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Comparison of Interpersonal skill competency for Australian Graduate and Experienced engineer frameworks

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ABSTRACT

CONTEXT

Engineers require excellent interpersonal skills and self-awareness (Crosthwaite et al., 2018; J. E. King, 2007; NAE 2004). Successful team-based practice and collaboration necessitate enhanced interpersonal skill competency, attributes, and attitudes (R. King, 2008; NAE 2004). Experience and formal education play a key role in development of these skills. Since the shift in the 1990s to outcomes-based attributes, Engineers Australia's (EA) accreditation frameworks have continued to drive standards of engineering programs and professional engineers in Australia (EA 2017a, 2018; Lloyd, 1991; Male et al., 2011). The Stage 1 (Graduate) and Stage 2 (Experienced Professional) frameworks establish enabling and practice competencies (EA 2003). How and where engineers are expected to develop the competencies required to progress from Stage 1 to Stage 2 is not clear. Understanding these expectations of interpersonal skills can assist engineers to better develop these skills.

PURPOSE OR GOAL

The research investigates expectations of interpersonal skill development in Australian engineers. It addresses two questions: What interpersonal skills, behaviours and attitudes are Australian engineers expected to develop according to EA Stage 1 and Stage 2 competency frameworks? What are the key differences and gaps between Stage 1 and Stage 2 Indicators of Attainment (IAs) in interpersonal skills and behaviours?

APPROACH OR METHODOLOGY/METHODS

We systematically compare EA Graduate and Experienced Professional Standards for the interpersonal competencies of communication, team membership and leadership, relationships, self-management, management and collaboration. Gaps and differences between the two frameworks will be identified and interpreted to understand the expected growth between the two career stages.

ACTUAL OR ANTICIPATED OUTCOMES

Significant focus has been placed on ensuring undergraduate students are work-ready, but these interpersonal attitudes, attributes and behaviours are largely expected to be developed in an industry setting. While some interpersonal skills and behaviour between the two Standards align, areas such as community engagement and providing feedback present a large learning gap. We conclude by offering recommendations about how and where engineers might develop the competencies required to progress from Stage 1 to 2.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Identifying areas of expected interpersonal skill growth informs approaches to engineering practitioners professional development and education at university and beyond. As the market for micro-credentials and short-courses expands, there is potential to target attitude, behaviour and skill competencies required of experienced engineers with Stage 1 and 2 competencies in mind.

KEYWORDS
Professional engineers, interpersonal skills, competency frameworks, life-long learning

Introduction

Engineering professionals require excellent interpersonal skills (Crosthwaite et al., 2018; J. E. King, 2007; NAE 2004). The interconnected nature of engineering work requires high levels of collaboration within and outside of engineering teams. High levels of self-awareness and interpersonal skills enable more successful engagement and collaboration with others and are pre-requisites for leadership skills (Lopes et al. 2015).

'Interpersonal skills' is one of several of terms used to describe "*the way people relate to and interact with others*" (Willmot & Colman, 2016). Hayes (2002) defines interpersonal skills as inherently goal-related: a suite of skills and behaviours that increase chances of a desirable outcome. However, this does not define from who or to whom the desirable outcome satisfies. Other terms include 'soft skills', interactive skills, social skills, emotional intelligence, people skills, and social competence (Hayes, 2002; Willmot & Colman, 2016). These terms encompass skills such as communication, leadership, teamwork, managing successful personal diverse relationships, collaboration, networking, and cultural understanding (Lappalainen, 2009, p. 123; Lopes et al., 2015).

This dimension of engineering practice has historically been desired, gaining greater prominence with the rise of university-based engineering education in the 20th C. Private industry highlighted to universities the need for graduates with higher levels of communication skills, and have continued to emphasise the role of interpersonal skills alongside technical aptitude in graduates (Lamb & Cawood, 1994; Munir, 2021).

Preparing graduates for employment is a key aspect of professional accreditation programs and university curriculum. Numerous interventions have been studied at the tertiary level which focus on identifying and developing interpersonal skills through the curriculum (Lopes et al., 2015; Smith et al. 2009; Van Der Molen at al. 2007). Measurement of these skills is considered difficult, with self-reporting measures, surveys and observation used to evaluate interventions (see Lopes et al., 2015; Mazzurco & Murzi, 2017). While formative, these interventions are bounded in tertiary education, rather than practice.

