

The formation of engineers through the development of Emotional Intelligence and Emotional Competence for global practice

Colin U. Chisholm

Glasgow Caledonian University
Glasgow, Scotland, United Kingdom

ABSTRACT: Emotional Competence (EC), based on the components of Emotional Intelligence (EI) is now emerging as a core set of skills, which needs to be included in the future engineering curriculum. This competence is discussed in relation to Emotional Intelligence in terms of providing a positive learning experience in academic programmes. Consideration is given to the need to evolve the components of Emotional Competence such that graduates can work effectively in global environments. Results from a recent study are described, which involved first year results obtained at a Canadian university, involving a comparative study of 400 students across the disciplines of engineering, business and humanities to facilitate observation of similarities and differences in EI levels. It is concluded that the establishment of a range of competencies, which reflect the key components of Emotional Intelligence is key for the future formation of engineers within the rapidly growing global information society.

Keywords: Emotional Intelligence, Emotional Competence, formation of engineers, global context, learning environments

INTRODUCTION

Over the last decade, an increasing awareness has developed across engineering and technology of the need to recognise that the practice of engineering increasingly transcends national and cultural boundaries. Anecdotal evidence reveals that combining global generic competencies with technical education makes engineering graduates much more acceptable to the job market. It essentially enhances their employability.

A key driver is the concern that social mission, ethical practices, society and the environment become subservient in the consideration of the formation of the professional engineer of the future. For example, although there are leading statements regarding the creation and development of the European Higher Education Area [1], (for example, the Bologna Process), that will promote public good and public responsibility as encapsulated in the Magna Charta *Universitatum* (1988) [2], there is, however, little evidence of implementation or that this is been driven through effective curriculum design and educational methods [3].

Evidence is also reported to show that engineering graduates with cross-cultural global experience have a greater empathy in dealing with cultural differences which they encounter [4]. With the rapid pace of change of technology, society and demographics, engineering educators are now faced with the challenge of developing a package of knowledge, skills inclusive of global Emotional Competencies. A starting point in establishing Emotional Competencies would be to understand and measure Emotional Intelligence in the lecture room.

EMOTIONAL COMPETENCE IN THE CONTEXT OF THE GLOBAL ENVIRONMENT

Anecdotal evidence shows that Emotional Intelligence (EI) has emerged as a range of key skills to underpin the development of engineering graduates both in terms of providing a positive and successful experience in completing academic programmes and in underpinning sustainable success in career professional development. As present and future graduates increasingly operate in a global environment, Emotional Intelligence as a skill becomes an essential core to support the development of sustainable Emotional Competence in the context of a global information society, where social responsibility, social justice and ethics are key components needed to address the formation of the global professional engineer. A key prerequisite for the formation of the global practising engineer will be the successful establishment of intercultural awareness. It has been suggested that:

A professional successful in the home environment will not necessarily be equally successful when working in a new environment with a different culture. Organisations often emphasise expatriates' technical competence and experience and ignore the non-technical knowledge and skills [5].

To address this, Emotional Competence needs to be developed starting at undergraduate level and to do this detailed reference needs to be made to the developments in EI over the last decade. The need for Emotional Competence in the context of intercultural awareness is further illustrated as follows;

...research evidenced 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 [6].

The author believes that the components, which constitute EI, could underpin the establishment of Emotional Competencies, which in turn, would underpin the formation of engineers capable of interpreting the global environments in which they practice and societies in which they serve. As EI has both personal and social components, it can also adequately underpin the development of social responsibility and social justice in global working environments.

Increasingly, industry and commerce are demanding graduates who can function successfully in global environments without causing major intercultural misunderstandings, which can generate enormous costs and damage to the organisations involved with lost contracts in the future. Again this serves to illustrate the urgent need for the development of Emotional Competence relevant to engineering formation in the context of global operation.

