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The Role of Mindsets in the Acquisition of Job-ready Skills

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ABSTRACT

CONTEXT

Engineering schools have wanted, for decades, to create graduates with high employability skills. While educators have been studying this for a long time, they have been much less successful at delivering employability skills than technical skills.

PURPOSE

This study examines whether teaching employment-related mindsets as part of skills delivery facilitates better employment outcomes among engineering alumni. It also examines the viability of delivering those mindsets and skills through a subject which appears to students on entry to be about something completely different – how to innovate. Empirically, we examine the extent to which learning of specific professional mindsets affects the employability of engineering graduates.

METHODS

We analyse responses by 99 alumni of the subject Creating Innovative Engineering at the University of Melbourne. Alumni were surveyed six months to five years after graduation. We asked the extent to which the subject changed their thinking on four dimensions (Growth Mindset, Value Orientation, Entrepreneurial Mindset, Relationship Orientation), and the extent to which the subject helped them clarify their career aspirations, get a job, and perform in their work. We used Latent Profile Analysis to divide the respondents into low and high mindset groups. Then using Cohen's d statistic on 1000 bootstrapped samples, we tested whether mindset predicted the three outcome variables.

OUTCOMES

Alumni in the high mindset group reported that the subject helped them to clarify their career aspirations to a greater extent ($p<0.01$)

Alumni in the high mindset group reported that the subject helped them in the process of getting a job to a greater extent ($p<0.01$)

Alumni in the high mindset group reported that the subject helped them to be effective in the workplace to a greater extent ($p<0.01$)

CONCLUSIONS

The findings confirm that students are more likely to learn employability skills if they are also taught mindsets that make them meaningful, valuable, and easier to learn. They also confirm the viability of a teaching approach designed to bypass barriers to learning.

KEYWORDS

Employability mindsets skills

Introduction

Employers across many industries, including engineering, prioritize graduates with strong communication, interpersonal, and teamwork skills. They also value initiative, enterprise, resilience, emotional intelligence, self-management, and leadership abilities (McCrindle Research Pty Ltd, 2023). Moreover, highlighting the interdependence of engineering knowledge and professional skills can enhance students' long-term employability (Winberg et al., 2018).

Recognizing that professional and employability skills have become crucial for graduates' career prospects, engineering educators has increasingly emphasized them (Kaushal, 2016; Nilsson, 2010; V. Saravanan, 2009) by integrating professional skills training into engineering curricula.

Engineering schools have had limited success improving the employability skills of their graduates (Leandro Cruz & Saunders-Smits, 2022; Male & King, 2019; Nair et al., 2009). Researchers have proposed many explanations, including inappropriate pedagogical methods, capability deficiencies of faculty members (Rao, 2014; Winberg et al., 2018), logistical challenges (Winberg et al., 2018), and curriculum design challenges (McHenry & Krishnan, 2022; Winberg et al., 2018).

However, when we examine the approaches that appear to be more successful -- subjects combining academic and commercial perspectives, focusing on real-world problems, and fostering students' self-awareness of their skills (Pulko & Parikh, 2003; Shekhawat & Bakilapadavu, 2017; Winberg et al., 2018) – we are pointed toward an alternative explanation. This study is based on the proposition that engineering students don't learn professional skills because they value other things more (Kolmos & Holgaard, 2019). We posit that their mental model of a professional engineer under-values those skills. They lack an appropriate mindset. As a result, when given a task designed to help them develop professional skills, they subvert it in favour of objectives they value more (e.g. saving time, conflict avoidance, high marks). For example, at the authors' institutions, when given a technical task in the form of a team project, stronger students often marginalise weaker students and those with poor English and just do the core of the project themselves, bypassing the teamwork learning opportunity.

In this paper, we evaluate a subject designed to test this proposition. Specifically, in the subject Creating Innovative Engineering (CIE) at the University of Melbourne, the syllabus is built around a project that is highly valued by those with a traditional technical mindset (learning how to innovate by working on a strategic challenge for an external sponsor). However, it is taught in such a way that the students are more likely to succeed if they develop particular skills – which happen to be the skills they need to become more employable. Furthermore, rather than teach the skills explicitly, the students have access to resources to help them learn them, are exposed to stimuli that give them feedback on whether they are learning them, and are taught a mindset that makes learning and demonstrating them easier. The mindset also reframes the students' nascent professional identity in a way that makes it obvious that they should want to learn the professional skills, and, not surprisingly, is a mindset that makes them more employable. The mindset we teach has five components -- an entrepreneurial mindset, a growth mindset, a relationship orientation, a value orientation, and an ethical compass. These are discussed below.