Engineers Australia (EA) is the peak professional body and accrediting agency for undergraduate engineering qualifications in Australia. They define competency standards for Graduate (Stage 1), Experienced Professional (Stage 2) and Executive (Stage 3) engineering practitioners. The Standards "*seek to provide objective statements of the skills that are genuinely needed for effective practice, on which the community and the profession can rely."* (EA 2003, p. 7), outlining "*the minimum competencies… members…may be relied upon to possess"* (EA 2003, p. 3). Conversely, the Standards respond to industry needs, driving expected practice, competence and consistency of engineering professionals.

Since the transition to competency-based outcomes in the 1990s, EA has sought to assess *"whether or not an individual actually possesses these skills, without prescribing how they should have been developed"* (EA 2003, p. 7). Stage 1 establishes the minimum standards for 'modern professional engineers' upon graduation from a four-year Bachelors degree. Accreditation is sought by the university seeking to accredit their degree. In Stage 2, accreditation is sought by individual practitioners with 3-5 years practice (EA 2021b). These practicing competencies build upon Stage 1 and are expected to be developed at work. The accreditation process reflects this as individuals responding to Indicators of Attainment (IA) in a written response and interview, drawing upon examples from their experiences.

The progression from Stage 1 to Stage 2 is similar to other signatories of the International Engineering Alliance's (IEA) Washington Accord (IEA 2021). This multi-lateral agreement between national bodies responsible for accreditation of tertiary-level engineering provides mutual recognition of qualifications, skills and abilities of graduate engineers. The

Washington Accord attributes and professional competencies establish expected standards of engineering practice across signatories and promote shifting requirements and priorities in engineering practice, such as consideration of sustainable development (World Federation of Engineering Organizations, 2021).The importance of interpersonal interaction is an area of increasing prominence in the Washington Accord, identified as a key area of engineering practice (World Federation of Engineering Organizations, 2021).

Our study compares EA's Stage 1 and 2 Standards to reveal the expected interpersonal skills and behaviour development between graduation and 3-5 years of practice, and understand how they build on each other. Through identifying gaps between the two frameworks, we can understand how gaps are currently bridged and how they may be overcome moving forward. This allows practicing engineers to better navigate their learning and assist education providers and employers to better support their graduate engineers.

Method

This paper seeks to compare the EA Stage 1 and 2 frameworks to identify similarities, differences and gaps in learning between the two with respect to interpersonal skills. The key questions are firstly, what interpersonal skills and behaviours are required in EA Stage 1 and 2 Competency Standards? And secondly, what are the key differences and gaps between EA Stage 1 and 2 Indicators of Attainment (IAs) in interpersonal skills and behaviours?

In this study, 'interpersonal skills' entails any interaction, consideration and relation to others. This draws on Hayes (2002, p. 3) definition of "*the ability to behave in ways that increase the probability of achieving desired outcomes… used in… interactions… to bring about a desired state of affairs*". This includes listening, awareness of self and others, presenting information to others, negotiating, asserting and influencing, collaborating, managing relationships and consideration of others (Hayes, 2002; Lappalainen, 2009, p. 123; Lopes et al., 2015).

To assess the Stage 1 and 2 Competency frameworks with respect to interpersonal skills, comparative document analysis is used (Bowen, 2009). Document analysis provides insight into the contents of the documents, the intended readership, and the context in which they were produced (Atkinson et al., 2011; Bryman, 2008, pp. 554–555). This approach allows data to be examined and interpreted to gain understanding, intended meaning and knowledge (Corbin & Strauss, 2008). As a qualitative investigation, document analysis is an efficient and simple technique for such a small number of documents. A limitation is the credibility of a small sample size (Yin, 1994, p. 80). This is managed by using documentation surrounding the competency frameworks to provide additional context (Atkinson et al., 2011). This does not mitigate the inherent bias or agenda of contributing authors, which may be examined in comparison to other international frameworks in additional investigations.

