# Stakeholder Perspectives on Professional Skills Priorities in Engineering Curriculum: A Systematic Literature Review

Zachery Quince[1], Samuel Cunningham[2], and Sarah Dart[3].
[1] School of Engineering, University of Southern Queensland (UniSQ), [2] Faculty of Engineering, Queensland University of Technology, [3] Learning and Teaching Unit, Queensland University of Technology
Corresponding Author Email: zach.quince@unisq.edu.au

**CONTEXT**
The Washington Accord sets out the professional competencies that should be developed through an engineering student's education. Although this includes both technical and professional competencies, engineering curriculum has historically prioritised the development of technical skills. This is further compounded by the competing perspectives of three key stakeholder groups – academic, industry, and students.

**PURPOSE**
The purpose of this literature review is to develop understanding of different stakeholders' perspectives of what professional skills are important for an engineering graduate. In this study the following research questions are addressed: (1) what has been the focus of empirical studies on the professional skills expected of engineering graduates?; and (2) how do the professional skills expected of engineering graduates vary by stakeholder group?

**APPROACH**
A systematic literature review approach guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework was applied. A database search returned 1595 records, which were screened based on set criteria including publishing date and quality of journal. Selected papers were then mapped to the seven professional skill competencies of the Washington Accord.

**OUTCOMES**
In total, 17 papers were identified as meeting the screening criteria. Most reviewed articles being published from 2020 onwards indicated that this area is increasing in interest. Out of the 17 papers, one investigated the perspective of academics, 12 considered professional engineers, and 7 included students' perspectives. Teamwork and communication skills were typically ranked among the most important, with environmental and sustainability often ranked lower for importance.

**CONCLUSIONS**
The review highlighted the importance of communication and teamwork skills as perceived by professional engineers, students, and academics. Environment and sustainability skills were not ranked highly among the stakeholders. Skills such as ethics varied in importance between stakeholders. Given the varying perspectives of the stakeholder groups, it is recommended that future work explores the similarities and differences between the graduate needs of industry, and the skills that academics believe are important for graduates. This would contribute to efforts to better align engineering curriculum with industry needs.

**KEYWORDS**
Professional skills, systematic review, graduate competencies, Washington Accord

# Introduction

Accrediting bodies define the competencies that students are expected to develop during engineering education experiences (Gómez et al., 2021; Male et al., 2011). Although most countries have their own standards, the International Engineering Alliance (2021) oversees the Washington Accord, which is used to recognise engineering qualifications and professional competence by member organisations around the world. The Washington Accord (International Engineering Alliance, 2021) states that the attributes expected of engineering graduates relate to (1) engineering knowledge, (2) problem analysis, (3) design/development of solutions, (4) investigation, (5) modern tool usage, (6) the engineer and society, (7) environment and sustainability, (8) ethics, (9) individual and team work, (10) communication, (11) project management and finance, and (12) lifelong learning. The former five represent technical skills, while the latter seven represent professional skills (also variously referred to as soft (Khoo et al., 2020), non-technical (Gómez et al., 2021), and transferable skills (Gutiérrez Ortiz et al., 2021).

In practice, engineering curriculum has historically prioritised the development of technical skills rather than professional skills (Gómez et al., 2021; Itani & Srour, 2016; Male et al., 2011; Simmons et al., 2021). This is a trend that continues to proliferate, despite persistent calls for programs to have a stronger and more deliberate focus on professional skills to better prepare graduates for the workforce (Hadgraft & Kolmos, 2020; Itani & Srour, 2016; Male et al., 2011). The lack of progress has been attributed to a range of contributing factors including resistance to change (including for time and financial reasons) (Aparicio & Ruiz-Teran, 2007; Crosthwaite, 2019), educator motivations toward preparing students for research rather than industry careers (Aparicio & Ruiz-Teran, 2007) and being more research than teaching-focused (Dart et al., 2022, 2023), and challenges in meaningfully connecting professional engineers into the university environment (Khoo et al., 2020) especially in relation to providing authentic learning experiences for large student cohorts (Crosthwaite, 2019).

