

Emotional intelligence and academic performance of engineering students

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Professional technical expertise is no longer the main standard by which employers evaluate college graduates. ‘Soft skills’, such as emotional intelligence (EI also referred to as EQ), are viewed as effective ways to distinguish potential high-performance workers. It is posited that high performing students will also exhibit more proficiency at these ‘soft skills’ than students with more modest academic success. The purpose of this paper is to attempt to correlate EI with the academic performance of civil engineering students. A student’s grade point ratio (GPR) is the criterion used in this research to measure academic performance. The hypothesis is that students with high GPRs will score better on measures of EI than other students. Literature reviews found that there is a growing area of research into EI and its relationship with job performance, specifically through the research presented in *Emotional Intelligence: Why It Can Matter More than IQ* [Goleman, D. (1995) *Emotional Intelligence: Why It Can Matter More than IQ*, Bantam Publishing, London. ISBN 0553375067]. There is a paucity of research, however, linking EI with academic performance in engineering students. There is also little information on the degree to which engineering students have been exposed to the concept of EI or received any training in EI. The purpose of this study was to examine the relationship between EI and academic performance and examine the potential difference in EI with respect to demographic and experiential characteristics. This research assumed the following principles: (1) there is a relationship between GPR and EI, (2) the relationship can be measured and (3) the participants in this research have anonymity and are guaranteed that their responses are not part of their individual academic evaluations, increasing the respondents’ ability to answer honestly. Through surveys of 141 civil engineering and construction management students from Clemson University and The Citadel, it is suggested that EI increases along with increases in GPR. EI then peaks for the 2.51–3.0 GPR student group. After that, EI decreases as GPR continues to increase. A positive connection was identified between the amount of work experience and higher EI scores. Based on the results of this analysis, this paper proposes increased emphasis on co-op and extracurricular programmes to help students develop their EI skills.

Keywords: Academic performance, education, emotional intelligence, engineering, leadership.

Introduction

The construction industry is very sensitive to economic cycles and thus suffers, at times, through cycles of ‘famine’ in terms of work available while enjoying ‘feasts’ of backlogs and an abundance of work opportunities at other times. The most recent economic downturn hit the construction industry in late 2008 and the industry has continued to suffer in the USA. In these leaner circumstances, construction companies tend to focus on improving the overall competence of the companies and the effectiveness of their workforce to

maximize their competitive opportunities (Jansen, 2002). Their workforce must be highly qualified, skilled and experienced—traits that are not normally associated with newly graduated engineering students. For civil engineering students to have the qualifications and competence that companies are seeking, they must receive and develop skills outside of those found in traditional classrooms (Riemer, 2001, 2003).

Emotional intelligence (EI) has emerged as a relevant indicator of positive work outcomes. The current research on the importance and relevance of the relationship between EI and work outcomes has been

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gaining momentum since the mid-1990s (Goleman, 1995). Technical expertise is no longer the only standard by which to evaluate new graduates. Employers are looking for graduates who will be able to compete technically in a fast-moving business as well as be competent leaders and team members within their work environment. Skills such as leadership and EI are viewed as effective ways to distinguish potential high-performance workers (Mayer and Geher, 1996). EI has also been correlated with conflict management and problem-solving competence in project managers (Davis, 2011).

This paper attempts to correlate EI with the academic performance of civil engineering and construction management students. It is hypothesized that higher EI will play a positive role in academic performance, as measured by the student's grade point ratio (GPR). To evaluate EI, 'The Emotional Intelligence Appraisal©', a skill-based self-reporting measure of EI, was utilized. This assessment was chosen because of its ease of collection and ability to further analyse data that are generated. This tool has been validated statistically and referenced in multiple research reports (TalentSmart, 2012a). Students were also asked to complete a supplementary questionnaire to collect information on student demographics, work experiences and other attitudes related to EI.

