

The Inclusion of Emotional Intelligence in Engineering Education: A Review

N Wint¹

Centre for Engineering Education (CEE), University College London (UCL)
London, UK

ORCID
0000-0002-9229-5728

Conference Key Areas: *Teaching the knowledge, skills, and attitudes of sustainable engineering, Educating the whole engineer: teaching through and for knowing, thinking, feeling, and doing.*

Keywords: *Emotional intelligence, EQ, EI, diversity, and inclusion.*

ABSTRACT

In recent years there has been an increase in research focused on the role that emotion plays within engineering practice. Of the related themes present within engineering education research (EER), emotional intelligence (EI) is reported as one of the most researched, its development being associated with multiple benefits. However, it is also claimed that emphasis on EI justifies an expectation for students to conform to norms, something which can result in inequality, and retention of power hierarchies. It can thus be argued that although the inclusion of emotion, and indeed EI, may, at first, appear advantageous in terms of diversity, it can act to sustain the status quo. This work is intended to examine the underlying assumptions associated with the inclusion of EI in engineering curricula. In so doing, a review of the literature is completed with the aims of understanding the way in which EI has been introduced within engineering education, as well as the reasoning behind its inclusion. 34 research articles were reviewed, with most motivated by the general benefits of EI in the context of the workplace. Whilst the majority of studies included use of EI measurement tools, the type varied significantly. Test results were typically used to identify domains of EI in which students scored least, this informing future course design, or student personal development plans. There was a lack of evidence to suggest that interventions included critical analysis of EI within a wider context, something which should be addressed in future work in the area.

¹ N Wint
nat.wint@ucl.ac.uk

1 INTRODUCTION

1.1 Introduction to EI

In recent years there has been an increase in research which considers the role that emotion plays within engineering. Much of this work was included in a scoping review of emotion within engineering education (Lönngren et al., 2021) which identified four themes: academic emotions; emotions and ethics; emotional intelligence (EI) and other socio-emotional competencies; and mental health. Of these, EI was one of the most researched something which was proposed to be because the quantitative methods used to study EI appeal to engineering researchers (Lönngren et al., 2023).

EI is used to conceptualise the relationship between cognition and emotion and can be considered as an attempt to counter views of emotion as associated with lower intelligence, and as a possible source of bias (Solomon, 2008). This is of particular interest within engineering, a profession associated with rationality (Lönngren, Adawi, & Berge, 2021). It became influential through popular work such as that of Goleman (1995; 1998; 2013), with the EI model (Mayer, Salovey, and Caruso, 2000), defining EI as “the subset of social intelligence that involves the ability to monitor one’s own and others’ feelings and emotions, to discriminate among them and to use this information to guide one’s thinking and actions” (Salovey and Mayer, 1990, p. 189), and as involving the ability to: perceive and express emotions; understand emotions and emotional change processes; use emotions to facilitate particular types of cognition; and regulate emotions in oneself and others. Whilst this (ability) model considers EI as a group of cognitive abilities, other work frames it as a personality trait involving dispositions (Petrides, Frederickson, and Furnham, 2004).

EI is typically studied using quantitative instruments developed within psychology, with the two EI models introduced being differentiated with respect to the measurement method used to operationalize them (Petrides, 2011). Trait EI involves self-perception measured via self-report, whilst ability EI measures cognitive abilities related to emotion measured via maximum performance tests. The model used has significant implications for the development of EI within education, with the ability model focusing on possessing certain cognitive competencies, and trait EI focusing on consistent, cross-situational traits such as self-esteem and happiness, which form part of personality. Although the distinction between the types is well documented, in some cases the distinction is not acknowledged, this having implications for the ability to organize development and accumulation of knowledge in the field (Petrides, 2011). Examples of the commonly used measures are shown below.

Ability based measures:

- The Mayer Salovey Caruso Emotional Intelligence Test (Mayer & Caruso, 2002; Mayer, Salovey and Caruso, 2004.) considers EI as four abilities.

Trait based measures:

- Schutte Emotional Intelligence Scale (Schutte et al., 1998) a self-report tool which focuses on users’ perceptions of their abilities.
- Bar-On Emotional Quotient Inventory (Bar-on, 1997a; 1977b; Bar-On, Brown, Kirkcaldy, and Thome’s (2000) EQ-i) which considers emotional-social intelligence as a mixture of skills, competencies and facilitators.
- Trait Emotional Intelligence Questionnaire/ TEIQue-SF (Petrides, Pita, and Kokkinaki., 2007) which considers EI as a subset of personality.

A significant amount of the work published in the area focuses on the gendered nature of results which have been shown to depend on the way in which the test is presented (Horgan & Smith, 2006; Ickes, Gesn, & Graham, 2000; Koenig & Eagly, 2005). In the case of self-report measures, the focus is on “abilities and the potential for performance” rather than performance itself (Bar-On., Brown, Kirkcaldy, & Thomé, 2000, p.1110) and results are often skewed by desire for positive self-presentation (Dawda & Hart, 2000; Mandell & Pherwani, 2003). Any gender differences tend to be associated with particular aspects of EI.