This paper reports on a survey of 99 engineering alumni who graduated and joined the workforce between six months and five years prior. We report on students' responses to questions about how the subject changed the way they think and how it impacted three key employability outcomes – their confidence in their career choice, their ability to get a job, and performance in that job. This allows us to address a key question of interest to engineering educators: *To what extent does teaching specific professional mindsets affect the employability of engineering graduates?*

Background

Professional skills development in Engineering Education

Engineering education has increasingly incorporated various approaches to develop students' employability and professional skills alongside technical knowledge. For instance, some institutions have introduced dedicated courses focused on organisational management and professional skills development into their engineering curricula (Shekhawat & Bakilapadavu, 2017). These courses integrate topics from psychology, management, and economics to support professional skill development. Project-based learning is another popular approach, with both entrepreneurship and design courses utilising this methodology to cultivate professional skills. These courses have shown positive impacts on students' creative self-efficacy and entrepreneurial self-efficacy, although their effects on risk-taking abilities were limited (Woodcock et al., 2019). Other initiatives include incorporating leadership education into engineering course structures (Pulko & Parikh, 2003). Additionally, flipped learning models have been employed to enhance students' communication skills, critical thinking, and creativity (Karabulut-Ilgu et al., 2018). These approaches often involve problem-based learning and teamwork assignments, going beyond simple video-watching to develop a range of professional skills. Some institutions have also introduced audit courses focusing on multidisciplinary domains to provide holistic education (Shekhawat & Bakilapadavu, 2017). These courses cover areas such as foreign languages, performing arts, and personality development, aiming to foster innovative and creative mindsets. Despite these efforts, challenges remain in effectively integrating professional skills with technical core subjects and engaging students in professional skills development (Winberg et al., 2018).

Professional mindsets and skills

Engineering students have been found to need support to understand engineering roles and the value of their engineering education to their future, and to suffer from a fixed mindset (Male & Bennett, 2015). We define mindsets as "the sum of your knowledge, including beliefs and thoughts about the world and yourself in it. It is your filter for information you get in and put out. So it determines how you receive and react to information" (Thum, 2012). Our mindsets can be influenced by conscious awareness and through our experiences and exposures, whether deliberately or inadvertently (Bosman & Fernhaber, 2018). We posit that mindsets shape skill formation by making it meaningful and valuable.

The five components of the mindset taught in CIE are valuable for effective innovation delivery. Importantly, they are also consistent with valuing and developing skills sought by employers and program accreditors (Engineers Australia, 2019; McCrindle Research Pty Ltd, 2023).

A *growth mindset* is a belief that one's abilities and intelligence can be developed through effort (Dweck, 2006). It can be contrasted to a fixed mindset – the belief that intelligence or abilities as fixed. While studies have shown that growth mindsets are linked to engineering student performance (see Campbell et al., 2021) we emphasise a growth mindset to mobilize students to believe they can take on the other components. We initially suspected, and have observed in many of their reflective essays, that students are often quite defensive about their abilities. They study from a position of weakness, not strength. They focus and identify with things they are confident they will not fail at -- the technical subjects. Absent a growth mindset, they will avoid the other components. An *entrepreneurial mindset* is the inclination to discover, evaluate, and exploit opportunities (Bosman & Fernhaber, 2018). This mindset is essential for students to empower themselves and take ownership of their careers and professional development, rather than delegate it to their employer. A *relationship orientation* emphasises the importance of interpersonal skills and collaboration. In CIE, we emphasise that engineering projects are increasingly interdisciplinary, intercultural and interorganisational, and so they are delivered by people who work and communicate effectively in teams, not just technical experts. Fourth, we teach a *value-orientation* to help student understand that people hire them to create value, potentially through technical problem solving, not for technical ability in and of itself. Finally, we encourage students to consider building their career within a framework of personal and professional values that will create an ethical framework for their work (Nilsson, 2010). Only the first four components are examined in this study because the ethical compass was added to the syllabus after most of the respondents completed the subject.

We believe that skills are generative. That is, when people learn skills, they do not learn specific behaviours. Rather, people deliver skills by understanding situations and then generating context-relevant behaviours *de novo,* drawing from a repertoire of rehearsed behaviours. The mindset makes it meaningful and motivating to learn the skill and makes it easier to recognise relevant situations and deliver the skill.

Subject design

CIE is built around two simultaneous projects, an industry-sponsored innovation project and a personal innovation plan. In the industry project, teams of 4-6 students work alongside a mentor and an industry sponsor to develop a proposal for a product, service, or organisational change. The innovation projects are engaging, large, complex, ambiguous and require human-centred design. To succeed, students must organise and conduct interviews, demonstrate professional empathy, work effectively in a multidisciplinary team, resolve conflicts, present their work in various ways, and consider strategic/business and ethical issues for the sponsor organisation. We also teach that the industry project is a metaphor for the way they will need to innovate themselves as their goals and the environment changes throughout their careers. Students write seven weekly reflections. They also give a peer feedback on each reflection (and receive) – developing feedback skills and encouraging conversations. These all provide data for their Personal Innovation Plan, which they submit at the end of the semester.