Emotional intelligence

There are five main competencies of EI, which can be grouped into two main categories: personal skills and social skills. Figure 1 summarizes these competencies and explains the sub-competencies (Goleman, 1998).

Personality can be defined as a person's pattern of internal experience and social interaction that arises from the action of his/her major psychological subsystems. EI is a part of human personality, and personality provides the context in which EI operates. EI can be considered a mental ability that involves the ability to reason validly with emotional information and the

Personal Skills (how we manage ourselves)	
Self-Awareness	Knowing one's internal states, preferences, resources, and intuitions. Recognizing ones emotions and their effects, strengths, limits, self-worth.
Self-Regulation	Managing one's internal impulses and resources. Keeping disruptive emotions/impulses in check, maintaining honesty and integrity, taking responsibility while being flexible and comfortable with new approaches.
Motivation	Emotional tendencies that guide or facilitate reaching goals. Striving to improve, aligning with goals of the group, acting on opportunities and persisting while overcoming obstacles.
Social Skills	
Empathy	Awareness of other's feelings needs and concerns. Sensing, others' feelings, needs, concerns. Anticipating and recognizing the needs. Cultivating opportunities and reading a group's emotional currents.
Social Skills	Adeptness and inducing desirable responses in others. Persuasion, communication, conflict resolution, leadership, managing change, nurturing relationships, collaboration, creating synergy.

Figure 1 Five EI competencies (Goleman, 1998)

action of emotions to enhance thought. Social skills are defined as social facility, which includes synchrony, self-presentation, influence and concern. It is a capability that allows one to influence and inspire others, manage social relationships and solve conflicts as well as adjust to the surrounding environment. It is important to note that EI is based on an inherited set of traits, but the associated skills can be learned and improved. It is also suggested that the capability to acquire EI skills apparently increases with age due to increased experience (Goleman, 1998).

Goleman *et al.* (2002) claimed that EI and intelligence quota (IQ) are important determinants for effective leadership. EI is a learned capability based on experience and knowledge throughout a person's life. Studies by TalentSmart (2012a), a leading EI research and training organization, indicate that there is a strong link between EI and job performance, particularly with top performers. Emotions clearly play a major role in helping an individual to decipher and interact with his/her surrounding environment. Positive emotions can affect memory organization so that cognitive material is actually better integrated and diverse ideas are seen as being more inter-related (Salovey and Mayer, 1990). Contrary to IQ, people can improve their EI by receiving feedback, practice and correct training and guidance. Findings suggest that IQ may be connected to as little as 4% of real-world success since IQ does not measure creativity or a person's unique potential (Cooper and Sawaf, 1997). It has also been stated that in industry, 'IQ gets you hired, but EI gets you promoted' (Gibs, 1995). Other studies suggest that success is determined by a combination of EI and IQ (Goleman, 1998; Butler and Chinowsky, 2006). For example, a manager at AT&T Bell Labs was asked to rank his top performing engineers. High IQ was not the deciding factor, but instead how the person performed regarding answering e-mails, how good he/she was at collaborating and networking with colleagues and his/her popularity with others in order to achieve the co-operation required to attain the goals were the deciding factors (Gibs, 1995).

EI versus leadership

Leadership has recently become an increasingly important consideration for engineering/construction organizations and project management. Work experience and experience as a project manager have also been shown to be important in the development of leadership skills (Skipper and Bell, 2006). It is widely suggested that EI, the ability to understand and manage moods and emotions in the self and others,

contributes to effective leadership in organizations. George (1995) found that work groups led by sales managers who tended to experience positive moods at work provided higher quality customer service than groups led by managers who did not tend to experience positive moods at work. Such findings can be explained in terms of EI, in that emotion and moods can subtly but systematically influence (through contagion) the culture of the workplace in a positive manner (Goleman, 1995).

In an EI and leadership study conducted on 358 managers from a global manufacturer, results showed that the highest performing managers have significantly more 'emotional competence' than other managers. The survey 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 and Brienza, 2002).

