack of technical competence.” (2002, p.22)

Therefore to address the lack of non-technical knowledge and skills, including social and ethical considerations, a change is required in how engineers are educated. In particular emotional competence needs to be developed from the beginning of an engineer's career, i.e. at the undergraduate level. If the components of EI are acknowledged and addressed within undergraduate education courses then the emotional competencies of engineers will be strengthened which can only serve to bolster the formation of engineers capable of interpreting the global environments. Therefore educators need to find ways to nurture the development of emotional competencies within an engineering education climate.

Before educators can nurture the EI skills of their students, it would be beneficial to have a better understanding of EI research in academia as well as the emotional competence of our engineering students. Specifically, it would be advantageous to obtain an understanding of engineering student EI evaluations both initially as they enter the university setting and subsequently, as they progress through a typical university engineering education program. One of the authors undertook such a study which follows a specific cohort of engineering students as they progress through three years of university engineering education.

Previous Emotional Competence Research

EI skill assessment has been extensively embraced in the workplace over the last 15 years in areas such as executive hiring, leadership training, organization building, team building and life skill coaching. Indeed the implementation of EI testing and assessment has galloped ahead of the science. EI research has steadily been undertaken in many diverse areas such as: workplace team building, leadership training (Boyantis et al, 1995, 1999a, 1999b); EI ability within the general population (Mayer et al, 1993, 1997, 1999) and EI traits within the general population (Bar-On, 1997a, 1997b).

Research within academic student cohorts has been more limited but has been growing in the past 10 years. There have been several recent studies of note into the EI of university students:

1. Dr. James Parker and the Emotion and Health Research Laboratory (EHRL) at Trent University, Peterborough, Ontario, Canada have been assessing the emotional competencies of students since 1999. They have conducted significant studies on a) the transition of students from high school to first year university (Parker, et al, 2005, vol. 17 p.67-78), b) using emotional competency as an indicator of academic achievement (Parker et al, 2003, vol.36 p.163-172) and c) why students drop out of their program (Keefer et al, 2008). These studies involved predominantly humanities students and

concluded that “academic success (*at the end of first year*) was strongly associated with several dimensions of emotional intelligence (specifically the intrapersonal, adaptability and stress management dimensions) assessed at the start of the academic year. Collectively, these variables were found to be strong predictors in identifying both academically successful and unsuccessful first year students” (Parker et al, 2003).

2. At the University of Edinburgh, Edinburgh, UK first year medical students completed an EI assessment. The EI score was found to be a strong predictor of success on a specific autumn course exam – Health and Society. “More extensive work on associations between academic success and adjustment throughout medical training would clearly be of interest.” (Austin et al, 2005). Interestingly, this University of Edinburgh study also confirmed previous studies results that found female students scored significantly higher than male students on total EI score and on several EI dimensions (e.g. empathy).

3. There have been limited quantitative studies completed on the EI skills of engineering students:

a) an EI skills study was conducted at Loughborough University, Loughborough, UK in 2007 on 400 undergraduate engineering students. The students EI skills were scored at the beginning of an academic year and then rescored at the end of the same year.

“Overall, EI score declined for most engineering programmes over the test-retest period. This suggests that the way in which we currently educate our students does little to enhance EI.” (Dainty et al, 2009)

b) a study undertaken at the University of Technology, Sydney, Australia (Scott & Yates, 2002) required successful working graduate engineering students to self-assess their EI skills as well as be assessed by their graduate academic supervisors to identify that it was their non-technical ‘soft’ skill set abilities that earmarked them as successful working engineers

