THE DEVELOPMENT OF SUCCESSFUL INTELLIGENCE IN CONSTRUCTION EDUCATION

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The measurement of student potential is a consistent topic within the education domain. Since the introduction of aptitude tests in the late 1800's, the desire to find a score that indicates potential success or failure has been a pursuit of many educators. However, the focus on traditional IQ scores appears to be missing a significant component of student success, the emotional component of the student capabilities. This study analyzes the impact of current engineering curriculum on the development of emotional intelligence in construction students and the potential to change existing curricula to enhance rather than hinder emotional intelligence development. The comparison of civil engineering and liberal arts students demonstrates that the growth of emotional intelligence in civil engineering students is lagging behind that of the comparison sample.

Keywords: curriculum, education, leadership.

INTRODUCTION

The desire to measure intelligence has been present in the education domain for decades. Since the introduction of tests such as the Binet-Simon Intelligence Scale and the Wechsler Intelligence Scale for Children, psychologists have been attempting to measure intelligence and the corresponding indication of potential success in education pursuits (Fancher 1985). The formalization of this pursuit in the introduction of the intelligence quotient (IQ) provided the education industry with a foundational measurement on which to base many placement and guidance decisions. While this singular measurement has been at the same time applauded and criticized by education researchers, it remains a fundamental component of intelligence study and education research as well as a fixture of the popular culture desire to place individuals in attribute groupings.

In the traditional concept of intelligence, success can be summarized in reports on GPA, grading curves, and ultimately, employment rates upon graduation. However, these measurements are singular in nature. Specifically, they fail to recognize that individual intelligence is a far more complex entity than a single IQ number. This complexity is reflected in a growing focus on the concept of multiple intelligences (Gardner 1993). In this concept, the intelligence of an individual is represented by several factors reflecting not only traditional IQ, but also extending to areas such as creativity, emotional awareness, and tacit knowledge. Pioneered by researchers including Howard Gardner, John Mayer, and Peter Salovey, this concept of multiple intelligences attempts to define and explain the ability of individuals to succeed in

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Chinowsky, P and Brown, H (2004) The development of successful intelligence in construction education. *In:* Khosrowshahi, F (Ed.), *20th Annual ARCOM Conference*, 1-3 September 2004, Heriot Watt University. Association of Researchers in Construction Management, Vol. 1, 525-32.

areas that are not measured by traditional IQ tests. For example, individuals who excel in creative arts or individuals who succeed based on tenacity and will rather than traditional intellectual strengths. These individuals may not rank at the top of traditional measurement ratings, but are equally successful in their pursuits over an extended period of time. Rather than being anomalies, these individuals represent a significant education demographic that requires greater attention in the development of construction courses and curricula.

The study documented in this paper builds upon this concept of multiple intelligences by examining the need for a greater concept of intelligence within the construction student. Specifically, the paper documents the growth of emotional intelligence within civil engineering students (where construction is taught at the University of Colorado) over the four-year university experience. The study of over 200 civil engineering students evaluated their emotional intelligence as measured by their emotional quotient (EQ). In this study, the authors demonstrate that emotional intelligence is given secondary attention in the civil engineering curriculum by illustrating how EQ scores fail to increase at significant levels during the four years of civil engineering study. This is significant since unlike intellectual intelligence that is thought to be a static quality, emotional intelligence can be taught and enhanced, thus leading to increased emotional quotient scores (Goleman 1995). If this increase is not reflected in student scores over the four-year university period, then a question can be legitimately raised concerning the need for greater emphasis on emotional intelligence in the civil engineering curriculum. As a comparison, the authors present emotional intelligence data on 90 liberal arts students. Although this data is preliminary, it provides a starting point from which to commence a comparison of the two curricula. This paper presents the results to begin this discussion.

MOTIVATION

The motivation for this research is based on research into the development of successful intelligence (Sternberg 1997). In this concept, individuals develop three areas of intelligence, intellectual, practical, and emotional. The intellectual intelligence represents the formal education received in school and through professional development, the practical intelligence represents the knowledge received through professional experience, and the emotional intelligence represents the knowledge associated with psychological, sociological, and interpersonal communications and relationships. The hypothesis within the research presented in this paper is that engineering schools focus extensively on developing intellectual intelligence, focus moderately on assisting students in developing practical intelligence, and focus minimally on developing emotional intelligence.