1.2 EI and participation and access in STEM

Findings pertaining to gender differences are particularly relevant within engineering. Several papers have focused on benefits of EI in terms of gender representation within STEM. For example, Tripon (2022) claims the ‘superior’ EI of girls could be key to motivating girls to study STEM. Besser et al. (2020) investigate how the inclusion of empathy needed for EI may act as a mechanism for cultural change and result in a critical mass of women in engineering. Van Oosten, Buse and Bilimoria (2017) describe a leadership course aimed at advancing and retaining women within STEM which featured “skill development in the areas of leadership and emotional intelligence” (p.3). Melbourne (2016) suggests that STEM educators trained in EI emphasize how emotion regulation skills can help someone succeed, something they say is essential for women and other underrepresented groups, saying that those not trained in EI may “internalize their failures” (p. 9). Similarly, Musa (2020) claims EI “can lead her to success in any engineering disciplines” (p. 3917).

1.3 Criticism of use of EI

There is a limited amount of literature within EER that highlights the need to be cautious with respect to EI. For example, in talking about experiential learning, McDermott, Göl, and Nafalski (2001) question “is it ethically defensible to seek to modify students’ intuitive or emotional behaviour?” (p. 74). Chan et al. (2020) draw upon the work of Blackmore (2011) to critique the way EI focuses on individualised competencies rather than context, as well as the power relations which define how expressions of emotion are controlled and understood. Lönngren et al. (2023) highlight the emphasis on individual self-improvement and expectations to conform to norms and encourage research to draw upon sociological perspectives. They highlight the work of Zembylas (2007) who compares EI to ‘emotional capital’, a concept based on the work of Bourdieu (e.g. Bourdieu, 1997).

More broadly with respect to equality, diversity, and inclusion (EDI), critical work in the area has highlighted the role of power and status in determining the components of EI considered of higher social value, and the way beliefs regarding ‘good’ and ‘bad’ emotion are tied to beliefs about characteristics such as social class and race (Shields, MacArthur, and McCormick, 2018). Shields and Warner (2007) argue that EI “favor(s) those who are in the position to recognize privileged knowledge and deploy it”, pointing out that “recognizing knowledge is distinct from the ability or privilege to use it. (p.172)”. They comment on the way types of EI that women are ‘supposedly’ not good at are framed to ignore structural issues, and how those emotions which are considered as ‘undesirable’ are often the ones experienced by those who undergo gender discrimination (Gibson, Schweitzer, Callister, & Gray, 2009; Vescio et al., 2005). Drawing upon expectation states theory (Ridgeway and Bourg, 2004), Shields and Warner (2007) describe political dimensions of emotions,

claiming that judgments pertaining to how and when emotion should be felt and displayed serve interests of regulating organization and functioning of social groups. In the context of education, Boler (1999) questions “how emotions are disciplined to maintain social control” (p. 22), this linked to the idea of ‘feeling rules’ which define who can feel which emotions, how they should feel them, and in which situations (Hochschild, 1979; 1983). In work examining emotional literacy programmes, Boler (1999) failed to observe instances in which emotions were analysed within the wider context and concluded that students were learning to perceive prescriptive rules regarding acceptable emotional behaviour. They raise several concerns around: imposing emotional rules that stem from embedded or arbitrary values; reinforcing the notion of victim blaming and advocating self-control; and contributing towards the maintenance of social hierarchies and capitalist interests.

It can therefore be argued that although the inclusion of EI, may, at first, appear advantageous in terms of diversity, it can act to sustain the status quo within engineering. This review is completed with the aims of understanding the way in which EI has been introduced within engineering education. It is not intended to act as a criticism and there is little doubt that the initiatives included provided a beneficial learning experience to students involved. Analysis is intended to examine underlying assumptions associated with inclusion of EI within engineering, and how educational practices are embedded within larger societal discourses.

2 METHODOLOGY

The research questions (RQs) focus on 1.) the ways in which the concept of EI is utilised within engineering programmes and 2.) the way in which the inclusion of EI within engineering programmes is justified. A systematic literature review (SLR) was chosen as an appropriate methodology to understand this emerging area and serve as a basis for future work. In general, an SLR involves: identifying scope and research questions; defining inclusion and exclusion criteria; appraising and synthesising studies; and reporting findings (Borrego, Foster, and Froyd, 2014).

The following inclusion criteria were used:

- Publications written in English, taking form of peer reviewed journal articles (excluding reviews), conference papers, books, or chapters.
- Work conducted in engineering programmes in higher education (HE).
- EI of engineering students is addressed (for examples as part of an intervention) or measured as part of the study.

Three of the databases recommended for SLRs in engineering education by Borrego, Foster, and Froyd (2014) were chosen, these being ERIC (ProQuest), Web of Science and SCOPUS. The search was completed in February 2024 and the keywords used were “engineering education” AND “emotional intelligence”. The search resulted in 173 records. 28 duplicates were removed because they appeared in multiple databases, 9 could not be accessed, 3 had been redacted. One literature review and one workshop were excluded. The remaining records were partly screened by abstract and partly by full paper to examine whether they met inclusion criteria. Most records removed were done so for: describing workplace-based studies; focusing on use of technology to develop EI more widely; mentioning EI briefly as something required in engineering, along with other skills and competencies; focusing on skills surveys or employer needs; being theoretical or conceptual in nature; focusing on staff within engineering education. The remaining

34 papers were read and further analysed in a spreadsheet using the following categories: author, title, publication year, journal/conference name, reason for focusing on EI/purpose (RQ2), context, measurement tool used (if any) and justification of choice (RQ1), findings, teaching approaches (RQ1).