In a study of 67 project managers from the UK involved in a variety of projects (construction, research and development, and professional services), it was found that there is a positive relationship between EI and transformational leadership. The study also found strong relationships between project manager competencies of teamwork, managing conflict and attentiveness (Clark, 2010).

EI for engineering

Engineers are expected to have a high degree of technical skills, but to be successful and competitive in a continuously changing work environment, they need more than technical expertise. In assessing the needs of the Polish engineering industry, the Technical University of Czestochowa Poland identified various practical and psychological elements required of its graduates in engineering areas. EI 'was seen as being of major importance in teamwork and in the management of a group of people' (Szkutnik, 2001). Another study surveyed 34 project managers and project engineers (PMEs) on projects in Thailand and found that PME with high EI scores used proven leadership techniques such as 'stimulating, rewarding, delegating, leading by example, open communication, listening, participating and proactive behaviour' more than PME with lower EI scores. This study suggested that a project manager or an engineer with high EI could better stimulate team performance and increase innovation (Sunindijo *et al.*, 2007). In a recent study, the EI of project managers was shown to impact projects positively and directly (Muller *et al.*, 2012).

There is little documented research related to EI and engineering students. To the authors' knowledge, this research paper is the first reported study of EI for

Profession	EI Score
Customer Service	77
Sales	74
Information Technology	73
Finance	72
Engineering	70
Unemployed	68

Figure 2 Average EI scores across professions (TalentSmart, 2012b)

undergraduate engineering students. A study of *graduate* engineering students found that communication skills can be augmented by the enhancement of certain EI elements (Riemer, 2001, 2003).

Figure 2 shows the average EI scores across several professional areas. Those working in sales or customer service scored higher than those working in highly technical professions. Self-management and relationship management are requirements for survival in these professions. Engineers scored lower, suggesting that they receive little (if any) training in EI and do not focus on social-emotional competence as much as those in other professions (Bradberry and Greaves, 2005). Although different specialties of engineering (civil, electrical, mechanical, etc.) may score differently on EI tests, the data indicate that in general engineers have room to improve in this area.

Improving EI

Measuring EI is of little value unless there are steps that can be taken to improve skills in this area. Noted researchers and authors, Goleman, Boyatzis and McKee have studied EI extensively and made the link with leadership behaviour and performance. They have also designed a five-step process to 'rewire the brain' towards more emotionally intelligent behaviour (Goleman *et al.*, 2001). Similarly, the National Aeronautics and Space Administration (NASA) Langley Research Center created the Consolidated Information Technology Services Contract (ConITS) to merge disparate technology services contracts and improve customer satisfaction and gain efficiencies. The ConITS designed a leadership training programme to enable leaders to develop more effective leadership skills. The curriculum included 14 two-and-one-half-hour sessions with each session building upon concepts learned in the previous session. EI was introduced in the fourth session and included in all the remaining sessions. As a result of this initiative, a strong cadre of high-performance leaders in a culture of servant leadership has been developed and there has been a significant rise in mentoring and personal development (Daniels, 2009).

Table 1 Sample questions evaluating 'self-awareness'

For each question, check one box according to	How often you...	Never	Rarely	Sometimes	Usually	Almost always	Always
(1) are confident in your ability							
(2) admit your shortcomings							

Clearly, EI need not be static and can be improved. Research indicates that programmes and education in areas related to EI can increase performance in these areas.

Research and methodology

The purpose of this study was to examine the relationship between EI and engineering student academic performance. Demographic issues were examined to determine if there were any other causal relationships associated with EI scores and academic performance. The research included the participation of three classes in the Civil Engineering Department at Clemson University and two classes in the Civil and Environmental Engineering Department at The Citadel. Participants were primarily juniors and seniors at both institutions, while the Clemson group did include 24 graduate students.

This research assumed the following two principles: (1) EI can be trained and learned, rather than being totally inherent and (2) the participants have anonymity and are guaranteed that their responses are not part of their individual evaluation, increasing the respondents' ability to answer honestly.