The shortcoming of this traditional approach to engineering education is that students graduate from school with an excellent foundation for technical problem solving, but possess a less developed capacity for addressing the breadth of issues that exist in real-world engineering environments. The evidence for this statement is seen in the reports and studies indicating that industry professionals believe that engineering students continue to graduate with strong technical skills but are missing critical leadership and management skills (NSF 1995). As stated in one National Science Foundation report by the authors, "…universities need to alter their traditional civil engineering perspectives to support the concept of a broader intelligence model including the successful intelligence model," (Chinowsky and Songer 2003).

Component Measured by EQ-i Subscales	***Definition The ability to …***	***Area***
Self-Regard	respect and accept oneself as basically good.	**Interpersonal Skills**
Emotional Self-Awareness	recognize one's feelings.	
Assertiveness	express feelings, beliefs and thoughts and defend one's rights in a nondestructive manner.	
Independence	be self-directed and self-controlled in thinking and actions and to be free of emotional dependency.	
Self-Actualization	realize one's potential capacities.	
Empathy	be aware of, to understand and to appreciate the feelings of others.	**Intrapersonal Skills**
Social Responsibility	demonstrate oneself as a cooperative, contributing and constructive member of one's social group.	
Interpersonal Relationship	establish and maintain mutually satisfying relationships that are characterized by intimacy and by giving and receiving affection.	
Reality Testing	assess the correspondence between what is experienced and what objectively exists.	**Adaptability**
Flexibility	adjust one's emotions, thoughts and behavior to changing situations and conditions.	
Problem Solving	identify and define problems as well as to generate and implement potentially effective solutions.	
Stress Tolerance	withstand adverse events and stressful situations without "falling apart" by actively and positively coping with stress.	**Stress Management**
Impulse Control	resist or delay an impulse, drive or temptation.	
Optimism	look at the brighter side of life and to maintain a positive attitude, even in the face of adversity.	**General Moods**
Happiness	feel satisfied with one's life, to enjoy oneself and others and to have fun.	

Table 1: The 5 composite and 15 individual categories measured with the Bar-On Eq-I test administered to the students.

THE EQ STUDY

The current study of EQ support in civil engineering education focused on the hypothesis that engineering does not support the development of emotional intelligence. Additionally, the authors wished to study the effect of time during the university experience on the growth of emotional intelligence as well as compare the civil engineering results to a comparative group of liberal arts majors. To study this time component, the authors expanded the study beyond the study of a single group of civil engineering students to a study of students from each of the four undergraduate years in both civil engineering and liberal arts.

The Test Given

There are a number of tools by which Emotional Quotient (EQ) can be measured. Typically, these measurement systems were created as researchers who were studying emotional intelligence realized it was possible to objectively measure emotional

intelligence. Four of these measurement tools are used with the highest frequency in research studies: The Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT), The Emotional Competence Inventory (ECI) 360, The Bar-on EQ Inventory (EQ-i) and the EQ Map.

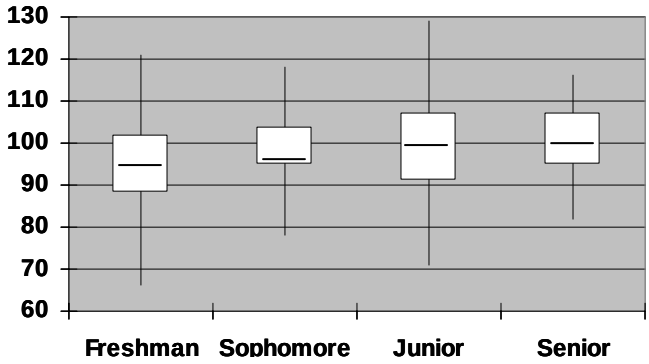

Figure 1: Total EQ score distribution and averages for CE.