3 RESULTS

Of the 34 papers, 14 were journal articles and 20 conference proceedings. Table 1 shows the locations in which studies took place. Perhaps unsurprisingly, over a quarter of papers describe studies situated in the USA. Although the number of articles per year are relatively similar, there are some peaks, primarily more recently in 2023, but also in 2017. Although the number of articles considered limits the extent to which trends can be identified, the increase in recent years may be linked to increasing focus on professional skills and competencies such as cultural awareness, within accreditation criteria and engineering education more broadly.

Table 1. A summary of EI papers by year published and context of study

Location of study	Number of papers	Year of Publication	Number of Papers
Abu Dhabi	2	2001	1
Brazil	1	2007	1
Canada	2	2009	3
China	1	2010	2
Colombia	1	2012	2
Hungary	1	2013	1
India	1	2014	1
Malaysia	4	2015	1
Morocco	1	2016	2
Peru	2	2017	4
Portugal	3	2018	1
Saudi Arabia	1	2019	2
Spain	3	2020	3
Turkey	1	2021	3
Ukraine	1	2022	1
USA	9	2023	6

In answering RQ1, papers were broadly split into three categories: those describing just the use of measurement tools (21); those focused on EI based interventions (6); and those including both (7).

3.1 EI measurement tools

28 of the 34 papers described studies that employed the use of EI measurement tools, 7 of which being used in combination with teaching based interventions. A summary of the 21 papers that made use of tools alone is provided in Table 2.

In three cases the tools were not named. Two studies used both Trait Meta-Mood-Scale (TMMS-24) and the Emotional Quotient Inventory, presumably to provide coverage of both ability and trait-based EI models. The variation in the tools used is of significance when considering transferability of practice within the community, something which was highlighted in one paper (Sushchenko, Borova, and Petrenko, 2023) which suggested a need for instruments that can be used to understand EI associated with activities within the engineering profession. Very few papers

discussed differences between ability and trait-based intelligence, this having implications for the development of knowledge (Petrides, 2011). Furthermore, few studies included justification for choice of tool (generally or in the context of EI model used), which impacts on the ability to design curricula or teaching practices based on findings of such work. One study (Kumar, 2019) made use of TEIQue-SF to measure students EI levels claiming it “has been successfully applied in the educational context” and that “traits EI is also able to suggest the right academic or vocational line in the higher education setting” (p. 210). Koontz (2017) made use of the EQI, claiming that the “assessment gives educators a way to measure student’s emotional development and offer specific personal-development recommendations” (p. 9268). Lye et al. (2023) said that the TEIQue-Short Form was selected because it measures ‘trait’ EI, which has a better predictive value compared to the ‘ability’ EI, in anticipating actual behaviours or outcomes in a range of situations” (p. 481). Although Belanger et al. (2007) do not provide reasons for using Schutte’s scale, they do discuss the implications of doing so with respect to findings that suggested no correlation between EI and academic performance, saying that Schutte’s scale is trait rather than ability based, meaning that it measures personality traits as opposed to cognitive ability which would be expected to have stronger correlation with academic performance.

6 papers made use variations of tools. One group of authors made use of the EQI adapted for Malaysian traditional culture where individuals may be more prone to appreciate and respect elder people and practice spiritual aspects (Saibani et al., 2012; 2013). Chen, He, and Yang (2020) made use of the Wong and Law Emotional Scale (WLEIS) which was based on 418 undergraduates in Hong Kong. Khefacha, and Sellei (2023) used the Hungarian version of the EQ-I but do not allude differences. Magano et al. (2021) and Nogueira, Castro, and Magano (2023) made use of an EI scale validated by Rego and Fernandes for the Portuguese population. Sushchenko, Borova and Petrenko (2023) used a Ukrainian variant of the Hall EI test which they claimed was short and more accessible for the context. In light of such discussions, it is interesting that some authors discussed potential impacts of socio-cultural factors on test results. For example, Kumar (2019) described a negative perception of emotions which should be avoided to show professionalism in Malaysia. Similarly, when exploring EI in the context of teamwork, Deveci (2015) suggested that higher satisfaction with teamwork, despite low EI, may occur as a result of the collectivist nature of Arab culture, and discouragement of expressing negative emotions explicitly.

Finally, in some papers there was a noticeable use of deficit-based language when justifying use of EI tools (RQ2). For example, Saibani et al., (2013) claimed that a “test is able to determine the EQ level ...which is also beneficial towards consolidating any domain that is deemed flawed” (p.78). Likewise, the same authors (Saibani et al., 2012) justified use of an EI tool “as an effort to examine what domain is lacking amongst the students and what can be done to elevate the low domains.” (p. 525).

3.2 EI measurement tools and interventions

Seven papers described the use of EI tools alongside a teaching intervention. One (Casado, Fernández, and Lapuerta, 2016) made use of a pre-post tests to evaluate EI training effectiveness. Deveci and Nunn (2016) used a tool with seminar discussions within a project-based module, claiming results could be used to inform content.