The Stage 1 and Stage 2 Competency framework documents are appropriate documents as are they official (authentic), credible (from EA), representative of the type of document and such a case, and have clear meaning (Bryman, 2008, p. 544; Scott, 1991). As EA is the peak professional body for engineers in Australia, and the key accreditation body for educational offerings, these Standards outline the key competencies required by Australian engineers. For this study, the general Stage 2 Engineering Competency Standard will be used, not the specific Separate Competencies and IAs used form some Areas of Practice.

This studies' primary documents are the EA Stage 1 and S 2 Competency Standards (EA 2012, 2017b). Supporting documents are the Australian Engineering Competency Standards (EA 2003), Writing Engineering Competency Claims (EA 2017c), Accreditation Management System Education Programs At The Level Of Professional Engineer Overview S01 (EA & Bradley, 2008) and Chartered Measure of Excellence (EA 2021b). These documents provide additional understanding of the application and use of the Competency Standards.

The two Standards broadly include an introduction, providing context to the document, expectations of practice through competencies and how the competencies can be

demonstrated. Each have 16 Elements of Competency, divided between multiple areas. Each Element contains IAs which "*serve as guides to the sorts of engineering work that are likely to demonstrate competence in the Element*" (EA 2017c). Stage 1 comprises 69 IAs and Stage 2 has 104. While the two frameworks differ in how the Elements of Competency are presented, the IAs are comparable in length, meaning and relation to the Elements. These provide the finest specificity and description, providing rich interpersonal skills comparison.

Each Standard's IAs are assessed to identify the required interpersonal skills. The decision regarding the described skill could be explicit, such as 'collaborate' or 'engage'. However, skills inferred to be inherent within achieving the specified IA are also considered. An example is balancing environmental, safety and human needs, which relates to understanding and assessing risks, concerns and wants of others. To avoid assuming values and viewpoints of others, engagement is required. We then compare IAs across the Standards to identify common skills, themes, gaps and differences. Appendix 1 provides a full list of the comparison, identified interpersonal areas and associated IAs.

Results

Overall, it is possible to see a number of areas where engineers are expected to develop interpersonal skills, capabilities and attributes. Stage 2 expanded upon interpersonal skills and behaviours included in Stage 1. Stage 1 presents the key foundations for engineering, but the increased number and specificity of Stage 2's IAs, extending the expectations of practitioners. The commercial environment and increased responsibilities of a practicing engineer were clear in Stage 2 when compared to the educational setting of Stage 1. An overview will be presented below, with full results available in Appendix 1.

Interpersonal skills are inherent or enmeshed in the Stage 2 IAs to a greater extent than Stage 1, with most discussion (57%) in the professional and personal attributes area. The organisation of Elements and IAs demonstrate the increasingly holistic nature of engineering practice, in comparison to the graduate engineer. While in Stage 1 "*indicators should not be interpreted as discrete sub-elements of competency mandated for individual audit…*[they] *must be tested in a holistic sense*" (EA 2017b), the separation of Elements and IAs divide technical knowledge and non-technical skills. Stage 2 presents the complex and interlinked skill set of a professional engineer, with interpersonal skills inherent across activities.

The areas of communication, building relationships and balancing needs in solutions in the engineering design process describe similar requirements, often expanding or using greater specificity. Communicating "*ideas to technical and non-technical stakeholders*" was emphasised in both Standards. However, Stage 2 emphasises this further, with communication explicitly or implicitly stated in at least 8 IAs across several Elements, but only two in Stage 1, mostly in one Element. Both Standards clearly articulate the activities involved in the engineering design process and management of projects. This demonstrates the importance of continual application and mastery of these skills in practice.

Analysis and Discussion

The interpersonal skill competency from Stage 1 to Stage 2 sees expansion and growth – of awareness, expertise and involvement with others. This is expected, as Stage 2 builds on the competencies of Stage 1. Stage 1 Standards present a technically knowledgeable graduate, open to learning. Stage 2 expands on this, presenting a capable communicator, creating value through considering and working with a vast range of stakeholders, confident in their knowledge and ability. The areas of communication, building relationships, balancing needs in solutions and activities in the engineering design process describe similar requirements, such as seen in Appendix 1. From this review, similar proportions of IAs in both Standards relate to interpersonal skills (37-38%). This highlights consistent importance of interpersonal skills between the two stages.