The EQ-i test developed by Reuven Bar-On was the measure selected for this study and is based on almost two decades of research on emotional intelligence. The Bar-On test measures a multifactorial array of emotional, personal and social abilities that allow individuals to cope with demands and pressures of their environments. The fifteen factors analyzed within the test are categorized within five primary areas of emotional intelligence as listed in Table 1.

A central focus of the Bar-On model is that it is intended to predict the potential for performance, rather than performance itself. Specifically, by analyzing multiple emotional traits of an individual, the test provides an EQ score that indicates that the individual has a capacity to perform at a specific emotional level. However, since additional environmental factors may intercede in any situation, the individual is not guaranteed to perform up to their potential capacity.

The Study Process

The Bar-On EQ-I test was administered to the civil engineering and liberal arts students in the fall semester of 2004. Four classes were selected in both the civil engineering and history departments to cover the four years of university education. In each case, a brief explanation of the purpose of the test was given to the class prior to the test. The students were told that the results would remain anonymous and were instructed to complete the test at home and return the answer sheet at the next class. The students were instructed to answer the questions honestly and at a steady pace in accordance with the Bar-On guidelines.

A total of 205 civil engineering students were tested. From this population, 142 valid tests were obtained for data analysis purposes. Within this group the sample consisted of 23 freshmen, 29 sophomores, 52 juniors, and 38 seniors. The 63 exclusions were a result of 29 students taking the test that were not civil engineers and 34 tests being declared invalid due to inconsistencies in answers as determined by the test guidelines.

As a comparison dataset, the authors are compiling a similar population of liberal arts majors. To date, the authors have compiled test data from 90 liberal arts students. This sample size is sufficient to present initial comparisons, but is not as yet sufficient to make conclusive statistical observations.

THE RESULTS

As Bar-On explains in the EQ-I Technical Manual, high EQ scores indicate that the emotional skills being measured are strong, well-developed, and function efficiently; and low scores suggest a deficiency and a need to improve particular competencies and skills in meeting environmental demands (Bar-On 2002). “High” and “low” scores are identified by how distant they are from the Bar-On mean score of 100. As described above, this scale is used to measure the individual from several perspectives

including Total EQ, the five composite categories, and the 15 individual categories. For the purpose of this study, the authors focused on Total EQ and the five composite scores.

Prior to administering the test, the authors expected that at least a minimum of EQ growth should be evident between the four class levels in each sample group due to the maturity process experienced during the college experience. This would correspond to the growth of EQ documented by previous researchers who state that EQ will be raised when individuals experience challenges during the course of their lifetime (Bar-On and Parker 2000). Specifically in this case, living in a new environment without parental guidance should enhance emotional growth by stimulating the intrapersonal skill of independence. The introduction of financial responsibility should develop the intrapersonal skill of self-awareness. Mandatory on-campus housing for freshmen should enhance interpersonal skills through close contact with dorm mates in addition to sharing a room with a roommate. Making new friends and working with study partners should also hone interpersonal social skills. Balancing the responsibilities of school, social gatherings, and possibly a part-time job requires increasing stress management skills. Adjusting to new environments, people and a way of living should enhance adaptation. General mood is affected by the move to college, managing financial responsibility, making friends, balancing stress and the ability to adapt. In summary, the aggregate of these experiences suggests that university students should experience emotional growth solely through the experience of attending a university.

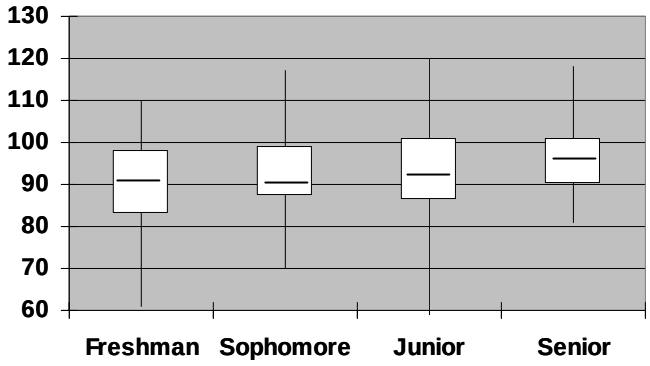

Figure 3: Interpersonal Score distribution among students.

