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Ākonga (student) perceptions of the value of the IEA graduate attributes to their future success as engineers.

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ABSTRACT

CONTEXT

When studying vocational engineering in New Zealand, ākonga (students) must meet 12 graduate attributes as part of the programme's accreditation under the International Engineering Alliance (IEA). Educators observe that ākonga assign different values to each IEA graduate attribute when considering early career development and success. The researchers wanted to know which attributes ākonga consider highly valuable and which they consider less valuable.

PURPOSE OR GOAL

This preliminary study aims to assess ākonga perception of the importance of various graduate attributes in the context of what will be the most useful when transitioning into the workplace. By exploring ākonga perceptions of the IEA graduate attributes, the research seeks to identify potential gaps between educational outcomes and industry requirements, thereby enhancing the relevance and quality of engineering education programs. Understanding these perceptions can provide insights into how curriculum and teaching methodologies can be tailored to meet industry needs better and improve graduate employability in engineering fields.

APPROACH OR METHODOLOGY/METHODS

A short survey asked participants to select the most/least valuable and most/least exciting IEA graduate attributes and justify their selections. The responses were thematically analysed and compared to the existing literature. The data collected is primarily qualitative, assessing which graduate attributes ākonga think are important, which they are excited to learn about, and the reasons for their choices.

ACTUAL OR ANTICIPATED OUTCOMES

Results from the survey's thematic analysis and literature review confirm the researcher's observations. Most first-year ākonga consider the IEA graduate attributes with explicit technical content most important, while the attributes with a higher proportion of professional/social skills are considered less important.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

It is recommended that a workshop is developed for ākonga on the IEA graduate attributes and the importance of each in an engineering context. It is also recommended that discussion about the IEA graduate attributes be better integrated into courses. As the preliminary study has been completed, the researchers intend to extend the work to a longitudinal study to see if changes to the teaching of the IEA graduate attributes change ākonga impressions of them.

KEYWORDS

Graduate Attributes, New Zealand, Polytechnic, Ākonga (Student) Perceptions

Introduction

The researchers wanted to know which attributes ākonga (students) consider highly valuable and which they consider less valuable. There was anecdotal evidence that ākonga value graduate attributes with a high level of technical knowledge over those with a perceived high level of professional skills or knowledge. The researchers investigated this phenomenon to inform their interactions with ākonga and their teaching methods and practise.

The study was conducted by staff at Otago Polytechnic, a New Zealand tertiary-level education provider. The Engineering Technologies department offers certificate, diploma, and degree level qualifications. This paper focuses on ākonga who have started their study for either the two-year Level 6 New Zealand Diploma of Engineering (NZDE) or the three-year Level 7 Bachelor of Engineering Technology (BEngTech). The NZDE and BEngTech are accredited under the IEA Dublin Accord and IEA Sydney Accord, respectively. Engineering disciplines offered in both the NZDE and BEngTech include Civil, Electrical and Mechanical engineering. The typical cohort size per discipline for NZDE is 15-25 students, while the BEngTech is 5-15.

As with many careers, what it means to "be an engineer" is constantly changing as modern technology and practice progress. Traditionally, engineering education has focused heavily on problem-solving and technical aspects, while professional skills like communication and teamwork are often considered byproducts of the course and education environment.

Literature Review

Scott and Yates (2002) carried out research with 20 Australian University Engineering graduates from multiple engineering specialities, including Civil, Electrical, and Mechanical. The graduates had been identified as successful by their employers and were early in their careers, having been employed for 1-6 years. The study referred to 49 capabilities categorised into groups, including emotional intelligence and profession-specific skills and knowledge. Findings showed that capabilities which fell within the emotional intelligence category were scored as the most important (Scott & Yates 2002). The researchers found that intelligence based on nonlinear thinking, for example, problem-solving when something goes wrong, scored highly and concluded that participants found the combined effect of emotional intelligence and problem-solving the most important.