In the expansion of requirements from graduate to practicing engineer, new dimensions of awareness and areas of knowledge are required, including commercial aspects of engineering such as finance, legislation and tenders, as well as managing others and representing the profession. The key differences between the two Standards and their Assessment reveal how interpersonal skills are enacted, and what they relate to within an engineer's role. Key differences between the Standards are explored below.

Assessment

While evaluation and assessment of the two Standards involves practicing engineers, the degree of involvement of the learner differs. Stage 2 is instigated by the learner, following a process of self-assessment, industry review, submission of an application with evidence, and an interview. This requires responses to the IAs and demonstration of "*acting independently at an acceptable standard without help or supervision in all Elements"* (EA 2021a). In contrast, demonstration of Stage 1 competencies is done by the education provider. While there are examples of engineering students responding to specific elements such as those in the professional and personal attributes, they are not required to submit statements of evidence or demonstration of competency. This creates a learning gap for engineers seeking Chartered status, to self-assess and make competency claims. It also raises the question of how much graduates are aware of their own levels of required competency, and if they understand the learning and expectations required of Stage 2. Discussion and monitoring of professional competencies should engage learners at all levels in their development.

Engagement

The importance and mastery of communicating to diverse stakeholders is seen in both Standards. In Stage 2, there is a consistent focus on communicating and engaging with stakeholders outside the engineering profession. This includes 'the community', 'users', 'clients', 'investors' and 'customer'. Engagement looks like "*dialogue...to reach an agreed understanding of technical issues*", "*negotiating equitable ways to share any costs and benefits between stakeholders and the community*", "*work*[ing]*…to develop solutions*" and seeking appropriate advice to inform decisions (EA 2012).

In contrast, Stage 1 describes less responsibility in engaging broadly with 'community', instead focusing on "r*ecognise[ing] the value of alternative and diverse viewpoints",* but limiting input to "*expert assistance and professional advice"*. While graduates should be able to express information, engage in discussions and present to technical and non-technical audiences, there does not appear to be a two-way discourse in how this discussion influences the work of an engineer, or outcomes (EA 2017b). Stage 2 more clearly articulates where engagement with others is expected, and whose perspectives should be considered. A direct and transparent mapping of communication from Stage 1 to 2 could create a framework for learners to reach mastery, similar to the Systems Engineering Competency Framework (International Council on Systems Engineering, 2018, pp. 45–52).

The ability to engage with others appears to be primarily developed in the workplace. While graduates should recognise the value of diverse viewpoints, they are not required to demonstrate efficacy in engaging with them. The way many degrees are structured, this opportunity for engagement with 'community', industry and other professions is limited (R. King, 2008). This is an area of development for graduates, and gap between Stage 1 and 2.

Communication embedded in all activities

In Stage 1, communication is often described a discreet skill, while in Stage 2 it is presented as a tool to demonstrate knowledge or achieve specific goals. Stage 1 describes it as a skill to be honed. It is mostly concerned with the ability to express information in verbal, written and non-verbal ways, and are not necessarily embedded or assumed within IAs in the two technical Elements. In contrast, Stage 2 emphasises the importance of communication to achieve outcomes, inherent within tasks. This is seen through drafting tender documents and contracts, project management and financial tracking records. This reveals the shift from

separating skills in formal education to contextualised and holistic employment of skills in domains of engineering practice. Greater support at universities and in the workplace could aid engineers' understanding, development trajectory and interrelation of interpersonal skills.

Seeking Input

While the importance of engaging with others is stressed in Stage 2, the integration of other viewpoints appears less influential for practicing engineers than graduates. The emphasis in Stage 1 of "*engag*[ing] *with professionals from* [STEM] *and commerce to exchange ideas"* (adapted from 3.3 c), as well as "*appropriately challeng*[ing] *engineering practices from technical and non-technical viewpoints"* indicates valuing and seeking advice from these viewpoints (EA 2017b). This presents graduates as open to integrating others knowledge into their practice. Stage 2 reduces this to include '*discussion with others and, where appropriate, integrate their views to improve deliverables*' (EA 2012), suggesting that as engineers grow in confidence, knowledge and ability, they do not need to integrate others input to the same degree. Or perhaps, this integration is implied through relationships developed as a practicing engineer, emphasised in Stage 2 separately. The ability to assess one's knowledge of a situation, acknowledge limits, identify and seek those who hold greater expertise demonstrates a high level of self-awareness, humility and social engagement. This is an important skill to cultivate throughout a career, helping to remain open-minded to others and be a life-long learner (Krumei et al., 2020). This could be more explicitly acknowledged in Stage 2, which is not an end point in an engineer's learning journey.