Other studies in this category made use of tools to help guide personal development activities. Stewart, Chisholm, and Harris (2010) used the College Achievement Inventory-Revised (CARI-R) because the “self-report assessment measures

Table 2. A summary of EI papers making use of EI measurement tools

Topic of interest	Tool(s)	Categories of Analysis	Reference
Coping strategies and EI as contributors to -major grade point average (GPA)	Schutte's EIS	GPA, discipline	Belanger et al. (2007)
EI as a moderator of design capability and computational thinking Relationship between EI and innovation	Wong and Law EIS (WLEIS)		Chen, He, and Yang (2020)
Relationship between teamwork satisfaction and EI	Schutte's EIS	Gender and nationality	Deveci (2015)
Levels of EI according to achievement	WLEIS	Gender, year/level of study, discipline	Encinas and Chauca (2020)
Strengths and weaknesses of students' EI to identify areas for development using neurolinguistics programming	EQI (Hungarian version)		Khefacha and Sellei (2023)
Impact of liberal arts on EI as an indicator for general success	Not provided	Gender, discipline, year/level of study	Kissani and Boudihaj (2019)
Relationship between academic performance and EI	Schutte's EIS	Gender	Koppad et al. (2023)
Gender differences in EI/EDI	TEIQue-SF	Gender	Kumar (2019)
EI as an indicator of how much time spent in each of the design activities	EQI-2.0	Year/level of study, gender, major	Koontz et al. (2017)
Determine differences in EI of high academic performance (HAP) students	TMMS-24 and EQI-S	HAP vs non HAP	Pertegal-Felices et al. (2017)
Relationship between team project marks and EI	EQI		Leicht et al. (2009)
Effects of EI and demographic characteristics on Psychological Capital	TEIQue-SF	Gender	Lye et al. (2023)
Impact of EI on students' motivation to learn more about sustainability and whether it plays a role in moderating the relationships between those variables	Rego and Fernandes	Gender, year/level of study, nationality	Nogueira, Castro, and Magano (2023).
Employability/performance in the workplace	EQI-S	Comparison with teaching students and survey results about competencies related to EI needed in workplace	Pertegal-Felices, Castejón-Costa, and Jimeno-Morenilla (2014).
Connection between achievement and EI in women, inclusivity, and diversity	Not provided	Gender, year/level of study, discipline, academic performance	Rizwan et al. (2019)
Cultural differences in EI	Malaysian EQI	major races in Malaysia	Saibani et al. (2012)
Employability/competitive advantage	Malaysian EQI	Year group/level of study	Saibani et al. (2013)
Relationship between EI and personality traits and resilience (needed for project management including teamwork and communication) of GenZ students.	Rego and Fernandes	Gender	Silva et al.(2020) Magano et al. (2021)
Development of (engineering specific) self-evaluation tools, represented by qualimetric instruments to evaluate EI	Hall (Ukrainian version)	Year/level of study	Sushchenko, Borova and Petrenko (2023)
General benefits/employability	Schutte's EIS	Age, gender, hobbies, engineer in family, professional pessimism	Tekerek and Tekerek (2017)

behavioural tendencies and self-perceived abilities” which is suitable when “the intent of EI assessment of students is to provide the student with an awareness of their behavioural tendencies and how to improve their self-perceived abilities.” Price, and Cordova-Wentling (2009) claim that EI tests allow for self-assessment and feedback necessary for improvement, and asked students to use their results as the basis of a personal development plan for the semester. Degen et al. (2022) describe teaching students on a programme for first generation students about the EQ-i 2.0 instrument, saying that they made use of their results to produce SMART goals for personal development. In their work into leadership development, Didiano, Simpson, and Reeve (2021) combined the use of a tool with one-on-one debriefs with the instructor which they said allowed students to clearly understand their strengths and areas for growth, this forming the basis of a personal development plan. Crowley et al. (2010) also described the use of EI tools to inform students’ development plans.

3.3 EI measurement based interventions

Six papers described EI based teaching interventions. These typically involved an introduction to the concept and discussion. Such content was introduced in leadership (Bayless, Mitchell, and Robe, 2009; Bayless and Robe, 2010) and management (Burgos-Vera et al., 2021) courses and as a core element of an Innovation, Leadership, and Engineering Entrepreneurship BS Degree Program (Newell, and Varshney, 2017). Catalano, Abdalla, and Delicato (2012) describe introducing EI to help students to differentiate themselves in the labour market. Rojas-Martínez et al. (2021) describes utilising a problem-based learning approach to introduce content addressing three axes within EI: motivation, tolerance, and resilience. The learning outcomes include identifying factors that affect emotional well-being, motivations, identifying situations of stress, setting goals and actions, healthy relationships, support groups, social and academic connections and activities which activate resilience.

4 SUMMARY

The main limitation of this work is the focus on only three databases and the exclusion of non-English publications or non-academic articles or reports. There are also limitations associated with the search terms used. Nevertheless, the findings show that, in the context of EER, EI based studies primarily make use of EI measurement tools. Results were typically analysed by characteristics such as gender, race, year of study and discipline and used to identify constructs of EI which are underdeveloped, to inform course design, or to help inform student personal development plans. In some cases, pre-post EI tests were used to assess the effectiveness of an intervention. In a few cases authors did not report the tool used and there was little consistency in tool used across range of papers. It would be beneficial for researchers to justify reasons for use of tools in the context of trait based or ability-based EI models and research aims. A more consistent approach would help facilitate faster development of knowledge within the field. In some cases, papers took a deficit approach to EI and there was little evidence to suggest that courses included critique of the emphasis on individual self-improvement and the expectation to conform to norms, or analysis of emotions within a wider context. Future interventions within engineering should focus on highlighting such issues. For example, Boler (1999) suggests several ways in which EI can be made explicit, suggesting reflective, collaborative, critical analysis of gendered and cultural differences in emotions and the role emotions play in maintaining power structures, topics which may be considered particularly relevant within engineering, which suffers from a lack of diversity.