Strong understanding of the skills engineering graduates should develop is invaluable for guiding curriculum reform (Gómez et al., 2021; Male et al., 2011; Ramadi et al., 2015). However, given space limitations within engineering programs, there is a knowledge gap around which skills should be most prioritised (Crosthwaite, 2019; Gómez et al., 2021). This is compounded by the competing perspectives of various stakeholders (which include professional engineers, academics, and students), that create tensions in educational design and implementation processes (Khoo et al., 2020).

Engineering workplaces are experiencing ongoing and rapid disruptions (Crossin et al., 2023; Khoo et al., 2020) with tasks previously performed by engineers increasingly being automated (Aparicio & Ruiz-Teran, 2007) and a sharper focus on the social impact of engineering activities (Hadgraft & Kolmos, 2020). Thus, with ongoing advances in technology (including trends around big data and artificial intelligence) as well as the growing criticality of global challenges like sustainability (Crosthwaite, 2019; Gutiérrez Ortiz et al., 2021; Hadgraft & Kolmos, 2020), educators are presented with a timely opportunity to review the empirical research on what professional skills should be prioritised in engineering students' development. This study will address the research questions:

1. What has been the focus of empirical studies on the professional skills expected of engineering graduates?
2. How do the professional skills expected of engineering graduates vary by stakeholder group?

To investigate the professional skill priorities this work adopts a systematic literature review approach (Borrego et al., 2014). To identify overarching trends the primary studies will be synthesised, contributing to more robust outcomes supporting identification of gaps and recommended future research directions.

# Methods

The methodology proposed by Borrego et al. (2014) for conducting systematic literature reviews in the field of engineering education was used. This is described below.

## Inclusion and Exclusion Criteria

Criteria were defined to select papers aligned to addressing the research questions. Papers were included that met each of the following criteria: (1) Reported empirical findings related to professional skill expectations with a specific focus on engineering. Articles that did not analyse presented data were excluded; (2) Focused on Bachelor level programs (larger than an individual subject). This excluded papers that focused on two-year degrees, diplomas, school equivalence, masters, and PhD programs. Papers focused on workplace settings were also excluded, except for those associated with work integrated learning experiences in Bachelor level programs; (3) Published in a journal article by a first or second quartile outlet as defined by SCIMAGO (https://www.scimagojr.com) based on publication year and the relevant field (i.e. engineering or education). Conference papers and grey matter were excluded to promote inclusion of high quality work with methodological transparency and rigor (Mazzurco et al., 2021), and to make the review's scope more manageable; (4) Published from 2012 to 2021 (inclusive); and (5) Articles published in the English language.

## Database and Search Terms

Scopus (https://www.scopus.com/) represents a large online repository of peer-reviewed literature and is frequently used for identifying articles for systematic literature reviews (Borrego et al., 2014; Mazzurco et al., 2021). As such it was used in this study, with the search performed on April 4, 2022. However, the use of only one database presents as a limitation of the approach as relevant studies may have been omitted. The search string was developed to include multiple key words aligned to the research questions. The search looked for studies that included both engineer and graduate as terms in the title or abstract, using wildcards to account for variations in how these terms were expressed. In addition, studies needed to use at least one of the following terms in their title or abstract (accounting for wildcards) – skill, requirement, capability, competency, and attribute – given these terms are often used interchangeably (Khoo et al., 2020). The search string is shown directly below.

```
(TITLE-ABS(engineer*) AND TITLE-ABS(graduat*) AND (TITLE-ABS(requir*) OR TITLE-ABS(skill*) OR TITLE-ABS(capabilit*) OR TITLE-ABS(competenc*) OR TITLE-ABS(attribute*))) AND LANGUAGE(english) AND PUBYEAR > 2011 AND DOCTYPE(ar) AND SRCTYPE(j) AND PUBYEAR < 2022
```

## Article Screening

The first screening stage involved reviewing each article's title and abstract by two researchers independently against the criteria. Disagreements were discussed to reach consensus or carried forward to the next screening stage. Full-papers were then screened, with discussion to reach consensus used to resolve all conflicts. Figure 1 shows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram (Page et al., 2021). In total, 17 articles were deemed eligible for inclusion in the study as summarised in Table 1.