This research utilized The TalentSmart Emotional Intelligence Appraisal[®] evaluation form. This form has been used to yield coefficient alphas ranging from 0.79 to 0.90 consistently in the measure of the reliabilities of the components of EI in Goleman's model (TalentSmart, 2011).

One hundred and forty students took part in the EI test. The students who participated were from Clemson University and The Citadel and were either civil engineering or construction management majors. The background of the students varied, including undergraduate and graduate students and both female and male students. Each participant was guaranteed anonymity although each student's survey was labelled with his/her student ID to allow comparisons between EI assessment scores and GPR. The student ID is not reported in the research. All students were told at the onset of the evaluations that this was an academic data-gathering exercise and that the results of the surveys would have no impact, either positively or negatively, on the grade in the course or their academic standing.

Each participant was given the assessment during a regular class period with no requirement made for the completion of the assessment. Each student was asked to state his/her GPR and the GPRs were verified for accuracy at the time of their assessment. A complementary questionnaire was handed out to each participant to collect demographic data such as age, gender, major, degree and work experience. Although gender differences were noted, the sample size of women was too small ($n = 21$) to provide statistically relevant information.

EI appraisal

Twenty-eight items were combined to obtain a total EI score and were divided into four sections, aimed to produce four composite scale scores: self-awareness, self-management, social awareness and relationship management. Questions as to how often a person would have a certain behaviour or thought were asked. Table 1 presents a couple of sample questions, evaluating self-awareness. Table 2 outlines guidelines for interpretation of the overall EI scores.

Results

The participating students' average scores for the main EI dimensions are shown in Figure 3. The students scored highest in the area of social awareness and

Table 2 Interpretive guidelines for EI appraisal

Score ^a	Meaning
90–100	A strength to capitalize on
80–89	A strength to build on
70–79	With a little improvement, this could be a strength
60–69	Something you should work on
59 or below	A concern you must address

^aNote: The scores are based on a comparison to tens of thousands of responses to discover where a participant's score falls relative to the general population (TalentSmart, 2012a).

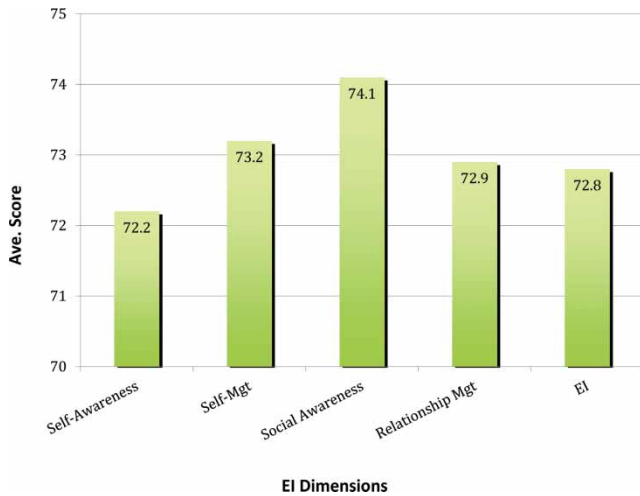


Figure 3 Average EI scores by dimensions

lowest in the area of self-awareness. Although all four EI competences contributed numerically to the total EI score, it is self-awareness—the ability to detect and understand one’s own emotion by recognizing verbal and non-verbal information—that accounts most behaviourally for EI. EI is impossible without the competencies involved in self-awareness (Saarni, 1990). Self-awareness is affected by ‘how well one person knows about EI’. This is evident by the participants’ mediocre EI scores and their lack of familiarity with EI and their own self-awareness.

EI is the compilation of the four subcategories of self-awareness, self-management, social awareness and relationship management. For the purpose of this study, the total EI score was utilized as a measure of EI and was used to compare student performance as measured by GPR.