At issue in this study with civil engineering students was whether this rise in EQ was occurring and was being enhanced by their education experience. Or, were the EQ scores not experiencing a gain, which may indicate that the education process is working against the maturity process to negate the natural rise in EQ.

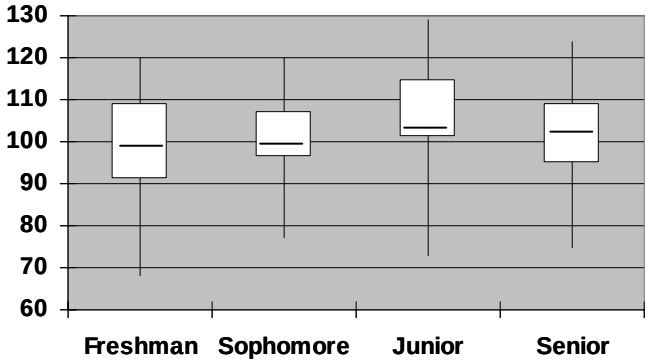

Figure 2: Intrapersonal Score distribution among students.

The Data Results

Figure 1 displays the results for Total EQ among the civil engineering students. Figure 1 indicates the total distribution and average of the scores with the 25th to 75th percentiles represented by the box and the min and max indicated by the tails. The average Total EQ score between freshmen and seniors rose from 96 to 100 with a standard deviation of 13 and 9 respectively. However, when a chi-square test was administered between these scores, no significant statistical difference could be

proven at even a 90% confidence level. Therefore, the slight rise in scores could not be interpreted as a significant difference between the freshman and senior Total EQ indicators.

The Total EQ score is an aggregate of 15 individual scores. This aggregation can lead to an evening of differences as variations in different categories are offset within the aggregate score. Therefore, the researchers focused on the five composite scores as additional indicators for the test results.

The first of these composite scores was the Intrapersonal category as illustrated in Figure 2. Once again, the data shows a slight increase from an average score of 99 for freshmen and an average score of 102 for seniors with a standard deviation of 13 and 12 respectively. This average is consistent with the overall population average in he Bar-On population. The second of the composite scores was the Interpersonal category (Figure 3). Although the average scores remain below the Bar-On mean of 100 throughout the four years, a slight increase from 91 in freshmen and 95 in seniors is observed with a standard deviation of 11 and 9 respectively. The third composite score is the Stress Management category. In this category, all four groups scored slightly above the Bar-On mean of 100 with the score rising slightly from a freshman average of 100 to a senior average of 103. The fourth composite score is the Adaptability category. In this category, the sample groups once again fall below the Bar-On population mean as the scores rise from only a 96 in the freshman year to a 99 in the senior year. However, standard deviations remain high in this category with a 14 in the freshman year and a 10 in the senior year. Finally, the fifth composite category studied was General Mood (Figure 4). In this category, the students displayed the largest growth, with the freshman population scoring an average of 99 and the senior sample growing to an average of 106. This score also reflects optimism in the students towards their environment.

Although the increases initially displayed by the averages in the five composite scores were minimal at best, they did represent an increase in the raw data set. However, to confirm that this rise was statistically significant, the researchers applied a chi-square test to determine if a 95% confidence level could be obtained in any of the categories. The result of this test was negative in each of the composite categories. In fact, a lower 90% confidence rating could not be reached in any of the categories except general mood. The lowest of the chi-scores occurred in the Stress Management category with the chi-square indicating very little confidence in the rise between the sample groups. In summary, the statistical significance of the growth in the composite categories could not be validated by the researchers at any level of confidence that is considered acceptable from a testing standard.

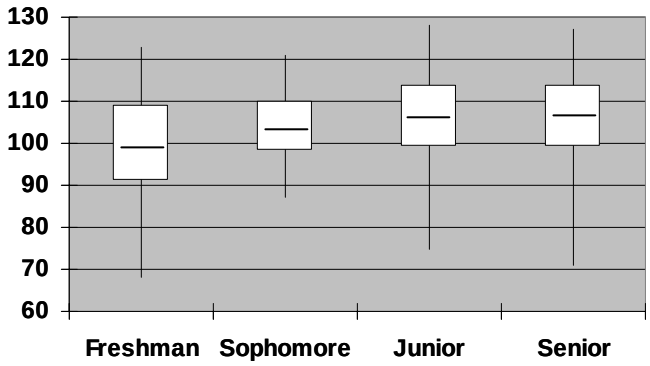

Figure 4: General Mood Score distribution among students.

