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Let's investigate the sociotechnical contexts and cultures that influence the professional practice of early career engineers.

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ABSTRACT

CONTEXT

Australian thought leaders in the engineering profession broadly agree that engineering curriculum requires a greater shift towards practice-focused education to achieve theory-practice balance and support the readiness of graduates for entry into the diverse industries that employ engineers (ACED, Burnett et al., 2021). Many studies have shown that engineering education programs can enhance graduate employability by meaningfully connecting student learning to the contexts of practice as early as possible (Crosthwaite, 2021; Passow & Passow, 2017; Winberg et al., 2020). However, many educators are not familiar with or experienced in engineering practice outside of academia (Cameron, Reidsema, & Hadgraft, 2011) which can make achievement of this balance a challenge.

PURPOSE

This paper proposes a research program that will develop tools and insights that support, inform and guide engineering educators with striking a balance between theory and practice in their learning and teaching. The intent is to contribute to the emerging body of knowledge that explores engineering practice and engineering educator perceptions of practice to inform curriculum, pedagogy, and assessment effective in preparing students for the world of work.

APPROACH

This paper presents a synthesis of insights collected from existing engineering education, employability, and practice literature to inform the motivation and design of a three-phase qualitative research program that will apply ethnographic methods of data collection and analysis.

OUTCOMES

The proposed research program is expected to contribute towards three calls to action revealed from the reviewed literature. These include the need to (1) develop students' knowledge, skills and values within sociotechnical contexts relevant to professional practice to enhance their employability, (2) support the professional development of engineering educators with the awareness of engineering practice contexts and cultures, and (3) further explore the nexus between engineering practice and engineering education research to inform curriculum, pedagogy and assessment practices that are effective in preparing students for the world of work.

CONCLUSIONS

A three-phase research program has been proposed to apply ethnographic research methods to gain a deeper understanding of the sociotechnical contexts and cultures that influence the professional practice of early career engineers, and the perceptions of these contexts from the perspective of engineering educators. Initial outcomes arising from the completion of phase 1 of this proposed program in the form of a conceptual framework for engineering professional practice has been presented, and next steps are identified.

KEYWORDS

Engineering practice, sociotechnical contexts, research proposal

Introduction

Australian thought leaders in the engineering profession broadly agree that engineering curriculum requires a greater shift towards practice-focused education to achieve theory-practice balance and support the readiness of graduates for entry into the diverse industries that employ engineers (ACED, Burnett et al., 2021). Many studies have shown that engineering education programs can enhance graduate employability by meaningfully connecting student learning to the contexts of practice as early as possible (Crosthwaite, 2021; Passow & Passow, 2017; Winberg et al., 2020). However, many educators are not familiar with or experienced in engineering practice outside of academia (Cameron et al., 2011).

This paper reviews existing literature to introduce a proposed research study that aims to investigate different sociotechnical contexts and cultures, and the influence they can have on the engineering practice of early career engineers (0 – 5 years after graduation). In doing so, the idea is to co-construct with practicing early career engineers an understanding of professional practice and how practice is shaped by the observable interplays between social and technical dimensions of engineering work in different contexts and cultures. Academic notions of engineering practice will be explored for comparison with the understanding that has been co-constructed with early career engineers, with a view to explore and identify the nexus between engineering practice and engineering education. The key objective of this proposed study therefore is to develop tools and insights that help inform and guide engineering educators with striking a balance between theory and practice in their learning and teaching.