EI versus GPR

To test the validity of whether ‘high EI contributes to high academic performance’, the GPRs of 141 students were classified into five GPR scales: 0.00–2.00, 2.01–2.50, 2.51–3.00, 3.01–3.50 and 3.51–4.00. These scales were chosen according to the process by which colleges and universities identify student performance with the less than 2.0 scale representing ‘failure’ and 4.0 representing the maximum score possible. The 2.00–4.0 scale was broken down into 0.5 increments because it is a common unit of measurement. Figure 4 shows a box plot of the EI scores for each GPR scale. The average total EI score was calculated within each GPR scale.

Figure 5 indicates that the average EI scores gradually increase as GPR increases, peaking for the 2.51–3.00

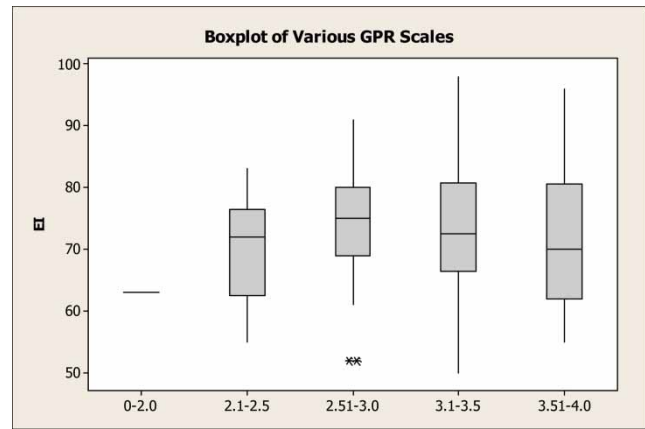


Figure 4 Box plot of EI score by GPR scale

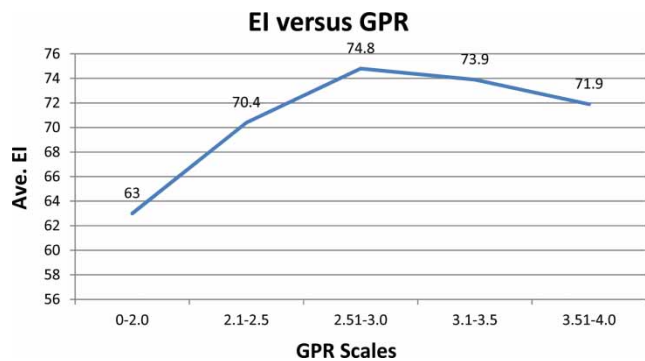


Figure 5 Average EI score by GPR scale

student group. After this point, the average EI score decreases as GPR increases. It should be noted that the box plot, as shown in Figure 4, for the highest academic group of 3.51–4.0 has a bigger range and more variation than that for the 2.51–3.0 group. Clearly, some of these high academic performers do also have high EI scores.

A positive relationship between EI and GPR was not statistically substantiated, as shown in the regression equation in Figure 6; therefore, the statistical data are not included. The hypothesis that high EI predicts outstanding academic performance was not proven statistically, but perhaps with a larger sample size, a more robust regression analysis could be conducted. It may also mean that further analyses are needed into whether GPR is the best measure of academic performance or if there is a better measure of student success involving a number of factors (GPR, extracurricular participation, work experience, etc.).

While the total regression analysis determined a *p*-value of 0.889 as indicated in Figure 7, the average total EI score over the GPR range showed an interesting trend. It is notable that as GPR increases, the average