Self-awareness

Stage 1 presents an awareness of interpersonal dynamics, but is not explicitly acted upon in Stage 2. Stage 1 highlights the ability to identify "*the structure, roles and capabilities of the engineering workforce*" (EA 2017b). This speaks to an awareness of dynamics within and outside the systems you operate in. Further, it highlights a self-awareness and understanding of engineers' roles within the community and trust placed in the profession. While this may be assumed to manifest in engagement with many diverse stakeholders as a professional engineer, mastery of this skill was not explicit in the Stage 2 Standard. This should be further highlighted, or addressed as to how to identify and navigate the dynamics in engineering work. In contrast, the accrediting body for the United Kingdom, and a signatory of the Washington Accord like EA highlights the need for self-awareness at Stage 1 and 2 equivalency, calling for awareness of '*…the needs and concerns of others, especially where related to diversity and equality'* (Engineering Council, 2020).

Feedback

Providing and responding to feedback is present throughout Stage 2, but not Stage 1. Stage 2 describes the need to seek and provide peer reviews and comments to make improvements to personal and others work, as well as "*diagnose performance deficiencies and negotiate appropriate remedial measures*" (EA 2012). Providing constructive and helpful feedback appears to be developed entirely in the workplace, with no provision of feedback in Stage 1, only seeking. Greater scaffolding of the ability to assess the intended audience to provide the most helpful feedback at the time is required. This also connects with the relationship building and emotional intelligence required to provide feedback in a tailored and appropriate way, particularly when managing others. Greater emphasis on learning how to provide and receive feedback from peers and those in differing hierarchical positions is a key skill that evidently needs to be addresses prior to graduation from an engineering qualification. Boud and Melloy (2013) present a model of sustainable feedback, where feedback is a process used by learners to facilitate their own learning, rather than a control mechanism. They present a number of curriculum features to emphasise this model of feedback, which could be implemented as a learning strategy.

Recommendations

The gaps identified indicate significant learning is expected to occur within 3-5 years of full-time professional engineering work. In this time, graduate engineers are expected to develop and demonstrate highly effective engagement with a range of stakeholders, develop networks to seek information from, request and provide feedback. Suggestions are provided below to navigate the skill and structural gaps between EAs Stage 1 and 2 Competency Standards, and how might learners be better supported to bridge these gaps.

Recommendations for Australian workplaces:

- Embed self-assessments and benchmarking against the Stage 2 Competencies as part of annual reviews, or include EAs Industry Review. Other similar accreditation standards require Continuing Professional Development (CPD) planning and activities reporting, which could also be incorporated into annual reviews (Engineering Council, 2020; The Institution of Engineers Sri Lanka, 2021). This could be supported by a log book or portfolio, where learners document their experiences.
- Creating structural training opportunities for graduates to develop their skills. This may be training programs, targeted mentorship, or opportunities for feedback.

Recommendations for Australian engineering education providers:

- Involve students in understanding and articulating their demonstration of the Stage 1 Competencies. Further embed activities requiring students to reflect on their learning, to understand where they may require further development and how to assess their abilities. A log book or portfolio may assist in connecting study activities with skill development, such as those suggested by Kilgore et al. (2013) and Williams (2002).
- Emphasise the role of feedback in the curriculum, including training and development of providing useful feedback to others, advocated for by Nicol et al (2014) and demonstrated by O'Moore and Baldock (2007) and Boud and Molloy (2013).
- Further create opportunities for students to engage with 'the community,' cross-disciplinary learning and clients, such as through service-learning or interdisciplinary projects such as Duffy et al. (2008), Hirsch et al. (2001), Taajamaa et al. (2013).

Other ideas for Standards:

- Explicit articulation of the importance of interpersonal skills and emotional intelligence as a professional engineer, like the UK-SPEC (Engineering Council, 2020).
- Articulation of the importance of self-awareness, life-long learning and ability to influence within Standards.