So what needs to be considered in defining Emotional Competencies for engineering formation for global practice? Essentially, the competence has to be formed within the context of engineers operating in environments that are racially, culturally, ethnically, politically, ethically, socially and linguistically different from their home environment. Obviously, this is a challenging project, which will put pressures on the existing programme curricula that are already overloaded with technical knowledge to address the rapidly developing fields of engineering.

However increasingly, it is being accepted that key skills such as those supported through EI are fundamental to professional success. On this basis, educators need to find ways of developing Emotional Competence as a broad underpinning for the formation of engineers, with the process beginning at undergraduate level and, with the development of Emotional Competence and consequently EI being measured at the various levels of development. What still remains to be shown is what form of learning environment is liable to deliver the most effective growth in Emotional Competence. The traditional on-campus mode of learning may well be far from an ideal environment for the development of EI as it was essentially designed to address explicit knowledge IQ rather than the components of EI.

This means that educators need to be prepared to consider new approaches to the on-campus environment and the potential of off-campus environments to hopefully achieve more effective development of Emotional Competence. The achievement of the competence in the context of global aspects introduces an even greater challenge, particularly at undergraduate levels, where educators will need to innovate and be prepared to support students in learning environments globally which, in turn, will mean redesigning the programmes to facilitate developments in a global context.

It was reported that for successful interaction with other cultures, the only way forward is to learn about such cultures through a study of their values and rituals, and to develop an understanding of the differences in values regardless of whether these values are not ever going to become shared values [7]. This can only be achieved if students are able to experience the rituals and values, and be able to get along in such an environment using their developing Emotional Competence to deal with such differences in global environments.

EI AND EMOTIONAL COMPETENCE

Emotional Intelligence generally relates to a number of social and emotional abilities that previous research over the last 12 years has shown to be associated with enhanced workplace performance. Usually, the attributes are grouped into five groups as follows; self regulation, self motivation, social awareness, self awareness and social skills. Anecdotal evidence shows that many studies have confirmed that these skills are highly supportive of creating highly effective and motivated professionals. Thus, there is no reason why similar results could not be achieved in the student academic learning environments, leading to future graduates who enter their careers with an enhanced Emotional Competence on which they can further build a successful professional career.

Building Emotional Competence at undergraduate level, thus, has two main functions. First, the establishment and development of aspects of EI during the undergraduate programme may well ensure that students develop a level of Emotional Competence, which supports them in successfully achieving an engineering qualification. This, in turn, will provide a basis for further development of their EI as they practice in professional development. However, it is important that development is related to the context of global practice, where interaction in relation to race, culture, language, ethnicity, social systems, political systems and ethics can be enhanced through improved Emotional

Competence. It is the author's view that improved EI will develop as a function of operating in such a global context. Aristotle, in the Nicomachean Ethics, recorded the following:

Anyone can become angry - that is easy. But to be angry with the right person, to the right degree, at the right time, for the right purpose, and in the right way ...that is not easy.

This encapsulates the approach needed to develop a capability for Emotional Competence, taking into account the attributes of EI. It shows further why we need to look at alternative learning environments, which can support the achievement of the components of EI. It is hardly likely that the on-campus environment can support such emotional based learning. It is the development of an emotionally intelligent undergraduate, which is needed initially, where key emotional attributes are achieved. This is supported from the literature as follows:

The Emotionally intelligent person is skilled in four areas; identifying emotions, using emotions, understanding emotions and regulating emotions [8].

It was reported as early as 2001/02 of the need for in depth consideration to be given to EI as a way forward for more effective formation of engineers [9][10]. It was concluded that graduate engineers entering industry and commerce needed a range of skills derived from EI in addition to their university developed IQ. Attention was drawn to the fact that EI was most probably a prime factor for the development of engineers.

The Emotional skills offered through EQ are morally neutral, similar to intellectual skills. EQ does not provide values that govern use [10].