## Analysis and Synthesis

To synthesise the literature, each paper's content was mapped to the Washington Accord (WA) graduate attributes relating to professional skills (International Engineering Alliance, 2021). These were the engineer and society (WA6), environment and sustainability (WA7), ethics (WA8), individual and team work (WA9), communication (WA10), project management and finance (WA11), and lifelong learning (WA12). Not all studies investigated skills in a granular way that could be clearly mapped to the WA graduate attributes, as some studies discussed professional skills in general terms or in ways that did not align closely with the framework. This presents as a limitation of the approach.

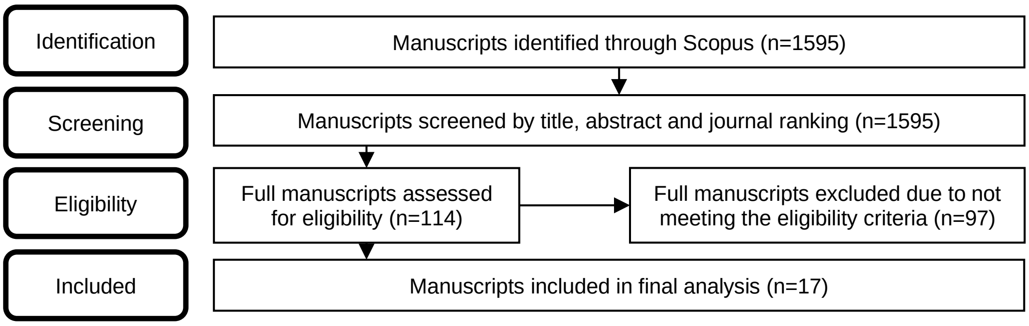


**Figure 1: PRISMA inclusion and exclusion diagram**

**Table 1: Article details for included studies; United States of America abbreviated to USA**

| Author (year) | Country | Data Collection Mechanism | Stakeholders |
|---|---|---|---|
| Holik & Sanda (2020) | Hungary | Survey | Students |
| Simmons et al. (2021) | USA | Survey | Students |
| Passow (2012) | USA | Survey | Professional Engineers |
| Itani & Srour (2016) | Lebanon | Survey | Students |
| Ahn et al. (2012) | USA | Survey | Professional Engineers |
| Khoo et al. (2020) | New Zealand | Survey and focus groups | Professional Engineers and Academics |
| Munir (2021) | South Africa | Survey and interviews | Professional Engineers |
| Hirudayaraj et al. (2021) | USA | Survey | Professional Engineers |
| Rizwan et al. (2021) | Saudi Arabia | Survey and interviews | Students and Professional Engineers |
| Gómez et al. (2021) | Chile | Survey | Professional Engineers |
| Ramadi et al. (2015) | Middle east and north Africa | Survey | Students |
| Suleiman & Abahre (2020) | Jordan | Interviews | Professional Engineers |
| Carpenter et al. (2014) | USA | Survey | Students |
| Rizwan et al. (2018) | Pakistan | Survey | Students and Professional Engineers |
| Ortiz-Marcos et al. (2020) | Europe | Interview | Professional Engineers |
| Zhang et al. (2021) | China | Survey and interviews | Professional Engineers |
| Walczak et al. (2013) | Chile | Survey | Professional Engineers |

# Findings

## Article Characteristics and Context

To provide context for the data set, several characteristics were mapped. Most articles (n=10, 59%) were published from 2020 onwards. The articles were drawn from a wide range of journals. The majority (n=13, 76%) were published in an engineering education specific journal rather than a technically focused journal. The International Journal of Engineering Education was the journal with the greatest number of included papers (n=4, 24%).