REFERENCES

- Bar-On, R. (1997). Bar-on emotional quotient inventory (EQ-i) A test of emotional intelligence. Multi-Health Systems.
- Bar-On, R. (1997a). The Emotional Quotient Inventory (EQ-i): A test of emotional intelligence. Toronto, Canada: Multi-Health Systems, Inc.
- Bar-On, R. (1997b). The Emotional Quotient Inventory (EQ-i): Technical manual. Toronto, Canada: Multi-Health Systems, Inc.
- Bar-On, R. 2004. "The Bar-On Emotional Quotient Inventory (EQ-i): Rationale, description and summary of psychometric properties." In *Measuring emotional intelligence: Common ground and controversies*, edited by G. Geher, 115–145. Nova Science Publishers.
- Bar-On, R., Brown, J. M., Kirkcaldy, B. D., & Thomé, E. P. (2000). Emotional expression and implications for occupational stress: An application of the Emotional Quotient Inventory (EQ-i). *Personality and Individual Differences*, 28, 1107–1118. [http://dx.doi.org/10.1016/S0191-8869\(99\)00160-9](http://dx.doi.org/10.1016/S0191-8869(99)00160-9).
- Bayless, D. J., J. Mitchell, and T. R. Robe. 2009. "Engineering leadership studies and the Robe Leadership Institute model in the Russ College of Engineering and Technology at Ohio University." 2009 39th IEEE Frontiers in Education Conference, San Antonio, TX, USA, 2009, 1-6. <https://doi.org/10.1109/FIE.2009.5350619>.
- Bayless, D., and T. R. Robe. 2010. "Leadership education for engineering students." Proceedings – 40th Frontiers in Education Conference, Washington DC, USA, October 27-30, 2010. <https://doi.org/10.1109/FIE.2010.5673554>.
- Belanger, F., T. Lewis, G. M. Kasper, W. J. Smith, and K. V. Harrington. 2007. "Are Computing Students Different? An Analysis of Coping Strategies and Emotional Intelligence," in *IEEE Transactions on Education* 50, no. 3:188-196. <https://doi.org/10.1109/TE.2007.900029>.
- Besser, D., K. Brown, A. Haugh, T. Brass, R. Leininger, and A. Thomas. 2020. "Empathy, Engineering, and Girls". Presented at 2020 ASEE Virtual Annual Conference. <https://doi.org/10.18260/1-2--34525>.
- Blackmore, J. 2011. "Lost in translation? Emotional intelligence, affective economies, leadership and organizational change," *Journal of Educational Administration and History* 43, no. 3: 207–225. <https://doi.org/10.1080/00220620.2011.586455>.
- Boler, M. 1999. "Feeling power: Emotions and education." Routledge.
- Borrego, M., M. J. Foster, and J. E. Froyd. 2014. "Systematic Literature Reviews in Engineering Education and Other Developing Interdisciplinary Fields." *Journal of Engineering Education* 103: 45-76. <https://doi.org/10.1002/jee.20038>.
- Bourdieu P. 1997. "The forms of capital." In *Education: Culture, Economy, Society*, edited by A. H. Halsey, H. Lauder and P. Brown, 46–58. Oxford: Oxford University Press.
- Burgos-Vera, O., C. Sotomayor-Beltran, D. Llulluy-Nuñez, and H. R. del Carmen. "Teaching management skills to first year engineering students." 2021 IEEE World Conference on Engineering Education (EDUNINE), Guatemala City, Guatemala, 2021, 1-4. <http://doi.org/doi:10.1109/EDUNINE51952.2021.9429141>.
- Casado, M., D. Fernández, and V. Lapuerta. 2016. "Socio-emotional competencies in engineering education." *International Journal of Engineering Education* 32: 1660-1678.