The moral neutrality ensures that these skills can be integrated effectively with intellectual skill, where synergistic learning may well be the effective outcome. It was effectively concluded that the off-campus workplace learning environment appeared to be ideal for the development of EI attributes at both undergraduate and postgraduate levels but concluded that a move in this direction would need a paradigm shift in academic thinking [9]. Also suggested was the use of a range of alternative life-place environments to achieve EI attributes alongside using the on-campus learning to provide the discipline knowledge.

The literature to date records no movement in the direction of addressing the establishment of Emotional Competence for engineering formation through the use of off-campus environments nor makes any reference to the need to develop the competence in the context of the global society.

For EI to be successfully achieved, the author believes that educators need to be prepared to introduce it, and sustain it, from the start of an undergraduate programme through to the postgraduate level such that graduates enter their careers, knowing they have an established base of EI alongside their discipline knowledge and other core competencies.

Students will need to understand that their EI development is of equal value to their discipline knowledge base, which can be used to drive forward their careers. As anecdotal evidence has shown, while IQ tends to peak around 17/18yrs and thereafter remains constant, EI, however, is not fixed at this age. Studies have shown that EI rises steadily from late teenage years on a continuous basis into the forties and above fifty only marginally drops [11].

This information is of fundamental importance as it regards the gradual development of Emotional Competence for engineering formation. Most students begin programmes at around 18yrs, which means that throughout their undergraduate and postgraduate years their EI can be developed as evidenced by these published results, whereas their IQ cannot really be improved. However, it is quite possible that improvements in EI may support much better use of their IQ to build up their discipline knowledge and other core skill needed for engineering formation.

It is important to differentiate between EI and Emotional Competence, where the latter refers to the range of personal and social skills, which need to be developed as part of engineering formation. It was reported that Goleman, Mayor, Salovey and Caruso are of the general view that by itself Emotional Intelligence is not the best predictor in relation to effective career performance. Rather, they believed that it was the competencies derived from EI, which ultimately underpinned effective career performance [12].

So for engineering formation, Emotional Competence needs to be researched and a set of Emotional Competencies put in place based on Emotional Intelligence.

EMOTIONAL INTELLIGENCE STUDIES

Dr J. Parker, Trent University, Canada, developed a self reporting Emotional Intelligence measure, the College Achievement Inventory – Revised (CAI-R) [13]. The intent of EI assessment of students is to provide the students with an awareness of their behavioural tendencies and, consequently, how to improve their self perceived abilities and, hence, develop Emotional Competence. The CAI-R was specifically designed for use with colleges and universities, giving a measure, which relates to five EI Scales [13][14]: Emotional Understanding, Psychological Mindedness,

Attentiveness, Emotional Self-Control and, a Total EI with four EI-related variables: Optimism, Social Integration, Performance Anxiety, Social Anxiety. The definitions for the basic five EI scales are discussed below [14].

Emotional Understanding

Relates to an individual's understanding of his/her feelings and emotional self-expression inclusive of abilities such as identifying and labelling emotions as they are felt, and being able to describe feelings to others.

Psychological Mindedness

Relates to the importance an individual places on thinking about and trying to understand self and others. Individuals high on psychological mindedness often use their feelings to guide their behaviours, and place great importance on self-awareness.

Attentiveness

Pertains to an individual's ability to effectively set and achieve goals. It relates to abilities such as keeping a focus on the task at hand, listening attentively to others, paying close attention to detail in order to avoid careless mistakes, tuning out distracting stimuli, keeping organised, and completing tasks.

Emotional Self-Control

Relates to the control an individual has over various types of emotional behaviour inclusive of abilities such as having patience, engaging in activities quietly when necessary, remaining still, listening and waiting for the appropriate time to respond.

Total EI (TEI)

This is an overall indicator of an individual's EI, which has a direct influence on their general psychological well-being, and is a key factor relating to an individual's ability. This scale is the averaged sum of the scores from the previous four EI scales.

Current EI studies involved around over 400 students at Ryerson University, Toronto, Ontario, Canada. The students were drawn from three distinct areas: engineering, humanities and information technology management (ITM - a business programme) [15][16]. They completed a self-reporting survey at the beginning of their first, second and third year of their studies.