In addition to simply assessing the EI of university students some researchers have investigated the possible use of student EI scores to proactively address the problem of attrition which is a chronic concern in engineering programs. For example, in addition to the research into first year humanities students emotional competency scores and academic success, Dr. Parker of Trent University undertook a study in 2008 into the effectiveness of using EI scores as a predictor of academically ‘at risk’ students, i.e. students who were at risk of achieving poor GPA (Grade Point Average) grades in their studies and/or withdrawing early from school. The first year students were asked to complete an EI measure before they entered their program in the Fall. Low EI scale scores were then used to identify students who were academically ‘at risk’ and then the students were subdivided into a study group and a control group. The study group students were then provided with upper year student mentors whom they met with on a regular basis through the first four months of the academic year to provide coaching on various problems that arose for the students as they progressed through their first year. The study results showed that the mentor coaching had a significant effect with the drop out rate decreasing it from 27% in the academically ‘at risk’ control group down to 17% in the academically ‘at risk’ group who were mentored (as compared with a 9% attrition rate in the academically ‘not at risk’ group which had higher EI scores). (Parker et al, 2003) One specific EI subscale - Psychological Mindedness [awareness of one’s self and others] - was identified as the subscale which was significantly lower for students who withdrew from the school as opposed to those who succeeded in their first year studies (Parker et al, 2003).

Summary of Previous EI Research Results

To date, general emotional competence research has shown that:

- EI increases with age whereas IQ plateaus;
- EI subscales can be indicative of people’s performance in specific jobs/positions;
- EI can be used in self awareness and self improvement programs.

To date the student focused emotional competence research has shown that:

- EI valuation can be indicative of academic success;
- EI valuation is more indicative of academic success in a university setting than high school graduation grade average;
- Specific EI scale valuation can be correlated to academic success;
- Evaluation may be used to identify academically 'at risk' students;
- EI training/coaching can provide an effective retention strategy.

In addition it is worth noting that past student EI research has involved predominantly non technical students, humanities students are probably more assessable to psychology researchers, and past student EI research have been mainly single assessment projects.

Scope of Current Study

One of the paper's authors initiated a longitudinal (3 year) assessment of the EI scale scores for three cohorts of students (engineering, humanities and business students) at Ryerson University, Toronto, Ontario Canada. The longitudinal nature of the current study will provide deeper and more detailed information on a student cohort which previous single assessment studies have not addressed. Also this overall study uniquely assesses three different cohorts and can provide comparison information between the three distinct student groups.

The current study was undertaken to determine the emotional competencies of undergraduate students, in particular engineering students, which could prove beneficial in identifying students who may profit from proactive mentoring and/or counselling programs that would help: a) the students transition successfully into a university environment from high school; b) develop the students emotional competencies as they progress through their program and improve their academic success in their studies and c) improve the skill set the students can offer a prospective employer. This paper reports on the results of the EI scores for the engineering students as they entered first year and an assessment of possible correlation between EI score and first year academic success. Future papers will follow the same cohort through their second and third years of study.

Emotional Intelligence Measurement Instrument Employed in Study

Dr. J. Parker, Trent University, Peterborough, Canada developed a self reporting emotional intelligence measure, the College Achievement Inventory – Revised (CAI-R) (Parker et al, 2005) which has been used over the past ten years in his own extensive student EI research. This self reporting assessment measure has been shown to strongly correlate to the Reuven Bar-On EQ-i measurement scale (Parker et al, 2005) and was adopted, with Dr. Parker's permission, in this study.

College Achievement Inventory – Revised (CAI-R)

The CAI-R was specifically designed for use with colleges and universities and measures five EI Scales: Emotional Understanding, Psychological Mindedness, Attentiveness, Emotional Self-Control and a culminating Total EI. The CAI-R manual provides definitions for the basic five EI scales:

- 1) *Emotional Understanding* relates to one's understanding and expression of his/her feelings;
- 2) *Psychological Mindedness* relates to the understanding and awareness of oneself and others;
- 3) *Attentiveness* pertains to one's ability to focus on a task and keep focused, tuning out distracting stimuli and keeping organized;
- 4) *Emotional Self-Control* relates to one's ability to control one's own emotional behavior; and finally
- 5) *Total EI (TEI)* which is an overall indicator of one's EI and is the averaged sum of the scores from the previous four EI scales (Parker et al, 2005).