- Catalano, F., A. Abdalla, and F. Delicato. 2012. "What is Missing for Traditional Design-Centric Engineering Education to Better Prepare Newly Graduated Engineers for the Global Era?*" . *International Journal of Engineering Education*. 28, no.4:852–858.
- Chan, A., C. Rottmann, D. Reeve, E. Moore, M. Maljkovic, and E. Macdonald-Roach. 2020, June. *Wisdom through Adversity: Situated Leadership Learning of Engineering Leaders* .Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual On line . <https://doi.org/10.18260/1-2—35583>.
- Chen, G. Y. He, and T. Yang. 2020. "An ISMP Approach for Promoting Design Innovation Capability and Its Interaction With Personal Characters," in *IEEE Access*, vol. 8, 161304-161316. <http://doi.org/10.1109/ACCESS.2020.3019290>.
- Crowley, L., R. Price, J. Dolle, and B. Litchfield. 2001. "Engineering Emotional Intelligence: Course Development and Implementation." Proceedings of 2001 ASEE Annual Conference and Exposition, Albuquerque, NM, United States, 24-27 June 2001, 4285-4309. <https://doi.org/10.18260/1-2--9193>.
- Dawda, D., and S. D. Hart. 2000. "Assessing emotional intelligence: Reliability and validity of the Bar-On Emotional Quotient Inventory (EQ-i) in university students." *Personality and Individual Differences* 28:797–812. [http://dx.doi.org/10.1016/S0191-8869\(99\)00139-7](http://dx.doi.org/10.1016/S0191-8869(99)00139-7).
- Degen C.M., A. Jensen; J. J. Kellar, M. West, L. Carlson, J. Herrera, M. E. Moore. 2022. "First-generation student success and the SD-FIRST program". ASEE Annual Conference and Exposition, Conference Proceedings.
- Deveci, T. 2015. "Freshman Students' Emotional Intelligence and Team-Work Satisfaction Levels. A Comparative Study: Gender and Nationality." *Yuksekogretim Dergisi*. 5, no.1: 35-43. <https://doi.org/10.2399/yod.15.007>.
- Deveci, T., and R. Nunn. 2016. "Development in freshman engineering students' emotional intelligence in project-based courses." *The Asian ESP Journal* 12: 54-92.
- Didiano, T., A. Simpson, and D. Reeve. 2021. A Leadership-Development Ecosystem for Engineering Graduate Students. 2021 ASEE Virtual Annual Conference. <https://doi.org//10.18260/1-2--36589>.
- Encinas, J. J., and M. Chauca. 2020. "Emotional intelligence can make a difference in Engineering Students under the Competency-based Education Model." *Procedia Computer Science* 172:960-964. <https://doi.org/10.1016/j.procs.2020.05.139>.
- Gibson, D. E., M. E. Schweitzer, R. R. Callister, and B. Gray. 2009. "The influence of anger expressions on outcomes in organizations." *Negotiation and Conflict Management Research*, 2: 236–262. <http://dx.doi.org/10.1111/j.1750-4716.2009.00039.x>.
- Goleman, D. 1995. *Emotional intelligence*. Bantam Books.
- Goleman, D. 1998. *Working with emotional intelligence*. Bantam Books.
- Goleman, D. 2013. *Focus: The hidden driver of excellence*. Harper.
- Hochschild, A. 1979. "Emotion work, feeling rules, and social structure". *American Journal of Sociology* 85: 551–575.
- Hochschild, A. 1983. *The managed heart: Commercialization of human feeling*. University of California Press.

- Horgan, T. G., and J. L. Smith. 2006. "Interpersonal reasons for interpersonal perceptions: Gender incongruent purpose goals and nonverbal judgment accuracy". *Journal of Nonverbal Behavior* 30: 127–140. <http://dx.doi.org/10.1007/s10919-006-0012-4>.
- Ickes, W., P. R. Gesn, and T. Graham. 2000. "Gender differences in empathic accuracy: Differential ability or differential motivation?" *Personal Relationships* 7: 95–109. <http://dx.doi.org/10.1111/j.1475-6811.2000.tb00006.x>.
- Khefacha, A., and B. Sellei. 2023. "Engineering Students Emotional Intelligence And Neuro-Linguistics Programming (NLP) As Developmental Tool." 51st Annual Conference of European Society for Engineering Education (SEFI), Dublin, Ireland, 11-14 September, 2023. <https://doi.org/10.21427/W0X3-B872>.
- Kissani, I., and A. Boudihaj. 2019. "Emotional Intelligence a Success Indicator for Implementing Liberal Arts Education in Morocco," *2019 IEEE Global Engineering Education Conference (EDUCON)*, Dubai, United Arab Emirates, 2019, 738-743. <https://doi.org/10.1109/EDUCON.2019.8725054>.
- Koenig A. M. and A. H. Eagly. 2005. "Stereotype threat in men on a test of social sensitivity." *Sex Roles* 52: 489–496. <https://doi.org/10.1007/s11199-005-3714-x>.
- Koontz, R., D. Dolan, K. Osberg, and J. Gibson. 2017. "Emotional intelligence and its connection to engineering design cognitive processes". Proceedings of Conference: International Technology, Education and Development Conference, 6th-8th March 2017, Valencia, Spain, 9267-9275. <https://doi.org/10.21125/inted.2017.2192>.
- Koppad, S., J. Gadad, P. Patil and V. M. 2023 "Understanding the Influence of Student's Emotions in Academic Success," *2023 2nd Edition of IEEE Delhi Section Flagship Conference (DELCON)*, Rajpura, India, 2023, 1-6. <https://doi.org/10.1109/DELCON57910.2023.10127402>.
- Kumar, J. A.. 2019. "Exploring Engineering Undergraduates' Emotional Intelligence: A Gender Comparison Study In Malaysia". Proceedings of ICEEPSY 2018: Education and Educational Psychology, 198-210. <https://doi.org/10.15405/epsbs.2019.01.20>.
- Law, K. S., C. S. Wong, and Song. 2004. "The Construct and Criterion Validity of Emotional Intelligence and Its Potential Utility for Management Studies." *Journal of Applied Psychology*, 89, no. 3: 483–496. <https://doi.org/10.1037/0021-9010.89.3.483>.
- Leicht, R., A. Lewis, D. Riley, J. Messner, and B. Darnell. 2009. "Assessing Traits for Success in Individual and Team Performance in an Engineering Course." Building a Sustainable Future - Proceedings of the 2009 Construction Research Congress. [https://doi.org/10.1061/41020\(339\)138](https://doi.org/10.1061/41020(339)138).
- Lye, A. J., P. Y. Liew, H. M. Fadzil, and C. C. Foong. 2023. "Effect of Emotional Intelligence and Demographic Characteristics on Psychological Capital among Chemical Engineering Students." *Journal of Chemical Education* 100, no. 2: 479-488. <https://doi.org/10.1021/acs.jchemed.2c00105>.
- Lönngren, J., T. Adawi, and M. Berge. 2021. "Using positioning theory to study the role of emotions in engineering problem solving: Methodological issues and recommendations for future research." *Studies in Engineering Education* 2, no.1: 53–79. <https://doi.org/10.21061/see.50>.
- Lönngren, J., A. Bellocchi, P. Bøgelund, I. Direito, J. Huff, K. Mohd-Yusof, H. Murzi, and R. Tormey. 2021. "Emotions in engineering education: Preliminary results from a

scoping review." Proceedings of 9th Research in Engineering Education Symposium, Perth (online), December 5–8, 2021, 641-650. <https://doi.org/10.52202/066488-0071>