Literature

Engineering jobs in Australia are diverse and often undertaken in small and medium enterprises (SME's), and through specialist service contracts that require graduates to meaningfully contribute to businesses early in their career (Lee et al., 2022). However, engineering graduates feel a lack of preparedness for the non-technical aspects of engineering work (Mazzurco, Crossin, Chandrasekaran, Daniel, & Sadewo, 2021). Recognising this need, engineering educators are called upon to develop students engineering practice knowledge and perspectives (Crosthwaite, 2021) to develop graduate employability. Employability is a topic that is often disputed as it is a term that can be viewed and defined from various perspectives and contexts depending how it is being applied and evaluated (Dacre Pool & Sewell, 2007; Harvey, 2001; Williams, Dodd, Steele, & Randall, 2016). However, there is general agreement that employability is lifelong in nature, and requires graduates to discern, acquire and adapt the knowledge, skills, and values (competencies) relevant to their practice contexts so they can meaningfully contribute to their profession and community (Oliver, 2015; Winberg et al., 2020; Yorke, 2006).

Williams et al. (2016) highlighted that the contextualisation of employability as a multifaceted construct is often overlooked and is needed to evaluate opportunities that contribute to the development of employability skills within the curriculum. This view is consistent with the views of Buch and Bucciarelli (2015) that technical skills and knowledge development should be contextualised to aid student preparedness for practice, and developing their understanding of the value contextual influences, including an individual's psyche, can have on the culture of practice and vice-versa. They claim that the traditional paradigm of 'content' focused engineering education is often 'value-free' and ignorant of authentic contexts or inherent cultures.

Passow and Passow (2017) have most recently synthesised a substantial range of lists of engineering competencies found in the literature, contending that the most important skill is "coordinating multiple competencies to accomplish a goal" (p. 500), and "solve problems" (p. 495) is possibly the only competency core to all practice contexts. Craps, Pinxten, Knipprath, and Langie (2022) engaged industry and education stakeholders to explicitly confirm the idea that different engineering role contexts require different competencies to successfully fulfill that role. This has implications for engineering educators to consider ways for designing programs with diversity at the core to develop individuals' capacity to select desired competencies for application in a range of professional contexts (Craps et al., 2022).

Accrediting bodies such as the US Accreditation Board for Engineering and Technology (ABET), and Engineers Australia also provide guidance on the competencies relevant to engineering practice contexts. Engineers Australia have defined the Stage 1 Competency Standard for Professional Engineers (2014), which is a list of 16 mandatory elements of competency broken down across three groupings: 1) knowledge and skill base, 2) engineering application ability, and 3) professional and personal attributes. ABET (2021) defined a set of criteria that is "intended to foster the systematic pursuit of improvement in the quality of engineering education that satisfies the needs of its constituencies in a dynamic and competitive environment" (p. 3). Rather than list competencies, ABET outlines a set of student learning outcomes that prepare graduates to enter professional practice in engineering. Learning outcomes defined at an entry to practice level are useful when taking a programmatic approach to scaffolding constructively aligned learning (Biggs & Tang, 2011).

Engineering practice research reveals the interplay between social and technical dimensions of engineering practice that helps confirm the 'sociotechnical' nature of engineering work (Faulkner, 2007; Fletcher, 2001; Trevelyan, 2010). The Australian Council of Engineering Deans (ACED) have encouraged engineering education providers to "embed a stronger focus on student engagement with contemporary engineering practice and its sociotechnical contexts" (Crosthwaite, 2021, p. 40, R1). Embedding this focus within engineering education curriculum requires an understanding of real-world contexts, as well as suitable pedagogies and assessment practices effective for preparing students for the world of work.

Active learning pedagogies such as problem-based learning (PBL), experiential learning, service learning and simulated workplace activities are often used to bridge the divide between theory and contemporary engineering practice and its sociotechnical contexts (Winberg et al., 2020). However, there is recognition that engineering academics are not sufficiently aware of the needs of industry and society (Male, King, & Hargreaves, 2016). Thebuwana, Hadgraft, and Alam (2017) draw attention to a misrepresentation of contextual factors within the curriculum resulting from a lack of understanding of those who write and instruct it. This is not isolated to Australia, with a recent European study (Cruz & Saunders-Smits, 2022) identifying a discrepancy between educators' intent and how they designed the formal curriculum. Notably, a low occurrence of attitudes, skills, and values desired by engineering graduate employers was identified in the documented curriculum, despite educators reporting that they teach and assess these competencies (Cruz & Saunders-Smits, 2022).