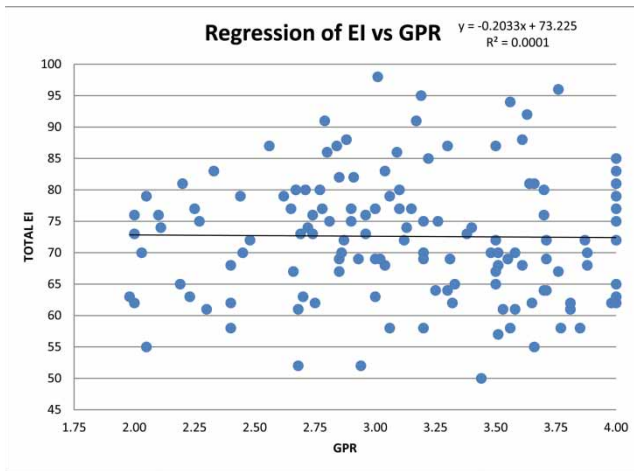


Figure 6 Scatter plot with regression of total EI versus GPR

total EI score increases gradually, with a peak in the 2.51–3.0 GPR range. The reasons underlying the relationship between GPR and EI are intellectual attributes (e.g. long-term memory and ability to think abstractly) and non-intellectual attributes (e.g. motivation and self-discipline). Both contribute to a student’s academic performance; however, non-intellectual capacity accounts for more than twice as much variance as IQ in final grades (Duckworth and Seligman, 2004). Some students who outperform their peers academically may be highly self-disciplined or, in terms of EI, be highly self-aware and self-managed. These students, as a result, can promptly become conscious of the change of their emotion, react positively to conflicting

moods and take the initiative to control inertia, slackness and negativity, as well as frustration. Even though IQ plays a significant role in academic success, improvements in EI may also lead to increased academic performance (Saarni, 1999). Although this reverse hypothesis was not tested in this research, it would be an interesting topic for further study.

It is particularly noteworthy that within the fifth GPR scale, which is from 3.51 to 4.0, there is a sharp decline in the average EI score. A number of factors were examined to determine if there was a statistically significant explanation for the decline in GPR in this fifth scale. There was little disparity in demographic factors (such as age and gender), and while there was some significance with respect to work experience, this study was not able to determine the cause of this disparity. The broad range of GPR and EI scores in this scale indicates that additional information, perhaps in a follow-up study, would be needed to determine if there were personality, unexamined demographic or other academic factors that would better explain why some engineering students with high GPRs also have high EI scores and others do not.

EI versus experience

Table 3 presents the average work experience for each GPR scale. The 2.51–3.00 GPR group, which had the highest EI score, also had the highest average work experience, in months. The type of work experience and the position held by the participant was not determined in the survey. Since work experience influences

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.0118
R Square	0.0001
Adjusted R Square	-0.0070
Standard Error	9.9565
Observations	142

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>Significance F</i>	
Regression	1	1.934	1.93	0.0195	0.889
Residual	140	13878.552	99.13		
Total	141	13880.486			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	73.225	4.658	15.719	1.014E-32	64.015	82.4344	64.015	82.434
GPR	-0.203	1.456	-0.140	0.889	-3.081	2.6743	-3.081	2.674

Figure 7 Regression analysis of total EI versus GPR

Table 3 GPR and work experience

GPR scale	<i>N</i>	Working experience (months)
0.0–2.0	1	6
2.1–2.5	21	11
2.51–3.0	35	19
3.1–3.5	34	9
3.51–4.0	45	14

the development of various EI dimensions in that more attention is focused on social awareness aspects and relationship management, it appears that this is a logical outcome. As an individual is involved more in the ‘real world’, he/she becomes more capable of sensing, understanding and reacting to others’ emotions while comprehending social networks. The more complicated the relationship network gets, the more the social awareness dimension is developed and improved. A well-established relationship network can demonstrate an enhanced EI. Work experience would provide the opportunities for students to develop and utilize relationship management skills.

Additional information on the type of work experience (part-time versus full-time, engineering or construction work versus other job experiences, etc.) would be recommended in a follow-up study to determine if the length of the work experience is as important as the type of experience or the position held. It is possible that students who are financially obliged to work while in college may be more inclined to benefit from the work experience emotionally or others may specifically choose to work to improve their resumes and begin the professional networking process. Other students may choose to focus on pure academic performance, increasing their GPR while not necessarily improving their EI or building networking opportunities.