The countries that articles focused on were diverse, covering North America, Europe, the Middle East, Australasia, Africa, and Asia. It is worth noting that not all of these countries have engineering programs accredited to the Washington Accord. The United States of America accounted for the largest number of papers (n=5, 29%), likely a reflection of the relatively large size of the American engineering education community. Most papers did not focus on a specific engineering discipline (n=13, 65%). Of those that did, four articles investigated civil and construction engineering, and one article looked at mechanical engineering.

All papers focused on the perspective of at least one stakeholder group (professional engineers, students, and academics). Most papers examined students (n=9, 53%) or professional engineers (n=7, 41%) exclusively. The remaining papers (n=3, 18%) examined a combination of two groups, with no papers that investigated all three stakeholder groups.

The main data collection mechanism was surveying (n=11, 65%). Some studies (n=4, 24%) coupled surveys with focus groups and interviews. Two studies (12%) used interviews only. The dominant intent of studies was to rank skills in terms of relative importance or competence. A key exception to this was Simmons et al. (2021), which instead clustered students into three groups according to their perceived importance of leadership qualities.

## Analysis of Skills Required of Engineering Graduates

Overall, studies repeatedly emphasised that technical skills remain the dominant focus of formal engineering curriculum, with professional skills frequently neglected (e.g. (Gómez et al., 2021; Holik & Sanda, 2020; Itani & Srour, 2016; Ramadi et al., 2015; Simmons et al., 2021)). Consequently, studies overwhelmingly agreed that universities worldwide needed to take more purposeful action to enhance engineering students' professional skills. Where each Washington Accord attribute was represented across the 17 papers is seen in Figure 2. Individual and team work (WA9) and communication (WA10) were most frequently considered. Lifelong learning (WA12) was the least mapped attribute. The following analysis is structured around the Washington Accord attributes in their numerical order.

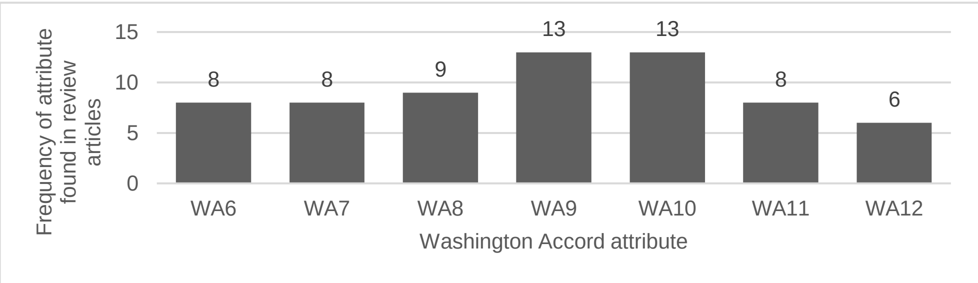


**Figure 2: Frequency of Washington Accord attributes investigated in included articles**

***The engineer and society (WA6) –*** The engineer and society capability is defined as, *"reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems"* (International Engineering Alliance, 2021). As this capability is broad, it was mentioned in different ways, such as responsibility (Holik & Sanda, 2020), local context (Gómez et al., 2021), contextual responsibilities (Suleiman & Abahre, 2020), social impact (Walczak et al., 2013), and contemporary issues (Passow, 2012; Walczak et al., 2013). In some articles, there was overlap between the engineer and society and the environment and sustainability attributes, with terms such as 'responsibility' (Holik & Sanda, 2020) including elements of both.

Walczak et al. (2013) noted that 'contemporary issues' had one of the largest gaps between the preparedness of graduates and how frequently they used these skills. Similarly, Walczak et al. (2013) reported that students' skills in social impact were inferior to the associated relevance of these skills in the workplace. Zhang et al. (2021) shared similar findings, concluding that social responsibility as a competency needed to be more greatly emphasised, linking this with sustainability. Ramadi et al. (2015) assessed the skill *'understand the impact of engineering solutions on society'* which was ranked by managers in the bottom quarter of all examined skills for both importance and satisfaction. For skills related to the engineer and society attribute, the perspectives on importance and competence differed between stakeholders, with students typically rating skills more favourably overall.