Law et al. (2016) surveyed engineering graduates from New Zealand polytechnics and institutes of technologies (collectively referred to as ITPs) and New Zealand universities. Their online survey adapted the tool used by Scott and Yates (2002) to include the capabilities of Level 6-8 engineering qualifications with questions aligned to Graduate Attributes. Eight of the top 12 skills from Scott and Yates (2002) were also in the top 12 for the respondents of Law et al. (2016).

There were differences in scoring between ITPs and university respondents, and individually, each group had only seven top-12 items in common with Scott and Yates. Differences in career expectations and responsibilities, especially those of Level 6 NZDE graduates, could explain these differences. For example, "Being willing to take responsibility for projects, including how they turn out" had a lower ranking of 18 for ITP respondents compared with 6 or 7 for University graduates from both studies. Both groups ranked a mixture of emotional intelligence and technical-based skills highly, clearly seeing the importance of both.

Otago Polytechnic graduate surveys allow graduates to provide comments in response to the best aspects of the programme, suggestions for improvement and reasons for not recommending the programme. These surveys are managed and compiled at an institutional level, so programme specific content like graduate attributes are not surveyed. While they were not directly surveyed about IEA graduate attributes, many comments can be linked to them, and strong positive or negative impressions can be seen. About half of engineering programme

responses specifically mentioned learning practical and industry relevant skills in positive feedback. Practical and industry relevant skills were the most commented on in positive and negative feedback. Communication skills were mentioned, but less often - usually in positive feedback. Training in ethics and environmental issues was not mentioned at all.

Both Scott and Yates (2002) and Law et al. (2016) found that early-career engineering graduates know the importance of both professional and technical skills. However, current graduates still appear to be more concerned with technical skills (noting they were providing feedback, not being surveyed about these things directly). While teaching, the researchers observe that ākonga see the importance of technical skills but do not always see the value and relevance of professional skills.

When reviewing the recent introduction of a graduate attribute-based approach in university engineering programmes in Bangladesh as part of provisional Washington accord accreditation, Haque et al. (2023) found that not all institutions recognised the need for student engagement in implementing graduate attributes. The respondent who recognised this was important was successfully accredited, noting that "unless faculty members, students and authority were all on-board, it was difficult to realise the desired changes".

Overall, the existing literature supported researchers' observations and provided a platform for designing the research tool. The literature also suggests that the further along the process of studying, qualification completion, and then establishment in an engineering career someone gets, the more they see the value in professional skills.

Methods

Data Collection

The data collection consisted of sending a survey to first-year ākonga (n = 53) across the three disciplines via the online tool Qualtrics. This was the first year in which the survey was conducted, and it was conducted during a two-week window during the final part of the first semester when ākonga were preparing for their exams. This may have affected the response rate. The project was approved by Otago Polytechnic | Te Pūkenga Research Ethics Committee, approval number 1030.

The survey consisted of 13 questions about the respondents' opinions of the 12 IEA graduate attributes, their engineering background, specialisation, and level of study.

Respondents were asked to select up to three graduate attributes each for the following criteria:

- Most important for their first engineering position
- Least important for their first engineering position
- Most excited about learning in their study
- Least excited about learning in their study

The ranking questions were drag-and-drop, with each ranking followed by open-ended questions, giving respondents space to provide explanations or context for their selections. Multiple choice questions were also used to identify ākonga study levels, disciplines, and if they had previously worked in an engineering-related role. The survey took approximately 10 minutes, and ākonga were not required to answer all questions. No incentives or rewards were offered to ākonga as part of this process.

Data analysis

Given the response rate, a statistically meaningful conclusion from this data set was not possible. Thirteen surveys were completed, giving a response rate of 24.5%. A thematic analysis was

performed on open-ended responses to inform future study design, and respondents were sorted according to engineering discipline.

Results

Table 1 below shows the breakdown of respondents' qualifications and specialisations. It shows a good balance between BEngTech and NZDE ākonga. The response rate of those studying Mechanical engineering was low.