In the classroom, students are taught the five mindsets, and these are embedded through classroom exercises, LMS materials, assessments, and interactions with their mentor, sponsor, innovation consultant and instructor. They are also taught specific concepts (e.g. the role of defensiveness in conflict resolution) and given simple tools (e.g. a tool for quickly analysing team process) to help them learn employability skills.

Methods

Participants

Here we report on 99 Master of Engineering alumni (71% male, 29% female) who graduated between one and five years prior to data collection. All participants provided written consent to be included in the study, consistent with the project's human research ethics approval.

Measures

Alumni were invited via email in 2023 to participate in a Qualtrics study examining the impact of CIE. Here we report on their responses to a four-item Mindset scale probing the extent to which students' four mindsets (i.e., growth, entrepreneurial, relationship and value-orientated) changed from the CIE experience. (e.g. "I changed as a result of my CIE experience: (1=not at all, 5=to a great extent): I embrace things that seem unfathomably hard as learning opportunities (i.e. I have grown my growth mindset)") and a three items probing the extent to which the CIE experience helped them clarify their career aspirations, helped in the process of getting a job, and supported job performance (1 = *not at all*; 5 = *to a great extent*) (e.g. "My CIE experience helped me to clarify my career aspirations (i.e. confirm I was on the right career trajectory, or realise that I needed to change it.")

Analytic strategy

We conducted a latent profile analysis (LPA) to identify groups of individuals with similar patterns of relationships between variables. This person-centred approach focuses on how variables collectively manifest within individuals rather than analyzing variables individually (Geiser, 2012). The LPA process involves trying a series of models with increasing numbers of classes, comparing each model with the previous one. Once the optimal model was determined, we examined classification reliability, named the resulting classes, and made individual class predictions (Wang & Wang, 2019).

Classification reliability is indicated by the entropy value, which ranges from 0 to 1, with values close to 1 indicating good classification (Clark, 2010). Various statistical criteria can be used to compare LPA models, including Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC)(Schwarz, 1978), entropy, and likelihood ratio tests (Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMRLR), Lo-Mendell-Rubin Adjusted likelihood ratio test (LMRLR). However, simulation studies suggest that BIC provides the best results when determining the number of class comparison models (Geiser, 2012). It is crucial to consider the posterior probabilities of profile membership, which show the likelihood of an individual belonging to a specific profile. These probabilities should ideally be at least 70% to ensure accurate profile assignment. To identify distinct profiles, it's important to evaluate the average scores of each variable. Differences between profiles can be compared using variance analysis, with profile membership as the independent variable and the profile-creating variables as dependent variables (Stanley, 2022).

Field (2024) recommends using bootstrap confidence intervals regardless of assumptions about normality. Given this, for comparisons across employment outcomes, we conducted group comparisons using 1000 bootstrap samples, calculating confidence intervals using the Bias-corrected and accelerated (BCa) method in SPSS 29. To determine the effect size of the difference between means, we used Cohen's d statistic (Cohen, 2013). A value of 0.2 to 0.5 indicates a low effect, 0.5 to 0.8 suggests a moderate effect, and 0.8 or higher signifies a high effect. Additionally, we computed BCa bootstrap 95% confidence intervals for the Cohen's d statistic value.

Results

After analysis, there were no concerns with the skewness and kurtosis of the data (see Table 1). Latent profile analysis was conducted with four mindset items. We compared several LPA models with 2, 3, 4, 5 and 6 classes in MPLUS 8.10 (Muthén & Muthén, 2017). Relative Model Fit Index and Information Criteria for the Mindset are present in Table 2. Figure 1 presents the AIC, BIC, SABIC and Entropy values from the table.

Table 1: Descriptive statistics

Mindset variables	Mean	SD	Skewness	Kurtosis	Correlations		
					GM	VO	E
Growth mindset (GM)	3.48	1.25	-.58	-.61			
Value Orientation (VO)	3.69	1.24	-.98	.02	.56**		
Entrepreneurial (E)	3.56	1.39	-.63	-.87	.57**	.64**	
Relationship Orientation (RO)	3.35	1.31	-.44	-.92	.64**	.64**	.52**

**correlations are significant at the $p < 0.01$ level (2-tailed).

Table 2 indicates a two-class model is the most appropriate. The BIC value suggests the two-class model is optimal. This conclusion is supported by the two likelihood ratio tests (VLMRLR, LMRLR). The classification reliability of the two-class model was found to be .95. These values correspond to near-perfect entropy values (Clark, 2010).