***Environment and sustainability (WA7) –*** The environment and sustainability attribute was often discussed as part of social responsibility, general professional skills, or global awareness requirements (Ahn et al., 2012; Hirudayaraj et al., 2021; Walczak et al., 2013). Studies sought various stakeholder perspectives from recruiters (Ahn et al., 2012), employers (Hirudayaraj et al., 2021; Khoo et al., 2020; Ramadi et al., 2015), recent graduates (Gómez et al., 2021), and academic staff (Khoo et al., 2020). A study comparing sectors found that public sectors rated the importance of global cultural awareness higher than private (Hirudayaraj et al., 2021).

Although environment and sustainability competencies were acknowledged as key in many studies, they were often ranked among the lowest for importance. For example Ahn et al. (2012) found that environmental awareness had the lowest average importance rating for recruiters from a total of fourteen skills and Gómez et al. (2021) reported that graduates ranked sustainability third last out of 34 skills. Several studies recognised that although environmental considerations were not currently ranked highly, they would become more important in the future (Ahn et al., 2012; Khoo et al., 2020), with one study predicting sustainability as the skill with the biggest projected future change in importance (Ahn et al., 2012). This was likely linked to a rising demand for environmentally conscious projects (Ahn et al., 2012). Ramadi et al. (2015) identified the environment in the bottom half of skills when ranked by importance, and when ranked by manager satisfaction of current graduate skills, it was rated second last.

***Ethics (WA8) –*** The ethics graduate attribute tasks the individual to "*apply ethical principles and commit to professional ethics*" (International Engineering Alliance, 2021). The literature referencing ethical skills covered a range of perspectives including undergraduate students (Simmons et al., 2021), graduates (Gómez et al., 2021; Passow, 2012), and professional engineers (Ahn et al., 2012; Hirudayaraj et al., 2021; Khoo et al., 2020; Ramadi et al., 2015; Walczak et al., 2013). Most papers measured the overarching competency of 'ethics', although some focused on more selected areas (Gómez et al., 2021; Hirudayaraj et al., 2021; Ramadi et al., 2015; Walczak et al., 2013). Others noted skills that could be aligned to ethics such as 'social impact' (Ramadi et al., 2015), 'contemporary issues' (Walczak et al., 2013) and 'global context' (Gómez et al., 2021). As such was difficult to determine what specific competencies these studies were asking participants to rank as clear definitions of ethics were typically not provided, and participants' understanding of ethics may have varied.

Perceptions of ethical skills varied greatly. Ahn et al. (2012) ranked ethics as the highest out of all competencies surveyed among professional construction engineers. In contrast Gómez et al. (2021) had ethics ranked in the bottom quarter of competencies for professional civil engineers. Overall, other studies ranked ethics towards the middle. Khoo et al. (2020) reported a perceived gap in the ethical competence of graduates from the view of both professional engineers and academics. This skill gap was further supported by Hirudayaraj et al. (2021) who reported that two criteria aligned to the ethics competency had a deficit of more than 10% between importance and proficiency when rated by employers.

***Individual and team work (WA9) –*** Individual and team work were mentioned in thirteen papers, tied for the most frequently represented attribute. Some studies only referenced teamwork broadly, while others broke it into sub-skills such as '*take directions well from supervisors*' (Ramadi et al., 2015) '*leadership'* (Khoo et al., 2020), and '*ability to work with a diverse groups of people*' (Hirudayaraj et al., 2021). Throughout the literature there was a mixture of stakeholders, with two studies focusing on student perceptions (Holik & Sanda, 2020; Simmons et al., 2021), several looking at graduates (Ahn et al., 2012; Gómez et al., 2021; Passow, 2012; Suleiman & Abahre, 2020), and the remaining six studies investigating professional engineer perceptions.