A shortage of engineering educators with "relevant and timely industry experience" (Cameron et al., 2011, p. 113) could be contributing to the introduction of a "null" or "hidden" curriculum that promotes values and expectations in conflict with effective workplace practices (Trevelyan, 2019). Beyond having limited exposure to practice, many academics also demonstrate limited awareness of minimum professional standards set by the profession for graduate engineers (Knight, Cameron, Hadgraft, & Reidsema, 2016; Stevens, Johri, & O'connor, 2014). Aligned to these observations, ACED have called for engineering schools to deploy teaching staff with appropriate practice experience and expertise to enable the stronger focus on student engagement with contemporary engineering work and the social contexts in which the work occurs (Crosthwaite, 2021). This will require augmentation of the workforce and investment to build the capacity of existing educators to offset their potential lack of awareness and experience of practice (Burnett et al., 2021).

Investigating the lived experiences of early-career engineers can help explore the relationship between engineering practice and education (Brunhaver, Jesiek, Korte, & Strong, 2021). However, there is a lack of empirical studies that bridge this gap between engineering education and practice (Buckley, Trevelyan, & Winberg, 2022), and a notable 'sparseness' of research on professional engineering work that focuses on the lived experiences of engineers (Jesiek, Buswell, & Nittala, 2021; Stevens et al., 2014). Recent studies on engineering practice (E.g., Beddoes, 2021; Jesiek et al., 2021; Lutz & Paretti, 2021), and those connecting the worlds of practice and education research (E.g.,Beddoes, 2022; Chance, Direito, & Mitchell, 2022; Craps et al., 2022; Cruz & Saunders-Smits, 2022) reveal the power of qualitative research methods, and

the value of using narratives to provide relational stories that can add depth and meaning to practice cultures and contexts that can inform educational approaches. Mazzurco et al. (2021) identified emerging themes from empirical studies of engineering practice that emphasise the need to define and include various contexts in engineering practice research and consider diversity beyond gender as key elements. Insights from this review highlight the need for further research into engineering practice and collaborations with practicing engineers to ensure currency in engineering education, and to provide examples of productive engagement between engineering education and the world of engineering practice (Brunhaver et al., 2021; Buckley et al., 2022; Male et al., 2016; Trevelyan, 2019).

Proposed research program

Three key calls to action emerge from the literature that can strengthen the engineering education-practice nexus to support the preparation of engineering students to meet the many challenges of becoming engineering professionals. We need to:

1. Develop students' knowledge, skills and values aligned to the sociotechnical contexts relevant to their future professional practice to enhance their employability.
2. Understand and support the professional development of engineering educators with limited to no experience or awareness of engineering practice outside of academia.
3. Explore the nexus between engineering practice and engineering education for the purposes of informing curriculum, pedagogy and assessment practices that are effective in preparing students for the world of work.

The following three research questions are proposed to inform a research program design that can contribute towards supporting these calls to action.

RQ1: What are the sociotechnical contexts and cultures that influence the professional practice of early career engineers and in what way are these contexts influencing their practice?

RQ2: How do engineering educators perceive the sociotechnical contexts and cultures of engineering practice in relation to the disciplines they teach, and how does this influence their teaching practice?

RQ3: What understandings can educators gather surrounding sociotechnical contexts and cultures influencing the engineering practice of early career engineers to support graduate readiness for practice?

A qualitative research methodology is proposed to address these research questions informed by the works of Beddoes (2021), (2022), Craps et al. (2022), Jesiek et al. (2021), Lutz and Paretti (2021), and Buch and Bucciarelli (2015) who emphasised the need to focus on context when discussing the development and application of technical and professional skills relevant to different organisational settings, individual identities, and privileges. Fletcher (2001), and Faulkner (2007) demonstrated the power of observation studies when they explicitly described the sociotechnical nature of engineering practice and revealed cultures and issues related to privilege and identity. The lens Cruz and Saunders-Smits (2022), Trevelyan (2019), Cameron et al. (2011) and Thebuwana et al. (2017) used inspired the need to explore the awareness, perspectives, and intentions of engineering educators when it comes to including practice contexts and professional learning in engineering education.