Table 1: Specialisation and Qualification

Specialisation (Number of ākonga, #)	**Qualification** (Number of ākonga, #)
Civil Engineering	3-Year degree (BEng Tech)
4	7
Electrical Engineering	2 -Year diploma (NZDE)
7	6
Mechanical Engineering	
2	

Tables 2 and 3 below show the 12 IEA graduate attributes and the number of ākonga who put them in the most/least important and most/least excited categories, respectively. All specialisations are combined, but the responses have been split into diploma and degree to see if there was a difference between the two qualification levels. Differences in totals between the columns are because respondents could select 0-3 attributes for each criterion. This has resulted in differences between the number of responses for 'least important' and 'least exciting' attributes, as some ākonga did not select three attributes each time.

Table 2: Survey Results: Number of Ākonga ranking "Importance of the Graduate Attribute in first engineering position"

	Most Important Attribute		**Least Important Attributes**	
Graduate Attribute	Diploma	Degree	Diploma	Degree
Engineering Knowledge	5	5	0	0
Problem Solving	6	6	0	0
Design/Development of Solutions	1	2	1	0
Investigation	0	0	3	2
Modern Tool Usage	0	3	3	0
The Engineer and Society	0	0	1	6
Environment and Sustainability	1	0	4	3
Ethics	0	0	3	2
Individual and Team Work	1	2	1	1
Communication	0	3	1	2
Project Management and Finance	2	0	0	4
Lifelong Learning	2	0	0	1
Total	**18**	**21**	**17**	**21**

Table 3 indicates that the ākonga find 'Engineering Knowledge' and 'Problem Solving' the most important attributes in their first engineering position. In contrast, 'The Engineer and Society' and 'Environment and Sustainability' are considered the least important. The table also shows that the ākonga find 'Engineering Knowledge' and 'Problem Solving' as the attributes they are most excited to learn, and 'Communication' and 'Ethics' provide the least exciting topics.

Table 3: Survey Results: Number of Ākonga ranking "Excitement for learning about the Graduate Attribute in study"

	Most Exciting Attributes		Least Exciting Attributes	
Graduate Attribute	Diploma	Degree	Diploma	Degree
Engineering Knowledge	5	5	0	0
Problem Solving	5	5	0	0
Design/Development of Solutions	2	4	1	0
Investigation	0	0	2	1
Modern Tool Usage	4	4	0	0
The Engineer and Society	0	0	0	2
Environment and Sustainability	0	0	2	4
Ethics	0	0	4	5
Individual and Team Work	0	1	2	0
Communication	0	0	4	3
Project Management and Finance	2	1	1	4
Lifelong Learning	0	1	1	1
Total	**18**	**21**	**17**	**20**

Table 4: Graduate Attributes Proportion Comparison

Graduate Attribute	Technical Skill	Professional and Societal
Engineering Knowledge	100%	0%
Problem Solving	75%	25%
Design/Development of Solutions	75%	25%
Investigation	75%	25%
Modern Tool Usage	100%	0%
The Engineer and Society	50%	50%
Environment and Sustainability	50%	50%
Ethics	25%	75%
Individual and Team Work	25%	75%
Communication	25%	75%
Project Management and Finance	25%	75%
Lifelong Learning	50%	50%
Total	**56%**	**44%**

The research team developed Table 4 amongst themselves to show the proportion of technical and professional/societal skills within each graduate attribute. The team assessed each attribute and ranked its technical and professional/societal impact. Table 4 shows that they consider five attributes to be highly technical (≥75%), and four are highly Professional/Societal. Three attributes are assumed to have a balanced focus. This table is not taken from external sources or acknowledged by the IEA.

Thirteen respondents completed at least some of the long answer questions, providing additional context to their selections. Eight of them completed all four of the questions explaining their rankings, and three completed three of the four questions. One student gave very long responses that appeared to be aided by an AI assistant. The response supported by AI was disregarded; all other responses were thematically analysed for recurring themes.

Most respondents considered technical skills important because they believe this is what engineers do. Some felt little other explanation was necessary "*because the main purpose of being an engineer is to solve problems and find solutions"* and "*the whole premise of being an engineer is to solve real world problems within an engineering context*". Two mentioned financial incentives. While there was a strong emphasis on technically based graduate attributes, about a third of respondents also saw the importance of professional and societal skills.