Most studies emphasised teamwork (working as a part or leading) as an important skill required of graduate students. For example, Walczak et al. (2013) reported that teamwork was rated most important of all competencies as measured by professional mechanical engineers in Chile, but was demonstrated infrequently, thus highlighting a competency gap. Similarly, Ramadi et al. (2015) reported that in the Middle Eastern and North African regions, engineering employers felt graduates had low ability to '*function as a team member*'. This competency was ranked the second lowest out of more than 35 skills. This deficit was further noted by Hirudayaraj et al. (2021) with a gap between employers' importance rating and graduate proficiency in '*ability to work in teams*' and '*leadership'*.

***Communication (WA10) –*** Communication was discussed in thirteen papers, tied for the largest number. Like the individual and team work attribute, some papers split out the types of communication (such as written and verbal), while others probed the broad communication competency area (e.g (Hirudayaraj et al., 2021)).

Overall, communication was ranked as highly important by stakeholders within the included studies. For example, each of Simmons et al. (2021), Passow (2012), Khoo et al. (2020), Walczak et al. (2013) and Gómez et al. (2021) ranked communication, or a subset of communication skills, as being the in the top quarter of all competencies measured. Moreover, this captured the viewpoint of professional engineers, students, and academics. Whilst most papers referenced communication as being of high importance, Ahn et al. (2012) had communication (which included both written and verbal) as the second last of those measured.

***Project management and finance (WA11) –*** Project management and finance skills appeared in eight papers. Although these skills were variously defined, some studies associated the skills with leadership in a general sense (Khoo et al., 2020; Simmons et al., 2021; Suleiman & Abahre, 2020). Most studies singled out specific aspects to probe directly such as risk management (Itani & Srour, 2016; Simmons et al., 2021), financial literacy (Itani & Srour, 2016; Khoo et al., 2020; Ramadi et al., 2015; Zhang et al., 2021), and management of staff (Gómez et al., 2021; Khoo et al., 2020; Suleiman & Abahre, 2020).

Overall, importance perceptions of project management and finance competencies were mixed. For example, Suleiman and Abahre (2020) reported management and leadership skills as the fourth most important skill group (out of eleven investigated) by recent graduates. However, Khoo et al. (2020) found that leadership, staff management, and financial literacy were among the least valued competencies by employers and academics. Where differences were found within individual studies, project management-related skills were more highly valued than those related to finance, regardless of the stakeholder cohort. For example, Ramadi et al. (2015) found possessing basic finance and economics knowledge was lowly valued by engineering managers, but explicit managerial skills (like leading a team and basic management abilities) were ranked of average importance among investigated skills. This finding was similar to Itani and Srour (2016) who found that risk management and project management were ranked of high importance by undergraduate students, but that basic accounting and finance skills were ranked least important.

***Life-long learning (WA12) –*** Life-long learning was mapped across the least number of papers. Life-long learning skills were probed at varying levels of detail. Some studies grouped these skills into wider categories, such as '*cooperation* and *continuous learning*' (Ramadi et al., 2015) and '*lifelong learning and self-management*' (Khoo et al., 2020), and subsequently explored multiple underpinning aspects. Other studies only probed the high-level competency area, such as '*recognizes the importance of continuous self-directed professional development*' (Gómez et al., 2021) or '*lifelong learning'* (Zhang et al., 2021).

Results for the importance of life-long learning skills were mixed among studies that assessed professional engineers' perspectives. For example, Ramadi et al. (2015) reported that '*acquire new skills and knowledge*' and '*desire to continuously learn*' were rated among the most important (and needed significant improvement in graduates). This was consistent with the industry perspective presented in Zhang et al. (2021). In contrast, both Gómez et al. (2021) and Suleiman and Abahre (2020) reported that life-long learning skills were among the least valued. Positioned between these outcomes, Khoo et al. (2020) found continuous improvement, help seeking (that is, learning from others), and adaptability (characterised by a willingness to learn) were ranked 8 to 10 out of 26 skills by employers (Khoo et al., 2020). Academics arrived at the same ranking for continuous improvement, but ranked adaptability and help seeking skills slightly lower (Khoo et al., 2020).