Proposed methodology – ethnography / naturalistic inquiry

> *"I prefer, as a constructivist, to think of a construction as a little more than a metaphor, not for something "real", but as a way of making sense of something." – Egon Guba, (Lincoln & Guba, 2013, p. 29)*

The method proposed to conduct this study intends to help make sense of engineering practice contexts and cultures, rather than prescribe a single reality or truth about engineering practice (Lincoln & Guba, 1985). This will be done by investigating how individual engineers experience

practice in their ‘natural’ workplace settings (Griffin & Bengry-Howell, 2008). Constructed descriptions of practice will not be altogether generalisable, however elements of these descriptions will likely be shared across many different practice settings and realities which makes them relatable (Hatch, 2002).

Ethnographic research is a naturalistic form of inquiry that focuses on the cultural interpretation of people’s actions and the contexts in which their actions occur, be it focused on a specific social group or culturally significant practice (Griffin & Bengry-Howell, 2008). Data collection takes the form of participant and non-participant observations, informant interviewing, and/or records of diaries or video. All methods include a degree of researcher participation (Griffin & Bengry-Howell, 2008; Hatch, 2002). Data artifacts such as field notes, audio/video recordings, or transcripts are analysed using qualitative methods to form a descriptive analysis of the culture and contexts being studied (Griffin & Bengry-Howell, 2008). In all cases workplace ethnographic researchers use their own experiences as a source of understanding to provide insight into to the culture and practices they study (Smith, 2001).

Proposed instrumentation, and phases of inquiry

Lincoln and Guba (1985, pp. 226 - 247) provide a set of guidelines for designing research that applies naturalistic methods. The first three steps of this guide relate to determining a focus for inquiry; ensuring there is a fit between the paradigm and research focus; and ensuring fit between the inquiry paradigm and substantive theory selected to guide the inquiry. Each of these conceptual elements have been addressed so far. The remaining steps for designing a naturalistic inquiry are more operational than theoretical. These include determining where and from whom data will be collected, and the successive phases and instruments of the inquiry. Then planning data collection and recording, analysis procedures, and logistics while considering ethical practices.

Data collection will be conducted in three phases to address the proposed research questions and aims. In each phase, the instrument collecting data will be the lead researcher, as is normal when conducting naturalistic inquiry (Hatch, 2002). Below is a summary of the proposed data collection protocols to be employed for each phase.

Phase 1: Aims to develop tools and insights that help inform and guide engineering educators with striking a balance between theory and practice in their learning and teaching. This will be done by constructing an initial framework from the thematic analysis of ten semi-structured interviews with engineering practitioners, triangulated against Engineers Australia Stage 1 competency standard (2014), and relevant literature. This framework will be used to inform data collection and analysis of phases 2 and 3, and continually refined and evaluated as it is applied and revised against further insights arising from phases 2 and 3 of the study.

Phase 2: Different sociotechnical contexts and cultures and the influence they can have on the engineering practice of early career engineers (0 – 5 years after graduation) will be investigated. This will be done by conducting a series of shadowing observations and interviews of 4 – 6 early career engineers across multiple practice contexts for 3 days at a time over a 12-week period. The intent is to capture at least two female, and two migrant engineer perspectives to capture insights related to inclusion and identity. Participants will maintain a diary to capture non-observable activities during the observation period. At least two people who frequently interact with each observed participant will be interviewed to ensure that documentation of practice contexts and cultures is not myopic to the observed participant’s perspective. Narrative and case study analyses will be conducted with participant involvement to co-construct descriptions of practice contexts and cultures. Outcomes from this phase will be used to further refine tools and frameworks established in phase 1 and inform approach to data collection in phase 3.