When asked why they had selected attributes as less important, four respondents said they thought the graduate attributes were all important, but some were not as important. One also said this in response to a later question. Eight respondents either directly ranked professional and societal attributes as important or acknowledged that all graduate attributes were at least somewhat important.

When asked which graduate attributes are the most exciting, few respondents seemed to factor their future careers into the decision, with almost all respondents finding the selected attributes personally rewarding. Modern Tool Usage and Problem Solving were common themes for this. "*They're probably not the most important as far a* [sic] *getting a job but they are what interest me most.*" was the response that most clearly showed this. It would be reasonable to conclude these first-year respondents are reporting based on the interests that brought them to study engineering in the first place.

Again, the personal dominated when considering which attributes they were the least excited to learn about. Attributes that respondents thought would be boring, already knew to be boring or were otherwise uninterested in learning were selected as least exciting. The attributes chosen as least exciting aligned with the attributes that the researchers consider to have a high proportion of professional/societal skills, as shown in Table 4 above with comments like "*It sounds like a lot of talking and spreadsheets*". Two respondents specifically mentioned the challenges of working in a team. Two respondents stated it is unnecessary to learn some professional and societal graduate attributes; both selected communication and ethics as unexciting.

Interestingly, the only respondent who has worked in an engineering-related field sees the importance of professional skills: "*Professionalism of* [sic] *overlooked in my opinion. Timeliness, how you present yourself etc are not displayed by a lot of fellow students*."

This was the research team's first attempt at qualitative research which impacted the quality of the research tool. Surveys were sent out while ākonga were preparing for exams and were open during a limited time frame. Because of the advancing deadline, the promotion and communication about completion was quick.

Discussion

As shown in the survey results of Table 2, engineering ākonga value the highly technical attributes while largely disregarding some of the more professional/societal attributes. This aligns with lecturers' perceptions and informal discussions with the ākonga during their first years of study. However, most respondents either listed at least one professional/societal attribute as important or later said that all graduate attributes were somewhat important. This does not detract

from the strong emphasis on technical attributes being regarded as the most important and exciting by most respondents. As noted in the introduction, early career engineers value both technical and professional skills. New graduates still appear to find technical-based skills more important but are very much focused on industry relevance.

With this in mind, the research group plans to continue beyond this preliminary investigation. An improved research tool, better planning, larger sample size, and other data collection techniques will be used to provide a more comprehensive data set, allowing for meaningful statistical analysis. We hope to understand how the ākonga perceptions of the attributes evolve over their study. An obvious future avenue of study is to look at how these perceptions might change once an ākonga has a full-time position in industry after 1, 5, and 10-year intervals. Other areas of interest could also involve understanding if there are any differences between final year NZDE and BEngTech ākonga at the end of their studies.

Research on local industry perceptions of graduate attributes would add valuable scope to this study as this is where many of the ākonga find employment. Some of the more professional/societal attributes might be more valued by industry. Finding ways to convey this information to learners via industry representatives might help increase ākonga engagement on the less technical attributes. Increasing and improving industry engagement would also help build a better student experience.

Industry feedback regarding the importance of the various graduate attributes could also help design courses which maximise 'work-readiness' in our graduates. For example, only 3 out of 13 respondents chose 'Communication' as a ‘most important’ attribute, and 3 chose it as a ‘least important’ attribute. The researchers expect that a more comprehensive study involving industry views would find communication skills more important than several more technical attributes.

This research question emerged from the Australasian Association for Engineering Education Winter School Program. This paper hopes to begin assessing graduate attributes in New Zealand and equip the research team with new skills and an understanding of new research techniques. The results suggest that the team has achieved all of these aspects.

The research team consists of educators working within vocational engineering education. Their backgrounds include engineering, mathematics, communication, and research. While we have attempted to analyse the results of this work without bias, we acknowledge that we have approached this work through an education and research lens, and our own personal experiences and values may have impacted the interpretation of our results.

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