# Conclusions

The findings of this research demonstrate that professional engineers, students, and academics echo the importance of professional skills given the employability benefits, including for promotion, career development, and progression. The *individual and team work* as well as *communication* attributes were most frequently discussed in the articles reviewed. In addition, they were often the most highly rated across the stakeholder groups. This demonstrates their perceived relative importance, and positions these skills as those that most likely need to be prioritised within engineering curriculum. In contrast, both the *engineer and society* and *environment and sustainability* skills were ranked relatively low. This is in direct contrast with priorities from accrediting bodies, and predictions that these will be increasingly important considerations in the future (Crosthwaite, 2019). The lack of perceived importance of these skills may explain why they have historically had limited representation in curriculum and continue to face challenges in increasing the extent to which they are embedded.

Given only one study examined the views of academics who have such a fundamental role in developing curriculum, there would be benefit for future research to explore similarities and differences between the graduate needs of industry, and the skills that academics believe are important for graduates. If these priorities are aligned, academic staff will be able to develop responsive learning experiences, while also appropriately conveying the importance of competencies clearly to students. To ensure that engineers of the future are trained with the required skills, it will be important for these stakeholders to have a shared view.

## Acknowledgements

This research project received funding from the Australasian Association for Engineering Education's 2021 Grant Scheme.

## References

Ahn, Y. H., Annie, R. P., & Kwon, H. (2012). Key Competencies for U.S. Construction Graduates: Industry Perspective. *Journal of Professional Issues in Engineering Education and Practice*, *138*(2), 123-130.

 

Aparicio, A. C., & Ruiz-Teran, A. M. (2007). Tradition and Innovation in Teaching Structural Design in Civil Engineering. *Journal of Professional Issues in Engineering Education and Practice*, *133*(4), 340-349.

Borrego, M., Foster, M. J., & Froyd, J. E. (2014). Systematic literature reviews in engineering education and other developing interdisciplinary fields. *Journal of Engineering Education*, *103*(1), 45-76.

Carpenter, D. D., Harding, T. S., Sutkus, J. A., & Finelli, C. J. (2014). Assessing the ethical development of civil engineering undergraduates in support of the ASCE body of knowledge. *Journal of Professional Issues in Engineering Education and Practice*, *140*(4), A4014001.

Crossin, E., Richards, J. I., Dart, S., & Naswall, K. (2023). A taxonomy of common engineering activities and competencies. *Australasian Journal of Engineering Education*, *28*(2), 181–193.

Crosthwaite, C. (2019). *Engineering Futures 2035 Stage 1 Report*. Australian Council of Engineering Deans. http://www.aced.edu.au/downloads/Engineering%20Futures%202035_Stage%201%20report%20for%20ACED_May_16_2019.pdf

Dart, S., Cunningham, S., Gregg, A., & Young, A. (2022). *Representation of future-focused teaching capabilities in selection criteria used to recruit Australian engineering academics.* Australasian Association for Engineering Education Conference, Parramatta.

Dart, S., Cunningham, S., Gregg, A., & Young, A. (2023). Defining the capabilities required to teach engineering: Insights for achieving the Australian sector's future vision. *Australasian Journal of Engineering Education*, *28*(1), 47-58.

Gómez, M. Á., Herrera, R. F., Atencio, E., & Munoz-La Rivera, F. C. (2021). Key Management Skills for Integral Civil Engineering Education. *International Journal of Engineering Pedagogy (iJEP)*, *11*(1), 64-77.

Gutiérrez Ortiz, F. J., Fitzpatrick, J. J., & Byrne, E. P. (2021). Development of contemporary engineering graduate attributes through open-ended problems and activities. *46*(3), 441-456.