Phase 3: Aims to explore academic notions of engineering practice for comparison with the understanding that has been co-constructed with early career engineers. This will help further explore and identify the nexus between engineering practice and engineering education, and refine the framework developed in phase 1 specific to its intended audience. A semi-structured

interview protocol will be applied to capture data from approximately ten engineering educators. The protocol and participant inclusion / exclusion criteria will be informed by the descriptions of practice contexts and cultures, literature, and the refined framework arising from phase 2.

In each phase, participant and organisation involvement will be both voluntary and anonymous. All collected data will de-identified and coded to protect anonymity of all involved. Participant confidentiality will be considered paramount to ensure no adverse effects to them within their workplace. Participants will be offered opportunities to review, contribute, retract, or withdraw at various stages, and all data will be stored electronically on a user-controlled server.

Recommendations for future research that supports the professional development of engineering educators aimed at enhancing student employability will be developed at the conclusion of all phases.

Initial outcomes – phase 1

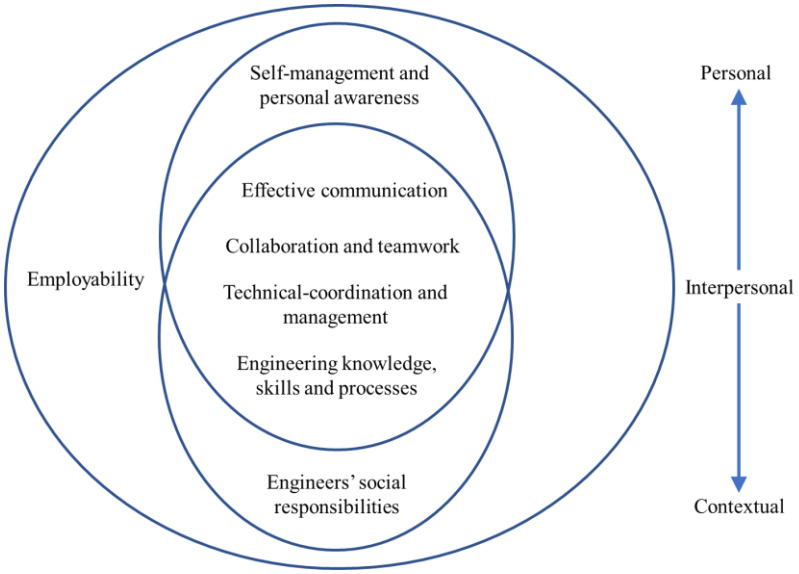

FIGURE 1: A conceptual model for the proposed engineering professional practice framework (McHenry & Krishnan, 2022, p. 1307)

Phase 1 of this study has been completed and published in the European Journal of Engineering Education (McHenry & Krishnan, 2022). A conceptual framework for engineering professional practice (EPP) is proposed to support embedding employability skill development within engineering programs using the language of learning outcomes. This allows academics to create learning experiences that intrinsically motivate students and explain the "skills, understandings and personal attributes" (Oliver, 2015, p. 59) relevant to developing the employability of engineering graduates. From a teaching perspective, this requires engineering educators to deliberately design learning and assessment experiences to ensure that these skills, understandings, and personal attributes can be taught and assessed across the whole of a program, so that graduates can demonstrate their ability to "discern, acquire and continually adapt" (Oliver, 2015, p. 59) as they transition into and progress through their careers.

Six key themes that emerged from this study are written as graduate level engineering professional practice learning outcomes (Table 1) that readily supports explicit inclusion of engineering professional practice in curriculum design. These key themes are illustrated along a continuum of personal, interpersonal, and contextual competencies and attitudes in Figure 1 to communicate the interrelated nature of engineering employability skills (McHenry & Krishnan, 2022). This is not a universal framework for engineering professional practice skill development; however, its potential broader relevance was considered by mapping the learning outcomes against those defined by ABET (2021).