Lönngren, J., I. Direito, R. Tormey, and J. Huff. 2023. "Chapter 8: Emotions in Engineering Education." In *International Handbook of Engineering Education Research*, edited by A. Johri, 156-182. New York: Routledge.

Magano, J., C. S. Silva, C. Figueiredo, A. Vitória and T. Nogueira. 2021. "Project Management in Engineering Education: Providing Generation Z With Transferable Skills," in *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, 16, no. 1, 45-57, Feb. 2021. <http://doi.org/10.1109/RITA.2021.3052496>

Mandell, B., and S. Pherwani. 2003. "Relationship between emotional intelligence and transformational leadership style: A gender comparison." *Journal of Business and Psychology* 17: 387–404. <http://dx.doi.org/10.1023/A:1022816409059>.

Mayer, J. D., and D. R. Caruso. 2002. Mayer-Salovey-Caruso emotional intelligence test (MSCEIT) user's manual. Multi-Health Systems.

Mayer, J. D., P. Salovey, and D. Caruso. 2000. "Models of emotional intelligence". In *Handbook of intelligence*, edited by R. J. Sternberg, 396–420. Cambridge University Press.

Mayer, J. D., P. Salovey, and D. R. Caruso. 2004. "Emotional intelligence: Theory, findings, and implications." *Psychological Inquiry* 15, no. 3: 197–215. https://doi.org/10.1207/s15327965pli1503_02.

McDermott, K., Ö. Göl, and A. Nafalski. 2002. "Considerations on Experience-based Learning." *Global Journal of Engineering Education* 6, no.1:71–78.

Melbourne, K. 2016. "Keeping Women in Science: How Emotional Intelligence Training Supports Healthy Classroom Environments" Available from http://katiemelbourne.me/STEM_Education_and_EI.pdf.

Musa, T. (2020, August). "Sudanese Women in Extractive Industries: Engineering Education Point of View." In *5th North American International Conference on Industrial Engineering and Operations Management*. <https://doi.org/10.46254/NA05.20200778>.

Newell, B. S., and L. R. Varshney. 2017. "The first cohort in a new innovation, leadership, and engineering entrepreneurship B. S. degree program," 2017 IEEE Frontiers in Education Conference (FIE), Indianapolis, IN, USA, 2017, 1-6. <https://doi.org/10.1109/FIE.2017.8190631>.

Nogueira, T.; R. Castro, and J. Magano. 2023. "Engineering Students Education in Sustainability: The Moderating Role of Emotional Intelligence." *Sustainability*, 15: 5389. <https://doi.org/10.3390/su15065389>.

Pertegal-Felices, M. L., J. L. Castejón-Costa, and A. Jimeno-Morenilla. 2014. "Differences between the personal, social and emotional profiles of teaching and computer engineering professionals and students." *Studies in Higher Education* 39, no.7: 1185-1201. <https://doi.org/10.1080/03075079.2013.777410>

Pertegal-Felices, M. L., J. L. Castejón-Costa, R. Gilar-Corbí, R., and H. Mora-Mora. 2017. "Emotional Intelligence Profile of High Academic Performance Students in Computer Engineering." *Journal of Education*, 197, no. 3: 25-33. <https://doi.org/10.1177/0022057418782343>.