From the reliability and validation work conducted in Dr. Parker's Emotion and Health Research Laboratory (EHRL) over the past ten years normative statistical data for all four subscales and the total EI has been obtained for a university audience of over 3500 students. As the literature claims, EI improves with age and so an EI score evaluated for a general population would be different than an EI

score evaluated for a more relevant and age appropriate study comparison population of university students. Therefore the study group comparisons will provide a more valid and relevant assessment.

In addition the CAI-R was investigated by the EHRL to determine correlation between EI scale scores and the two variables of i) age and ii) gender. It was determined, not surprisingly, that EI scale scores increased with age (Parker et al, 2005) as identified in many previous references. In addition, it was found that females tended to score higher on all four subscales of emotional understanding, psychological mindedness, attentiveness and emotional self-control and hence also on the total EI scale, TEI (Parker et al, 2005).

Study Evaluation for First Year Engineering Students

Since the students are young and just entering first year we expect them to score low on all CAI-R EI scales and in future year results we hope to see their scale evaluations increase.

For a student to succeed academically in an engineering education climate, I would propose that the two scales of Attentiveness (ability to stay on task and focus) and Emotional Self-Control (controlling one's emotional behaviour) are the most important. In the first year of a traditional engineering curriculum the courses concentrate exclusively on rote learning in science and math courses where personal subjective interpretation of ideas is non-existent. Therefore I expect higher valuations of these EI subscales for academically successful students and higher correlation evaluations between these scales and academic success (as measured by GPA).

The authors do not expect high valuations (or correlations) on the Emotional Understanding (expressing one's feelings) scale and Psychological Mindedness (awareness of oneself and others) scale as these are not skills that are called upon extensively within the first year of an engineering education. These scales would be higher for humanities students who generally take courses delivered in a significantly different manner than science and math courses and which employ significantly different assessment methods, for example essay writing. Previous studies involved predominately humanities students and therefore the results for the engineering students in this study are not expected to duplicate the results from previous work.

Results

This current study involved over 240 engineering students at Ryerson University, Toronto, Ontario, Canada. The students completed the self reporting survey at the beginning of their first year. Table 1 shows the resulting valuations of the engineering cohort on the five scales in comparison with the normative statistical evaluations of the cumulative database of 3500 students collected by Dr. Parker's lab.

Table 1 EI Scale Scores For First Year Engineering Students

Engineering Students Cohort	First Year Engineering Students Mean [n=243]	Scale Mean (standard deviation) <i>Total sample normative data</i>
Emotional Understanding	3.49	3.70 (0.75)
Psychological Mindedness	3.36	3.50 (0.56)
Attentiveness	3.36	3.56 (0.75)
Emotional Self-Control	3.26	3.55 (0.66)
Total EI	3.55	3.59 (0.50)

From Table 1 it can be seen that the first year engineering cohort fall below the mean scale value on all five scales. Since emotional intelligence is known to increase with maturity it is not unexpected that first year university students score low on all scales.

Attentiveness deals with one's ability to maintain a focus on a particular task, listen attentively to directions or tune out any distracting stimuli so as to successfully complete the task (Parker et al, 2005). This scale addresses the particular skill set that is utilized in a math and science focused field of study like engineering therefore this scale is one that should be investigated further with respect to a possible correlation between individual attentiveness scores and individual academic success.

Emotional Self-Control relates to abilities such as waiting patiently, engaging in activities quietly when necessary, remaining still, listening and waiting for the appropriate time to respond. Again, these abilities are indigenous to "engineering training in universities (which) has evolved only slowly" (Henley Report, 2006) and requires the students to remain still and listen without interruption and so further assessment of this scale is warranted.

Finally the Total Emotional Intelligence (TEI) scale is an overall indicator of a person's EI which provides an indicator of overall psychological well-being. This scale is the averaged sum of the scores from the previous four EI scales discussed.