Table 1: Engineering Professional Practice Learning Outcomes (McHenry & Krishnan, 2022, p. 1309)

Program Level Learning Outcome: An engineering graduate will be able to…
Self-management and personal awareness: Proactively and critically self-assess and use reflection as a strategy for lifelong learning, professional development, and career thinking. Manage personal actions, priorities, and behaviours effectively in consideration of others, to ensure integrity in professional judgement and decision-making.
Effective Communication: Effectively apply verbal and non-verbal communication skills by actively listening, speaking, reading, writing, and graphically representing an engineering position using appropriate means, considerate of the audience and viewpoint of others.
Collaboration and teamwork: Demonstrate the value of trust by being a competent, reliable team member, who recognises and respects the roles and viewpoints of others, the fundamentals of team dynamics, and the value in pursuing expert assistance when required to nurture relationships that foster mutual engagement of others to collaboratively solve problems together.
Technical coordination and management: Work with, influence, and organise other people and resources to perform necessary work in accordance with a mutually agreed schedule, by applying the fundamentals of business and project planning, financial management, risk management, and human resources to an engineering context.
Engineering knowledge, skills, and processes: Demonstrate capability to identify and use relevant engineering knowledge, skills, tools and processes to collect and interpret data and ambiguous information to define and solve problems, and design sustainable solutions.
Engineers' social responsibility: Situate their individual practice as engineers in its wider social context, by demonstrating commitment to safe, ethical, and sustainable practices, and applying the social, legal and environmental responsibilities of a professional engineer to exert a positive influence on the broader community.

Conclusions

A brief review of the literature on employability and engineering education, and the relevance of engaging in engineering practice research to inform education practices has been presented. Insights revealed three key calls to action that can strengthen the engineering education-practice nexus to support the preparation of engineering students for professional work. These calls to action arising from the literature included the need to:

1. Develop students' knowledge, skills and values aligned to the sociotechnical contexts relevant to their future professional practice to enhance their employability.
2. Understand and support the professional development of engineering educators with limited to no experience or awareness of engineering practice outside of academia.
3. Explore the nexus between engineering practice and engineering education for the purposes of informing curriculum, pedagogy and assessment practices that are effective in preparing students for the world of work.

Leveraging these insights, a three phase research program has been proposed to apply ethnographic research methods to help address three research questions that aim to gain a deeper understanding of; the sociotechnical contexts and cultures that influence the professional practice of early career engineers and in what way are these contexts influencing their practice; the perceptions of these contexts from the perspective of engineering educators and their teaching practices; and the understandings of practice contexts and cultures that can be constructed with educators to help inform their professional development.

Initial outcomes arising from the completion of phase 1 of this proposed program have been presented, with further details available in the full paper (McHenry & Krishnan, 2022). Further work in this program relates to the completion of phases 2 and 3, where observations of 4 – 6

early career engineers will be conducted using a combination of shadowing, interviewing, and use of a participant diary. Insights from these observations will be used to inform the interview protocol of engineering educators to co-construct a series of tools, insights and recommendations that can help inform and guide engineering educators with striking a balance between theory and practice in their learning and teaching.

References

ABET, A. B. f. E. a. T. (2021). Criteria for Accrediting Engineering Programs, 2021 – 2022. In *I. General Criteria for Baccalaureate Level Programs*. Online.

Beddoes, K. (2021). Examining Privilege in Engineering Socialization Through the Stories of Newcomer Engineers. *Engineering Studies, 13*(2), 158-179. doi:10.1080/19378629.2021.1958824

Beddoes, K. (2022). Gender as structure in the organisational socialisation of newcomer civil engineers. *European Journal of Engineering Education, 47*(1), 102-116. doi:10.1080/03043797.2021.1915251

Biggs, J. B., & Tang, C. (2011). *Teaching For Quality Learning At University*. Maidenhead, UNITED KINGDOM: McGraw-Hill Education.