In this study, it was shown from initial results that all three first year student cohorts - humanities, information technology management and engineering - were below the mean scale value for the Emotional Understanding scale. As it has been shown via anecdotal evidence that Emotional Intelligence can increase with maturity, it is not surprising that first year university students tend to score low on this scale. It was also reported that the engineering student cohort was predominantly male (above 75%), the ITM cohort was also male dominated (above 60%), whereas the humanities cohort was female dominated (above 60%).

The lower valuation for engineering and ITM students may thus be associated with the gender factor or with the possibility that Humanities and, to a lesser extent the ITM programme, students took courses that are more reflective in nature, where the individual is required to take a position on an issue or topic and have open ended discussions during their courses.

Engineering students, however, were viewed as taking more explicit courses in science and mathematics, which do not have the same levels of reflection or open ended discussion and, hence, it was viewed that emotional skills in this area were not developed to the same extent as the Humanities cohort. It was also recorded that the Humanities students scored higher, being above the mean value on the Psychological Mindfulness scale. The engineering and ITM students scored less than the mean value, with the ITM cohort having the lowest score. Again, it was suggested from these results that it was possibly the gender factor, which was operative with perhaps female students developing Emotional Intelligence at a faster rate than male students supported by the different nature of the study methods and subject matter being studied.

However, it was found that a significant change in ranking was found for the Attentiveness and Emotional Self-Control scales [15][16]. While all cohorts scored less than the mean value, the engineering students scored the highest, followed by humanities and lastly ITM for the Attentiveness component. It was argued that this scale addresses the particular skill set, which directly relates to a mathematical and science focused field of study such as engineering. With the Emotional Self-Control scale again, the engineering cohort had the highest score, the ITM the second highest and the Humanities cohort the lowest.

On this basis, it was argued that these abilities are indigenous to engineering education, where regular and traditional delivery of lecturing takes place, particularly in the first year of a course, which requires the students to remain still and listen without interruption. It was noted that this delivery method is not as common in a humanities or ITM programme where class discussion and open ended debate is a much more common form of delivery.

The overall combined Total Emotional Intelligence (TEI) scale was evaluated for all three student cohorts, and the humanities cohort had the highest score followed by the engineering cohort and lastly the ITM cohort. This overall scale needs more study with respect to the potential for improvement and development of Emotional Competence as the students progress through their degrees.

This study of the EI of engineering students was undertaken to achieve an understanding of the students with respect to other student cohorts to try and obtain an understanding of their EI strengths and weaknesses. Current instructional delivery methods need to be reviewed with a view to improving opportunities to integrate the development of various EI components as they progress through their programme and the use of alternative learning environments, which provide an understanding of other cultures is needed to drive Emotional Competence in a global context.

CONCLUSIONS

These initial studies show that Engineering students have stronger initial EI in certain areas such as Attentiveness and Emotional Self-Control but are weak at this first year stage in others such Emotional Understanding and Psychological Mindedness capabilities. These components are essential if graduates are to work effectively in cross cultural global environments.

Establishment of Emotional Competence will facilitate and enhance engineering formation in the context of working and operating in environments where race, religion, ethnicity, culture, politics, social systems and ethics have to be carefully considered alongside technical development.

Components such as empathy, social responsibility, interpersonal relationships and Emotional Self Awareness should significantly contribute to effective professional practice in global based environments.

Over the last 5 years, considerable work has been completed on looking at alternative learning places such as work-based and life-place environments, which could facilitate the effective development of Emotional Competence in the context of the global society.