- Petrides, K. V. 2011. "Ability and trait emotional intelligence." In *The Wiley-Blackwell handbook of individual differences*, edited by T. Chamorro-Premuzic, S. von Stumm, and A. Furnham, 656–678. Wiley Blackwell.
- Petrides, K.V., N. Frederickson, and A. Furnham. 2004. "The role of trait emotional intelligence in academic performance and deviant behavior at school." *Personality and Individual Differences* 36, no. 2: 277–293. [https://doi.org/10.1016/S0191-8869\(03\)00084-9](https://doi.org/10.1016/S0191-8869(03)00084-9)
- Petrides, K. V., R. Pita, and F. Kokkinaki. 2007. "The location of trait emotional intelligence in personality factor space". *British Journal of Psychology* 98, no. 2: 273–289. <https://doi.org/10.1348/000712606x120618>.
- Price, R., and R. M. Cordova-Wentling. 2009. "Human behavior skills and emotional intelligence in engineering." 2009 ASEE Annual Conference and Exposition, Conference Proceedings.
- Rego, A. and C. Fernandes "2005. Inteligência emocional: Contributos adicionais para a validação de um instrumento de medida." *Psicologia* 19: 139–167.
- Ridgeway, C. L. and C. Bourg. 2004. "Gender as status: An expectation states theory approach." In *The Psychology of Gender*, edited by A. H. Eagly, A. E. Beall, and R. J. Sternberg, 217-241. New York: Guildford.
- Rizwan, A., H. Alsulami, N. Elnahas, M. Bashir, F. Bawareth, R. Kamrani, and R. Noorelahi. 2019. "Impact of emotional intelligence on the academic performance and employability of female engineering students in Saudi Arabia." *International Journal of Engineering Education* 35, no.1:119-125.
- Rojas-Martínez, S. L., C. A. Castelblanco-Torres, L. Y. Parra-Rodríguez, A. P. Acosta, and G. Muñoz-Puerta. 2023. "Strengthening of Love and Meaning of Life in Engineering Students supported by Problem-Based Learning." Proceedings of the PAEE/ALE'2023, International Conference on Active Learning in Engineering Education 15th International Symposium on Project Approaches in Engineering Education (PAEE) 20th Active Learning in Engineering Education Workshop (ALE) São Paulo - Brazil, 28-30 June 2023, 120-129.
- Saibani, N. & B. Deros, N. Muhamad, D. Abd Wahab, and J. Sahari. 2012. "The Influence of Type of Race among Engineering Students towards the Level of Emotional Intelligence (EQ) Scores." *Procedia - Social and Behavioral Sciences* 56: 523–529. <http://doi.org/10.1016/j.sbspro.2012.09.684>.
- Saibani, N., M. Sabtu, N. Muhamad, D. Abd Wahab, and J. Sahari. 2013. "The Score Difference of Emotional Intelligence among Engineering Students at Different Levels of Academic Year". *International Education Studies* 6, no. 6: 72-79. <https://doi.org/10.5539/ies.v6n6p72>.
- Salovey, P., and J. D. Mayer. 1990. "Emotional Intelligence." *Imagination, Cognition and Personality*, 9, no. 3: 185-211. <https://doi.org/10.2190/DUGG-P24E-52WK-6CDG>
- Schutte, N. S., J. M. Malouff, L. E. Hall, D. J. Haggerty, J. T. Cooper, C. J. Golden, and L. Dornheim. 1998. "Development and validation of a measure of emotional intelligence." *Personality and Individual Differences* 25, no. 2: 167–177. [https://doi.org/10.1016/S0191-8869\(98\)00001-4](https://doi.org/10.1016/S0191-8869(98)00001-4).
- Shields, S. A., H. J. MacArthur, and K. T. McCormick. 2018. "The gendering of emotion and the psychology of women". In *APA handbook of the psychology of women: History, theory, and battlegrounds*, edited by C. B. Travis, J. W. White, A.

- Rutherford, W. S. Williams, S. L. Cook, & K. F. Wyche, 189–206). American Psychological Association. <https://doi.org/10.1037/0000059-010>.
- Shields S. A. and L.R. Warner. 2007. "Gender and the emotion politics of emotional intelligence". In *The emotional organisation: Passions and powers*, edited by S. Fineman, 167-183. London, UK: Blackwell.
- Silva, C. J. Magano, C. Figueiredo, A. Vitória and T. Nogueira. 2020. "A multi generational approach to project management: implications for engineering education in a smart world," *2020 IEEE Global Engineering Education Conference (EDUCON)*, Porto, Portugal, 2020, 1139-1148. <https://doi.org/10.1109/EDUCON45650.2020.9125144>.
- Stewart, M. F., C. Chisholm, and M. Harris. (2010) "Engineering Student Learning and Emotional Competencies," *2010 IEEE Transforming Engineering Education: Creating Interdisciplinary Skills for Complex Global Environments*, Dublin, Ireland, 2010. 1-17. <http://doi.org/10.1109/TEE.2010.5508871>.
- Solomon, R. C. 2008. "The philosophy of emotion". In *Handbook of emotions (3rd ed.*, edited by M. Lewis, J. M. Haviland-Jones, and L. Feldman Barrett, 3–16. The Guilford Press.
- Sushchenko, T. Borova and V. Petrenko. 2023. "Measuring Engineering Students' Emotional Competence With Qualimetric Instruments," *2023 IEEE 5th International Conference on Modern Electrical and Energy System (MEES)*, Kremenchuk, Ukraine, 2023, 1-5. <http://doi.org/10.1109/MEES61502.2023.10402509>.
- Tekerek, M., and B. Tekerek. 2017. "Emotional intelligence in engineering education." *Turkish Journal of Education* 6, no. 2 88-95. <https://doi.org/10.19128/turje.306499>.
- Tripon, C. 2022. "Fostering women to choose stem career by using emotional intelligence as key element." *Journal of Educational Sciences* 45, no. 1: 51-68. <https://doi.org/10.35923/JES.2022.1.04>.
- Van Oosten, E. B., K. Buse, and D. Bilimoria. 2017. "The Leadership Lab for Women: Advancing and retaining women in STEM through professional development." *Frontiers in Psychology* 8. <https://doi.org/10.3389/fpsyg.2017.02138>.
- Vescio, T. K., S. J. Gervais, M. Snyder, and A. Hoover. 2005. "Power and the creation of patronizing environments: The stereotype-based behaviors of the powerful and their effects on female performance in masculine domains." *Journal of Personality and Social Psychology* 88: 658–72.
- Wong, C.-S., and K. S. Law. 2002. *Wong and Law Emotional Intelligence Scale (WLEIS)*. APA PsycTests.
- Zembylas, M. 2007. "Emotional capital and education: Theoretical insights from Bourdieu." *British Journal of Educational Studies* 55, no.4: 443–463. <http://dx.doi.org/10.1111/j.1467-8527.2007.00390.x>.