Engineering, due to the highly technical and qualitative focus of the field, faces unique challenges in producing students with improved EI scores. Figure 2 reports that of the professions surveyed, engineering has the lowest EI score of any field of workers in the survey. Unfortunately, undergraduate engineering education remains highly demanding and, in most cases, precludes students from part-time work or even, in many cases, from summer employment. Those students who must work their way through school will frequently transfer to a less demanding major. Therefore, students may have to choose between two options: (1) work part time for financial reasons and not focus on academic skills (which may increase EI and may not increase GPR) or (2) do not work outside of school and focus on academic skills (which may not increase EI score but may help improve GPR).

Conclusions

The purpose of this research was to determine if there was a positive relationship between high academic performance (as measured by GPR) of an engineering student and a high EI score. The hypothesis that EI plays a positive role in academic performance was not proven. The relationship that was suggested is that as GPR increases, EI also increases, although only to a point. EI scores in this study peak for the 2.51–3.00 GPR student group, after which the EI scores decrease as GPR continues to increase. This relationship suggests that students with the highest GPRs may be focusing on their academic success rather than on building or improving their relationships with others. Anecdotally, these results are consistent with comments made by some employers who expressed concerns about hiring students with exceptional academic performance records.

The research also suggests that student work experience may be an indicator of higher EI. The data show that as GPR increases, work experience also increases, reaching a peak for the 2.51–3.00 GPR group with 19 months of work experience. As GPR increases beyond 3.00, these students have lower amounts of work experience. These results infer the value of work experience in helping students mature and be better aware of their relationships with fellow students and fellow employees. Students who do not have to work, or choose not to work, may have higher grades, but they may also tend to have lower EI scores.

Recommendations

The current trend of the American Society of Civil Engineers and the Accreditation Board for Engineering and Technology is to place more emphasis on skills such as leadership, communications and teamwork. These trends should continue and be supported as they may lead to enhanced EI in engineering students and engineers in the workforce and thereby improve the overall success of the engineering career field.

Many employers provide co-op opportunities for undergraduate and graduate engineering students. These programmes provide an excellent opportunity for potential employers to observe the technical and non-technical skills of potential employees before offering a permanent position. Likewise, these co-op programmes afford students the opportunity to gain valuable real-life work experience as well as further develop their EI and other leadership, communication and teamwork skills. These programmes should be supported and expanded whenever possible.

Most colleges and universities offer challenging extra-curricular programmes that may also serve to increase

student EI scores. For example, at Clemson University, the Civil Engineers for Developing Countries programme offers students the opportunity to work as a team and gain valuable real-life experience in overseas cultures. At The Citadel, many students are under military contracts where they undergo rigorous military training during the summer. All these opportunities may serve to increase the students' EI scores and ultimately improve their performance in the workforce. Both Clemson University and The Citadel are focusing some attention on providing leadership training and instruction for their undergraduate students, consistent with the unique culture of each school. Activities of this type should be encouraged and possibly expanded.

Due to the importance of EI for leadership and overall job performance, it is recommended that colleges and universities with engineering programmes consider developing courses or course work specifically designed to increase EI behaviours. Research indicates that EI is not static and can be improved (Goleman *et al.*, 2001; Daniels, 2009). Graduates of these programmes with such skills should, therefore, be in a better position to gain and maintain leadership roles with their employers.

The findings of this study have their limitations. Although this research did have 141 samples, it is clear that further research with an expanded sample size would be valuable. The students were primarily from the USA and the results are not generalized for other countries. A larger sample size may offer better gender comparisons, as well as enable a more refined study of specific GPR groups. Additional demographic, specific work experience and personality trait information would also be beneficial for determining some of the factors that contribute to student academic and EI performance. No control was established to obtain representative samples across other engineering degree programmes or for the universities represented in this study. Finally, further research may afford the opportunity to evaluate the differences between freshman engineering students and seniors to determine how or if EI evolves over a student's time at university.

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