REFERENCES

1. Herling, D., Herling, A. and Peterson, J., Integrating engineering and global competencies: A case study of Oregon State University's international degree program. *Proc. 31st ASEE/IEEE Frontiers in Educ. Conf.*, Reno, NV, USA, F2B-4-7, 2 (2001).
2. Magna Charta Universitatum (1988), 15 October 2009, http://www.magna-charta.org/pdf/mc_pdf/mc_english.pdf
3. The Bologna Process 2020. (2009), 15 October 2009, http://www.ond.vlaanderen.be/hogeronderwijs/Bologna/conference/documents/Leuven_Louvain-la-Neuve_Communique_April_2009.pdf
4. Tsirigotis, G., Papadourakis, G. and Karasavoglou, A., Humanity dimension studies of technological sector of higher education in Greece, *Proc. 6th Inter. Conf. on New Horizons in Industry, Business and Educ.*, Santorini, Greece, 43-50 (2009).
5. Korhonen, K., Intercultural communication through hypermedia. *Proc. 5th Nordic Symposium on Intercultural Communication*, Gotteborg, Sweden (1999).
6. Andreason, A., Ensuring the success of expatriate managers. *J. of Business and Public Affairs*, March (2002).
7. Hofstede, G., *Cultures and Organisations; Software of the Mind*. (2nd Edn), New York: McGraw Hill (1997).
8. Mayer, J.D. and Salovey, P., The intelligence of Emotional intelligence. *Intelligence*, 17, 4, 433-442 (1993).
9. Chisholm, C.U., Analysis of why work based learning is a better model for creating the engineers that society needs. *Proc. 3rd Global Congress on Engng. Educ.*, Glasgow, Scotland, 380-383 (2002).
10. Riemer, M.J., IQ versus EQ: Emotional intelligence and the graduate engineer. *Proc. 5th Baltic Region Seminar on Engng. Educ.*, Gdynia, Poland, 79-82 (2001).
11. Stein, S.J. and Book, H., The EQ Edge. *Emotional Intelligence and Your Success*. Jossey-Bass, 18-19 (2006).
12. Cherniss, C., Emotional Intelligence: What it is and why it matters. Paper presented at Annual Meeting of the Society for Industrial and Organisational Psychology, New Orleans (2000), December 2009, http://www.eiconsortium.org/reports/what_is_Emotional_intelligence.html
13. Parker J.D., Summerfeldt, L., Hogan, M. and Majeski, S., Emotional Intelligence and academic success; Examining the transition from high school to university. *Personality and Individual Difference*, 36, 163-172 (2003).
14. Parker, J.D., Wood, L.M. and Bond, B.J., College Achievement Inventory (CAI): Technical Manual. Peterborough, Canada: Emotion and Health Research Laboratory (2005).
15. Stewart, M.F., Chisholm, C.U. and Allan, M., Academic success of first year engineering students: Emotional intelligence a predictor? *Proc. Conf. EE2010 – inspiring the next generation of engineers*. Aston University, Birmingham, UK, 1-9 (2010).

16. Stewart, M.F., Chisholm, C.U. and Harris, M., Engineering student learning and Emotional competences. Presented: *IEEE Transforming Engng. Educ. Conf.*, Dublin, Ireland (2010).

BIOGRAPHY



Colin Urquhart Chisholm graduated in metallurgy from Strathclyde University and completed a PhD at St Andrews/Dundee University. He is Emeritus Professor at Glasgow Caledonian University, where he continues to research and publish. He led the establishment of work-based learning, leading to awards up to Professional Doctorate. He has published around 300 scientific/education papers in refereed journals and conference proceedings. He has researched a range of engineering and educational developments and collaborated with the UNESCO International Centre for Engineering Education (UICEE), Australia, setting up the first *UICEE satellite centre* at GCU.

He was awarded the UICEE Silver Badge of Honour in 1998, the Gold Badge of Honour in 2000, and the inaugural *UICEE Order for Excellence in Engineering Education* in 2006. He has been Associate Editor of a number of international journals and is a member of the editorial boards of a number of journals. He is currently a member of the editorial advisory boards of the *World Transactions of Engineering and Technology (WTE&TE)* and the *Global Journal of Engineering (GJEE)* of the World Institute of Engineering and Technology Education (WIETE), and is currently a Vice-President of the WIETE International Academic Advisory Committee (WIETE-IAAC).