EI Scale and Academic Success Analysis

The GPA results for the first year engineering students were recorded (students had given their permission for the researcher to access their academic records during their years at the university) and a simple correlation assessment was conducted for the five EI scales and the academic success indicator of GPA for the entire student sample. Low or non-significant correlations were determined for all five scales and GPA, as shown in the first row of Table 2.

A second analysis was then conducted (as was identified by Dr. Parker's work, Keefer et al, 2008) with a stronger definition of academically successful and unsuccessful students being utilized. In effect, academically successful students are defined as students who obtain a GPA of above 3.33 (a GPA which places a student on the Dean's academic achievement list) and an academically unsuccessful student is defined as a student who obtains a GPA of less than 2.0 (a GPA value that immediately places a student on a probation status which may result in suspension at a later date). Therefore a correlation analysis was conducted between: 1) the student population with a GPA < 2.0 and the EI scales and 2) the student population with a GPA > 3.3 and the EI scales.

Table 2 Correlation Analysis Of EI Scales And First Year Academic Success (GPA)

GPA Student Groupings	Emotional Understanding	Psychological Mindedness	Attentiveness	Emotional Self-Control	Total EI
CGPA--[entire student sample]	-0.033	0.045	0.135	0.146	0.107
CGPA <2.0 [82 students]	0.119	0.027	0.227	0.153	0.210
CGPA >3.3 [61 students]	0.018	-0.112	0.137	0.303	0.127

For the academically successful students, the strongest correlation resulted for emotional self-control and GPA ($r = 0.303$). Emotional self-control is the ability to control one's emotional behaviour and to not behave in an impulsive manner. Such EI skills capabilities would definitely prove to be beneficial for success in an engineering program which requires consistent controlled response to the pressures of engineering studies.

For the academically unsuccessful students, the strongest correlation resulted for the attentiveness scale and GPA ($r = 0.227$). It is even stronger than the attentiveness and GPA correlation for successful students ($r = 0.137$). The attentiveness scale refers to a person's ability to be highly focused and organized, personal competencies that one would not associate with unsuccessful students who achieve a GPA of less than 2.0.

To provide another view of the differences between the EI scale valuations for successful and unsuccessful student groups, an assessment of the mean and standard deviation values for the EI scales of the two student groups was conducted and is documented in Table 3. Significant differences are not observed in the TEI versus GPA grouping for both the successful and unsuccessful students but stronger differences were observed on specific subscales. The emotional self-control scale mean is higher for the successful students ($M = 3.59$) than the unsuccessful students ($M = 3.47$) which is a positive result, supported by previous research conclusions (Parker et al, 2005). The attentiveness scale mean is higher for successful students ($M = 3.32$) than the unsuccessful students subgroup ($M = 3.20$) which again is expected based on previous research results (Parker et al, 2005). However, the emotional understanding and psychological mindedness scales have higher means for the unsuccessful students group than the successful students group which is an unexpected result.

TABLE 3 EI Scale Mean And Standard Deviation For The GPA Divided Subgroups.

	Emotional Understanding <i>Mean (Std Deviation)</i>	Psychological Mindedness	Attentiveness	Emotional Self-Control	Total EI
Entire Sample	3.49 (0.792)	3.36 (0.599)	3.36 (0.731)	3.55 (0.641)	3.42 (0.449)
CGPA < 2.0	3.52 (0.838)	3.32 (0.631)	3.20 (0.795)	3.47 (0.671)	3.38 (0.463)
CGPA > 3.33	3.38 (0.780)	3.21 (0.538)	3.32 (0.751)	3.59 (0.598)	3.40 (0.500)

Discussion

The initial EI assessment results for the first year engineering students (Table 1) showed that the students mean EI scale evaluations were lower than the average for every scale. Since these students have just entered university, and it is known that EI increases with maturity and age, this is a completely expected result. In addition, the engineering student cohort is predominantly male (over 75%) and therefore the lower valuation for engineering students is to be expected as the CAI-R measure has been shown to return a lower scale value for males than it does for a more female student cohort.