Brunhaver, S. R., Jesiek, B. K., Korte, R. F., & Strong, A. C. (2021). The Early Career Years of Engineering: Crossing the Threshold Between Education and Practice. *Engineering Studies, 13*(2), 79-85. doi:10.1080/19378629.2021.1961570

Buch, A., & Bucciarelli, L. L. (2015). Getting Context Back in Engineering Education. In S. H. Christensen, C. Didier, A. Jamison, M. Meganck, C. Mitcham, & B. Newberry (Eds.), *International Perspectives on Engineering Education: Engineering Education and Practice in Context, Volume 1* (pp. 495-512). Cham: Springer International Publishing.

Buckley, J., Trevelyan, J., & Winberg, C. (2022). Perspectives on engineering education from the world of practice. *European Journal of Engineering Education, 47*(1), 1-7. doi:10.1080/03043797.2021.2000694

Burnett, I., Crosthwaite, C., Foley, B., Goldfinch, T., Hargreaves, D., Hadgraft, R., . . . Wilson, J. (2021). *Engineering change: The future of engineering education in Australia*. Retrieved from https://www.aced.edu.au/downloads/2021%20Engineering%20Change%20-%20The%20future%20of%20engineering%20education%20in%20Australia.pdf

Cameron, I., Reidsema, C., & Hadgraft, R. (2011). *Australian engineering academe: a snapshot of demographics and attitudes*. Paper presented at the AAEE Conference, Fremantle, Western Australia.

Chance, S., Direito, I., & Mitchell, J. (2022). Opportunities and Barriers Faced by Early-Career Civil Engineers Enacting Global Responsibility. *European Journal of Engineering Education, 47*(1), 164-192. Retrieved from https://ezproxy.deakin.edu.au/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1322371&site=eds-live&scope=site
http://dx.doi.org/10.1080/03043797.2021.1990863

Craps, S., Pinxten, M., Knipprath, H., & Langie, G. (2022). Different roles, different demands. A competency-based professional roles model for early career engineers, validated in industry and higher education. *European Journal of Engineering Education, 47*(1), 144-163. doi:10.1080/03043797.2021.1889468

Crosthwaite, C. (2021). *Engineering Futures 2035: Engineering Education Programs, Priorities & Pedagogies* Retrieved from https://www.aced.edu.au/downloads/Engineering%20Futures%202035%20R2%20report%20to%20ACED.pdf

Cruz, M. L., & Saunders-Smits, G. N. (2022). Using an industry instrument to trigger the improvement of the transversal competency learning outcomes of engineering graduates. *European Journal of Engineering Education, 47*(1), 30-49. doi:10.1080/03043797.2021.1909539

Dacre Pool, L., & Sewell, P. (2007). The key to employability: developing a practical model of graduate employability. *Education + Training, 49*(4), 277-289. doi:10.1108/00400910710754435

Engineers Australia. (2014). Stage 1 Competency Standard for Professional Engineer In. engineersaustralia.org.au.

Faulkner, W. (2007). `Nuts and Bolts and People': Gender-Troubled Engineering Identities. *Social Studies of Science, 37*(3), 331-356. doi:10.1177/0306312706072175

Fletcher, J. K. (2001). *Disappearing acts: Gender, power, and relational practice at work*: Mit Press.

Griffin, C., & Bengry-Howell, A. (2008). The SAGE Handbook of Qualitative Research in Psychology. In. doi:10.4135/9781848607927

Harvey, L. (2001). Defining and Measuring Employability. *Quality in Higher Education, 7*(2), 97-109. doi:10.1080/13538320120059990

Hatch, J. A. (2002). *Doing qualitative research in education settings*: Suny Press.