Hadgraft, R. G., & Kolmos, A. (2020). Emerging learning environments in engineering education. *Australasian Journal of Engineering Education*, *25*(1), 3-16.

Hirudayaraj, M., Baker, R., Baker, F., & Eastman, M. (2021). Soft Skills for Entry-Level Engineers: What Employers Want. *Education Sciences*, *11*(10), 641.

Holik, I., & Sanda, I. D. (2020). The Possibilities of Improving Communication Skills in the Training of Engineering Students. *International Journal of Engineering Pedagogy (iJEP)*, *10*(5), 20.

International Engineering Alliance. (2021). *Graduate Attributes and Professional Competencies*. https://www.ieagreements.org/assets/Uploads/Documents/IEA-Graduate-Attributes-and-Professional-Competencies-2021.1-Sept-2021.pdf

Itani, M., & Srour, I. (2016). Engineering Students' Perceptions of Soft Skills, Industry Expectations, and Career Aspirations. *Journal of Professional Issues in Engineering Education and Practice*, *142*(1), 04015005.

Khoo, E., Zegwaard, K., & Adam, A. (2020). Employer and academic staff perceptions of science and engineering graduate competencies. *Australasian Journal of Engineering Education*, *25*(1), 103-118.

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., 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*, 479-502.

Munir, F. (2021). More than technical experts: Engineering professionals' perspectives on the role of soft skills in their practice. *Industry and Higher Education*, *36*(3), 294-305.

Ortiz-Marcos, I., Breuker, V., Rodríguez-Rivero, R., Kjellgren, B., Dorel, F., Toffolon, M., Uribe, D., & Eccli, V. (2020). A Framework of Global Competence for Engineers: The Need for a Sustainable World. *Sustainability*, *12*(22).

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., & Brennan, S. E. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Systematic reviews*, *10*(1), 1-11.

Passow, H. J. (2012). Which ABET Competencies Do Engineering Graduates Find Most Important in their Work? *Journal of Engineering Education*, *101*(1), 95-118.

Ramadi, E., Ramadi, S., & Nasr, K. (2015). Engineering graduates' skill sets in the MENA region: a gap analysis of industry expectations and satisfaction. *European Journal of Engineering Education*, *41*(1), 34-52.

Rizwan, A., Alsulami, H., Shahzad, A., Elnahas, N., Almalki, S., Alshehri, R., Alamoudi, M., & Alshoaibi, H. (2021). Perception gap of Employability skills between Employers' and female Engineering graduates in Saudi Arabia. *International Journal of Engineering Education*, *37*(2), 341-350.

Rizwan, A., Demirbas, A., Hafiz, N. A. S., & Manzoor, U. (2018). Analysis of perception gap between employers and fresh engineering graduates about employability skills: a case study of Pakistan. *International Journal of Engineering Education*, *34*(1), 248-255.

Simmons, D. R., Clegorne, N., Polmear, M., Scheidt, M., & Godwin, A. (2021). Connecting Engineering Students' Perceptions of Professional Competencies and Their Leadership Development. *Journal of Civil Engineering Education*, *147*(2), 04020015.

Suleiman, A., & Abahre, J. (2020). Essential competencies for engineers from the perspective of fresh graduates. *Engineering Management in Production and Services*, *12*(1), 70-79.

Walczak, M., Uziak, J., Oladiran, M. T., Baeza, C. C., & Paez, P. T. (2013). Industry Expectations of Mechanical Engineering Graduates. A Case Study in Chile. *International Journal of Engineering Education*, *29*(1), 181-192.

Zhang, X., Tang, W., Duffield, C. F., Zhang, L., Hui, F. K. P., Liu, Y., & Kang, Y. (2021). A Competency Framework for Construction Engineering Graduates: An Industry Perspective. *International Journal of Engineering Education*, *37*(4), 856-873.

## Copyright Statement