Conclusion

Engineers are expected to be capable technologists, problem solvers, project managers, networkers, team members and experts. Fulfilling these roles requires high levels of collaboration and refined interpersonal skills. Comparing the expected growth of these skills through the EA Stage 1 and Stage 2 Competency Standards, engineers are expected to develop and apply their interpersonal skills between these two stages. Education providers, workplaces and EA can help engineers better bridge this expected development gap, creating engineers who are better supported to succeed and create more positive outcomes for those their work touches.

References

Atkinson, P., Coffey, A., & Delamont, S. (2011). Ethnography: post, past, and present. *SAGE Qualitative Research Methods*. P. Atkinson and S. Delamont.

Boud, D., & Molloy, E. (2013). Rethinking models of feedback for learning: the challenge of design. *Assessment & Evaluation in Higher Education*, *38*(6), 698–712.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*.

Bryman, A. (2008). *Social research methods* (3rd ed.). Oxford : Oxford University Press.

Corbin, J., & Strauss, A. (2008). Strategies for qualitative data analysis. *Basics of Qualitative Research. Techniques and Procedures for Developing Grounded Theory*, *3*.

Crosthwaite, C., Hargreaves, D., Wilson, J., Lee, P., Foley, B., Burnett, I., … Symes, M. (2018). Engineering futures 2035. In *29th Australasian Association for Engineering Education Conference 2018 (AAEE 2018)* (p. 668). Engineers Australia.

Duffy, J., Barington, L., Moeller, W., Barry, C., Kazmer, D., West, C., & Crespo, V. (2008). Service-learning projects in core undergraduate engineering courses. *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship*, *3*(2).

Engineering Council. (2020). *The Accreditation of Higher Education Programmes: UK Standard for Professional Engineering Competence*. Retrieved from https://www.engc.org.uk/engcdocuments/internet/Website/Accreditation of Higher Education Programmes third edition (1).pdf

Engineers Australia. (2003). *Australian Engineering Competency Standards*. Retrieved from https://www.ecm.uwa.edu.au/__data/assets/pdf_file/0003/1611948/EA_Stage2.pdf

Engineers Australia. (2012). *Australian Engineering Competency Standards Stage 2-Experienced Professional Engineer*.

Engineers Australia. (2017a). *Our Strategic Direction*.

Engineers Australia. (2017b). *Stage 1 Competency standard for professional engineer*. *Engineers Australia*. Retrieved from http://www.engineersaustralia.org.au/shadomx/apps/fms/fmsdownload.cfm?file_uuid=DBA27A80-95B2-94BD-5BE8-A105DEDDED21&siteName=ieaust

Engineers Australia. (2017c). *Writing Engineering Competency Claims*. Barton.

Engineers Australia. (2018). *Our Code of Ethics*. Retrieved from https://www.engineersaustralia.org.au/sites/default/files/resource-files/2018-10/EA Code of Ethics Final_1.pdf

Engineers Australia. (2021a). Chartered Engineer: the Measure of Excellence. Retrieved July 21, 2021, from https://www.engineersaustralia.org.au/Chartered

Engineers Australia. (2021b). *Chartered The Measure of Excellence*. *Thinking about becoming Chartered*. Retrieved from https://www.engineersaustralia.org.au/Chartered

Engineers Australia, & Bradley, A. (2008). *Accreditation Management System Education Programs At The Level Of Professional Engineer Overview S01* . Engineers Australia.

Hayes, J. (2002). *Interpersonal skills at work*. Routledge.

Hirsch, P. L., Shwom, B. L., Yarnoff, C., Anderson, J. C., Kelso, D. M., Olson, G. B., & Colgate, J. E. (2001). Engineering design and communication: The case for interdisciplinary collaboration. *International Journal of Engineering Education*, *17*(4/5), 343–348.

International Council on Systems Engineering. (2018). *Systems Engineering Competency Framework*. Retrieved from https://www.incose.org/products-and-publications/competency-framework

International Engineering Alliance. (2021). Washington Accord . Retrieved August 6, 2021, from https://www.ieagreements.org/accords/washington/

Kilgore, D., Sattler, B., & Turns, J. (2013). From fragmentation to continuity: engineering students making sense of experience through the development of a professional portfolio. *Studies in Higher Education*, *38*(6), 807–826.