	Freshman	**Sophomore**	**Junior**	**Senior**	**% Growth So. – Sr.**
Total EQ CE	96	96	99	100	4.2%
Total EQ LA	**	91	94	97	6.2%
Intrapersonal CE	99	99	102	102	2.9%
Intrapersonal LA	**	92	97	99	7.1%
Interpersonal CE	91	90	92	96	6.7%
Interpersonal LA	**	94	96	97	3.2%
Stress Management CE	100	101	101	103	2.0%
Stress Management LA	**	99	95	100	1.0%
Adaptability CE	96	96	98	98	2.1%
Adaptability LA	**	87	92	95	9.2%
General Mood CE	99	103	105	106	2.9%
General Mood LA	**	96	101	101	5.2%

Table 2: Average EQ test scores for civil engineering (CE) and liberal arts (LA) students.

The Comparison Sample

As stated in the beginning of this paper, the authors are attempting to compare the civil engineering growth in emotional intelligence with that of comparative liberal arts majors. To that end, the authors have currently obtained data from 90 liberal arts majors. The data presented in this section from these students is not as yet statistically conclusive, but provides an indicator of the deficiency that exists within the civil engineering curriculum when compared to the liberal arts sample population.

As illustrated in Table 2, the foundation of the comparison between the two groups lies in the growth of emotional intelligence over the university experience. Specifically, when the percentage of score increase is measured between the sophomore and senior years, the liberal arts students demonstrated a greater growth pattern than the civil engineering students[2]. In the Total EQ, Intrapersonal, Adaptability, and general mood categories, the liberal arts students demonstrated greater growth than the civil engineering students. The Stress Management category reflected a negligible difference between the two groups. The only category where civil engineering students demonstrated a greater growth was in the Interpersonal category. Although in this category the civil engineering students demonstrated greater growth, the final scores at the senior level ended up very close. This is the only category where the final scores end up at essentially the same score at the end of the senior year.

Although the data for the liberal arts students is still preliminary, the sample size is large enough and the numbers are clear enough to state that there appears to be a tangible difference in the EQ growth rates for the two student populations. The basis for this difference remains to be investigated in the continuation of this study.

Data Implications for Construction

Contrary to the hypothesis that EQ growth should be evident in the population just from life experience, the data indicates that no significant growth is occurring within the civil engineering student population. This suggests that either the civil engineering students are not experiencing emotional growth in their college experience, or that the educational program is in some manner inhibiting this growth.

[2] Freshman data is not used for liberal arts students since an insufficient number of data points have currently been collected.

Since the former is considered less likely due to the situation outlined previously, the researchers believe that the latter must have at least a partial influence.

One hypothesis for the negative influence of the civil engineering curriculum on the EQ scores is the orientation of the civil engineering curriculum. Specifically, engineering curriculum, based in math and science, is taught through factual theorems and utilizes an approach focusing on applied problem solving that precludes independent thought, an interpersonal skill. Additionally, minimal group work in the first two years limits the communicative skills associated with interpersonal skills. The lack of personalization in large lecture classes precludes emotional support for stress management. Memorization is rewarded, not the problem solving skill of adaptation. In general, the civil engineering curriculum may hinder creative thought and contribute to the limited growth in emotional intelligence.

The impact of this implication has direct relevance in two areas: education development and professional preparedness. In the former, the lack of emotion intelligence growth would have a direct impact on the problem solving capabilities of the senior civil engineering students. Specifically, if the students are not enhancing their creativity and problem solving skills from a non-analytic perspective, then it must be questioned as to whether these students are being prepared to solve design problems from a creative standpoint.