Jesiek, B. K., Buswell, N. T., & Nittala, S. (2021). Performing at the Boundaries: Narratives of Early Career Engineering Practice. *Engineering Studies, 13*(2), 86-110. doi:10.1080/19378629.2021.1959596
Knight, D. B., Cameron, I. T., Hadgraft, R. G., & Reidsema, C. (2016). The influence of external forces, institutional forces, and academics' characteristics on the adoption of positive teaching practices across Australian undergraduate engineering. *International Journal of Engineering Education*.
Lee, P., Crosthwaite, C., Reidsema, C., Burnett, I., Foley, B., Hargreaves, D., . . . Wilson, J. (2022, 2022//). *Preparing Engineers for 2035: Transforming Australia's Engineering Education for Emerging Roles and Expectations.* Paper presented at the Applied Degree Education and the Future of Learning, Singapore.
Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverley Hills, CA: Sage.
Lincoln, Y. S., & Guba, E. G. (2013). *The constructivist credo*: Left coast press.
Lutz, B., & Paretti, M. C. (2021). Exploring the Social and Cultural Dimensions of Learning for Recent Engineering Graduates during the School-to-Work Transition. *Engineering Studies, 13*(2), 132-157. doi:10.1080/19378629.2021.1957901
Male, S., King, R., & Hargreaves, D. (2016, June 12-16, 2016). *Drivers and barriers to industry engaging in engineering education.* Paper presented at the Proceedings of 12th International CDIO Conference, Turku University of Applied Sciences, Turku, Finland.
Mazzurco, A., Crossin, E., Chandrasekaran, S., Daniel, S., & Sadewo, G. R. P. (2021). Empirical research studies of practicing engineers: a mapping review of journal articles 2000–2018. *European Journal of Engineering Education, 46*(4), 479-502. doi:10.1080/03043797.2020.1818693
McHenry, R., & Krishnan, S. (2022). A conceptual professional practice framework for embedding employability skills development in engineering education programmes. *European Journal of Engineering Education, 47*(6), 1296-1314. doi:10.1080/03043797.2022.2164255
Oliver, B. (2015). Redefining graduate employability and work-integrated learning: Proposals for effective higher education in disrupted economies. *Journal of Teaching and Learning for Graduate Employability, 6*(1), 56-65. Retrieved from https://search.informit.org/doi/10.3316/informit.174658230609829
Passow, H. J., & Passow, C. H. (2017). What Competencies Should Undergraduate Engineering Programs Emphasize? A Systematic Review. *Journal of Engineering Education, 106*(3), 475-526. doi:https://doi.org/10.1002/jee.20171
Smith, V. (2001). Ethnographies of Work and the Work of Ethnographers. In A. C. Paul Atkinson, Sara Delamont, John Lofland, Lyn Lofland (Ed.), *Handbook of Ethnography* (pp. 220 - 233). doi:10.4135/9781848608337
Stevens, R., Johri, A., & O'connor, K. (2014). Professional engineering work. *Cambridge handbook of engineering education research*, 119-137.
Thebuwana, H., Hadgraft, R., & Alam, F. (2017). Addressing Graduate Competencies: Understanding the Contextual Factors Impacting the Engineering Discipline. *Energy Procedia, 110*, 359-364. doi:https://doi.org/10.1016/j.egypro.2017.03.153
Trevelyan, J. (2010). Reconstructing engineering from practice. *Engineering Studies, 2*(3), 175-195. doi:10.1080/19378629.2010.520135
Trevelyan, J. (2019). Transitioning to engineering practice. *European Journal of Engineering Education, 44*(6), 821-837. doi:10.1080/03043797.2019.1681631
Williams, S., Dodd, L. J., Steele, C., & Randall, R. (2016). A systematic review of current understandings of employability. *Journal of Education and Work, 29*(8), 877-901. doi:10.1080/13639080.2015.1102210
Winberg, C., Bramhall, M., Greenfield, D., Johnson, P., Rowlett, P., Lewis, O., . . . Wolff, K. (2020). Developing employability in engineering education: a systematic review of the literature. *European Journal of Engineering Education, 45*(2), 165-180. doi:10.1080/03043797.2018.1534086
Yorke, M. (2006). *Employability in higher education: what it is-what it is not* (Vol. 1): Higher Education Academy York.

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