King, J. E. (2007). Educating Engineers for the 21st Century, Royal Academy of Engineering. *London UK*.

King, R. (2008). Engineers for the future: Addressing the supply and quality of Australian engineering graduates for the 21st century. *Australian Council of Engineering Deans*.

Krumrei-Mancuso, E. J., Haggard, M. C., LaBouff, J. P., & Rowatt, W. C. (2020). Links between intellectual humility and acquiring knowledge. *The Journal of Positive Psychology*, *15*(2), 155–170.

Lamb, B. C., & Cawood, C. P. (1994). *A national survey of communication skills of young entrants to*

industry and commerce. Queen's English Society London.

Lappalainen, P. (2009). Communication as part of the engineering skills set. *European Journal of Engineering Education*, *34*(2), 123–129.

Lloyd, B. E. (1991). *Engineers in Australia: A profession in transition*. Macmillan Company of Australia.

Lopes, D. C., Gerolamo, M. C., Del Prette, Z. A. P., Musetti, M. A., & Del Prette, A. (2015). Social skills: A key factor for engineering students to develop interpersonal skills. *International Journal of Engineering Education*, *31*(1), 405–413.

Male, S. A., Bush, M. B., & Chapman, E. S. (2011). An Australian study of generic competencies required by engineers. *European Journal of Engineering Education*, *36*(2), 151–163.

Mazzurco, A., & Murzi, H. (2017). Evaluating humanitarian engineering education initiatives: A scoping review of literature. In *28th Annual Conference of the Australasian Association for Engineering Education (AAEE 2017)* (p. 415). Australasian Association for Engineering Education.

Munir, F. (2021). More than technical experts: Engineering professionals' perspectives on the role of soft skills in their practice. *Industry and Higher Education*, 09504222211034725.

National Academy of Engineering, U. S. (2004). *The engineer of 2020: Visions of engineering in the new century*. National Academies Press Washington, DC.

Nicol, D., Thomson, A., & Breslin, C. (2014). Rethinking feedback practices in higher education: a peer review perspective. *Assessment & Evaluation in Higher Education*, *39*(1), 102–122.

O'Moore, L. M., & Baldock, T. E. (2007). Peer Assessment Learning Sessions (PALS): an innovative feedback technique for large engineering classes. *European Journal of Engineering Education*, *32*(1), 43–55.

Scott, J. (1991). *A Matter of Record: Documentary Sources in Social Research*. Wiley. Retrieved from https://books.google.com.au/books?id=3UljQgAACAAJ

Smith, J., Brown, L., & Cahill, A. (2009). Engineering social change: Engaging undergraduate engineers in community development research. In *20th Annual Conference for the Australasian Association for Engineering Education, 6-9 December 2009: Engineering the Curriculum* (p. 650). Engineers Australia.

Taajamaa, V., Westerlund, T., Liljeberg, P., & Salakoski, T. (2013). Interdisciplinary capstone project. In *41th SEFI Conference, Leuven, Belgium*.

The Institution of Engineers Sri Lanka. (2021, March 22). Professional Rules Review. Retrieved August 1, 2021, from https://app.box.com/s/2njy1j3vg59rjs0izn5272g0xpyq885j

Van Der Molen, H. T., Schmidt, H. G., & Kruisman, G. (2007). Personality characteristics of engineers. *European Journal of Engineering Education*, *32*(5), 495–501.

Williams, J. M. (2002). The engineering portfolio: Communication, reflection, and student learning outcomes assessment. *International Journal of Engineering Education*, *18*(2), 199–207.

Willmot, P., & Colman, B. (2016). Interpersonal skills in engineering education. Australiasian Association for Engineering Education.

World Federation of Engineering Organizations. (2021). Committee on Education in Engineering (CEIE) - GAPC Consultation. Retrieved August 6, 2021, from http://www.wfeo.org/wfeo-ceie-gapc-consultation/

Yin, R. K. (1994). Discovering the future of the case study. Method in evaluation research. *Evaluation Practice*, *15*(3), 283–290.

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