In the latter impact, students who are not receiving emotional intelligence development are not being adequately prepared for professional careers. Specifically, the professional leaders of tomorrow will emerge from today's entering professionals who display attributes such as leadership, communication skills, creativity, and an understanding of the multiple external variables impacting their business. Each of these attributes is directly tied to the emotional quotient variables. Therefore, the connection between long-term professional success and emotional intelligence enhancement at the university stage goes beyond the traditional analytic problem solving skills. Specifically, if the preferred outcome of a university program is to prepare students for leadership positions and successful careers rather than preparation for entry-level positions, then the university must enhance its focus on emotional intelligence.

POTENTIAL CHANGES TO ADDRESS EQ SHORTFALL

The indication that civil engineering students are not receiving adequate attention to the development of emotional intelligence, at least in this university setting, indicates a need to alter existing engineering curriculum to address this shortfall. The authors put forward the following recommendations as specific opportunities for engineering programs to enhance the development of emotional intelligence in their students.

Integrated EQ From the Beginning

The focus on the analytical development of engineering students in the first two years of the engineering curriculum has been a staple of engineering programs since the inception of the discipline. Although the introduction of freshman design courses is becoming increasingly common, these courses remain the exception to the analytic emphasis in the first two years of engineering education. The issue with this analytic focus is that students begin to get programmed that an overemphasis on analytic thinking is the key to engineering success. By the time these same students are asked to develop creative solutions in their capstone design courses, their ability to draw upon their alternative intelligences is hampered by previous developed solution patterns based on a single analytic focus. Therefore, to combat this delayed request for breadth, the authors strongly advocate the integration of emotional intelligence

concepts throughout the early engineering curriculum. Issues such as creativity, leadership, group interaction, and communications need to be introduced and fostered throughout the curriculum and not introduced as a late addition. Additionally, students need to be challenged to investigate solutions to open-ended problems rather than continually focused on solving problem sets.

Broader Scope of Upper Division

The introduction of capstone design courses has broadened the design experience of engineering students. However, the capstone concept does not go far enough in addressing the issue of breadth in the engineering curriculum. Rather, if engineering programs are going to significantly address the issue of breadth and the support of emotional intelligence growth, then the concepts of design must be expanded to include issues such as political influence, financial interactions, human resources, and market fluctuations. These issues may not reflect the analytic skills developed during the engineering curriculum, but the topics challenge the students to step out of their comfort zones to address issues that affect the development and implementation of real projects. This concept of challenge lies at the heart of emotional intelligence development. When students are challenged to achieve outside of established foundations, then their interest and curiosity in the problem will be enhanced which in turn, enhances emotional and successful intelligence (Sternberg 1997).

Connection to Career Development

The focus on lifelong learning is a concept that has been written about frequently in the last several years. The reason for this focus is rapidly being understood in industry. Specifically, the half-life of engineering knowledge is decreasing at an increasing rate. Therefore, to retain people who are familiar with the advances in their profession requires an active approach to lifelong learning. However, in addition to the traditional enhancement of technical skills, a greater professional focus is being placed on non-technical issues such as communications and leadership. Once again, a connection is established to emotional intelligence components. This connection can be enhanced if engineering programs place a higher emphasis on introducing these topics together with traditional engineering topics. In this manner, companies will have the opportunity to enhance employee skills rather than perceiving that it is there job to introduce this wide spectrum of essential, but non-technical, capabilities.

CONCLUSION

The evaluation of over 200 civil engineering students and 90 liberal arts students provides an initial insight into the development of emotional intelligence over a four-year education timeframe. The data provides an indication that an analytic-based curriculum may not be providing students all of the tools required to succeed in a professional career. Specifically, there arises the question of whether a traditional civil engineering curriculum may be inhibiting emotional intelligence growth. The initial study provides a basis for setting the hypothesis that current civil engineering curricula is at best a neutral influence on emotional intelligence development and that students are not achieving their full potential in emotional intelligence development. The results presented to support this hypothesis should not be interpreted as a refute of traditional IQ emphasis. Rather, IQ should be viewed as a complement to the emergence of IQ. Engineering success is highly dependent on analytic problem solving skills. However, long-term career and life success is as much dependent on the EQ abilities described in this study as an additional 10 points on an IQ test.

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