Engineering students take predominantly explicit courses in science and math which do not require much reflection or self assessment from the students and hence, with their skills in the areas of emotional understanding and psychological mindfulness not being targeted in their studies, these skills are not well developed as indicated again by their scale valuations in Table 1.

The results documented in Table 2 are more surprising. The strongest correlation for academically successful students is with the Emotional Self-Control scale and for academically unsuccessful students the strongest correlation is with the Attentiveness scale. This is an unexpected result as the authors expected both the Emotional Self-Control and Attentiveness scales to be correlated with successful students. This result suggests that exercising self-control abilities such as engaging in activities quietly when necessary or waiting patiently to participate in an activity are characteristics more associated with success than attentiveness abilities such as maintaining focus on a task, paying close attention to detail, keeping organized and completing tasks. This result appears to suggest that controlling one's behaviour, in effect how one might respond to stressful or unexpected situations is more important than keeping organized and completing tasks. The fact that one can stay on task and complete assignments does not mean that they can be completed effectively, they are merely completed. The benefit of this study is it's longitudinal nature and so the results for future years can be investigated to see if this is a consistent finding or not.

Also, the Psychological Mindedness scale correlated negatively for successful students. This is a scale that the authors believed would have low evaluations for engineers as it covers EI skills that are

not explicitly addressed in a science and math course curriculum as opposed to a humanities curriculum. A negative correlation suggests that a lower level of Psychological Mindedness, i.e. a lack of self awareness, assists someone undertaking engineering studies. Again, this study is longitudinal and so the results for future years will be assessed to determine if this is a consistent finding or if Psychological Mindedness improves with maturity as expected.

Previous studies (Parker et al, 2003, 2005) demonstrated higher correlation factors between the various EI scales and academic success, while this study resulted in weaker correlation analysis values for successful versus unsuccessful students with the EI scales scores. The main discrepancies are seen in Table 3 in the determination of mean values for successful and unsuccessful student groups on the EI scales. The mean values for the Attentiveness and Emotional Self-Control scales are highest for successful students as expected by the authors. The Emotional Understanding scale has the highest mean valuation for unsuccessful students, i.e. these students are being swayed more by their feelings and perhaps responding more to the social aspects of university and neglecting their studies.

Another question to be addressed, based on these initial results, is could EI skill scores be used proactively to identify early on (in first semester) those students who might benefit from intervention programs (e.g. student mentoring) thereby resulting in a decrease in student disengagement with the program as well as attrition? Previously studies with Humanities students (Keefer et al, 2008) suggested that a low score on the Psychological Mindedness scale could be used as an indicator for academically 'at risk' students. From the study results in Table 3, this assumption cannot be supported. This current analysis might suggest that a lower Emotional Self-Control scale valuation and/or a higher Assertiveness scale valuation might be used as a marker for a potential at risk student but further studies of engineering students entering university are needed to develop confidence in such assumptions.

There are many other questions raised by these results but it is felt that analysis of the second and third year performance of the same student cohort needs to be conducted before further informed conclusions can be determined.

Summary & Conclusions

Emotional and social competencies are a non technical skill set that is important in developing engineering graduates who have a positive and successful experience in completing their academic programmes.

Study of the CAI-R EI scales of first year engineering students determined that successful students have stronger attentiveness and emotional self-control scale scores than unsuccessful students.

Academically successful students have the highest correlation with the Emotional Self-Control scale.

Academically unsuccessful students have the highest correlation with the Assertiveness scale.

Engineering students need to conduct more reflective course exercises and experience working within a group dynamic to develop their emotional understanding and psychological mindedness capabilities.

For EI competence to be successfully achieved, educators need to be prepared to introduce and sustain EI development activities as well as EI assessment metrics from the undergraduate through to the postgraduate level, such that graduates enter their professional careers having an established EI skill set alongside their discipline knowledge.

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