Table 2: Relative model fit index and information criteria for mindsets

Sequential model comparisons	AIC	BIC	SABIC	Entropy	VLMRLR	LMRLR
1-class LCA	1319.74	1340.5	1315.24	N/A	N/A	N/A
2-class LCA	1162.24	1195.97	1154.92	0.95	<0.01	<0.01
3-class LCA	1152.38	1199.09	1142.24	0.87	0.82	0.82
4-class LCA	1139.18	1198.87	1126.23	0.90	0.14	0.14
5-class LCA	1131.40	1204.06	1115.64	0.83	0.23	0.23
6-class LCA	1127.61	1213.24	1109.03	0.85	0.45	0.45

Note: AIC Akaike Information Criteria, BIC Bayesian Information Criteria, SABIC sample-size-adjusted BIC, LMRLR Lo-Mendell-Rubin Adjusted likelihood ratio, VLMRLR Vuong-Lo-Mendell-Rubin likelihood ratio.

The probabilities for most likely latent class membership for alumni assigned to the first class was 0.98, and the second class was 0.99. These values fulfil the criterion that the average latent class probabilities should be 0.70 or above for the average latent class probabilities for the most likely latent class membership (Stanley, 2022). These results show high latent classification accuracy, or more plainly, the alumni separated cleanly into two classes. One class (Class 1) included about 23% of the alumni. They clustered around one constellation of scores across the four mindset measures (Low Mindset); The other, High Mindset (Class 2) included 77%.

Alumni with high mindset profile differed significantly from those with low mindset profile according to growth mindset, value orientation, entrepreneurial and relationship orientation (all Cohen's d > 1.67).

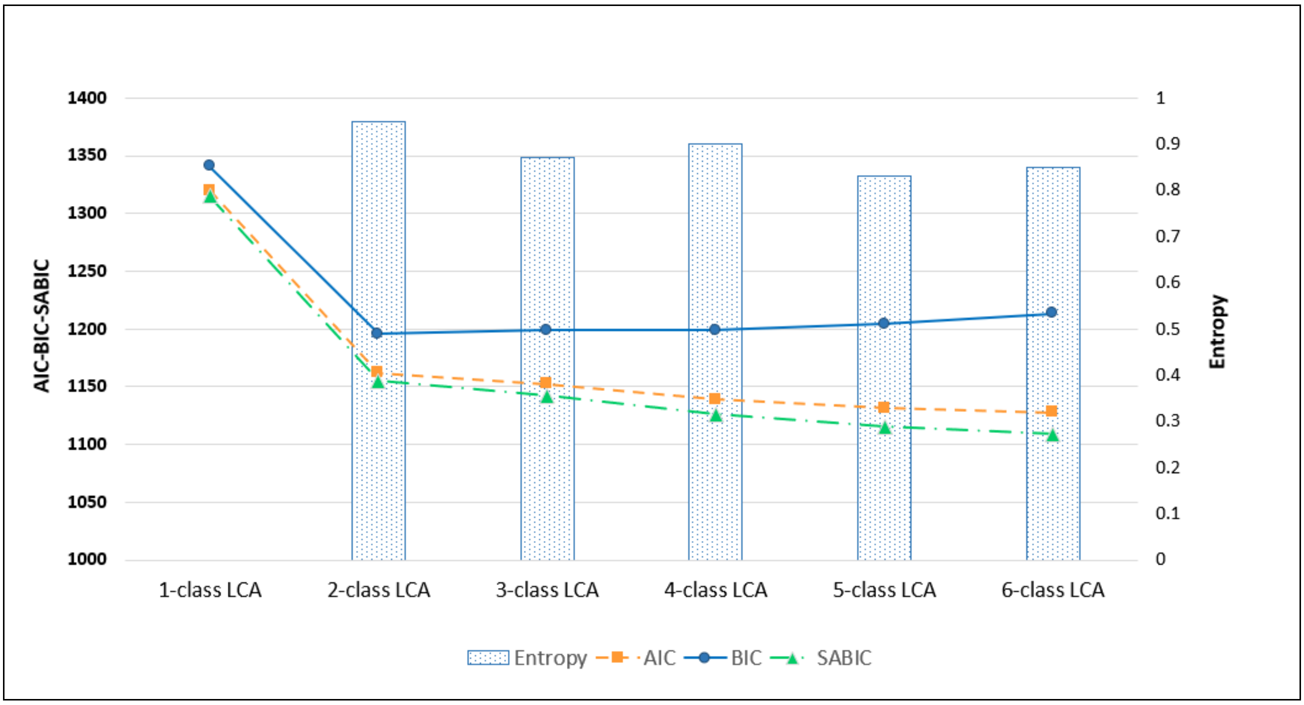

Figure 1. The AIC, BIC, SABIC and Entropy values for a 1 to 6 profile models.

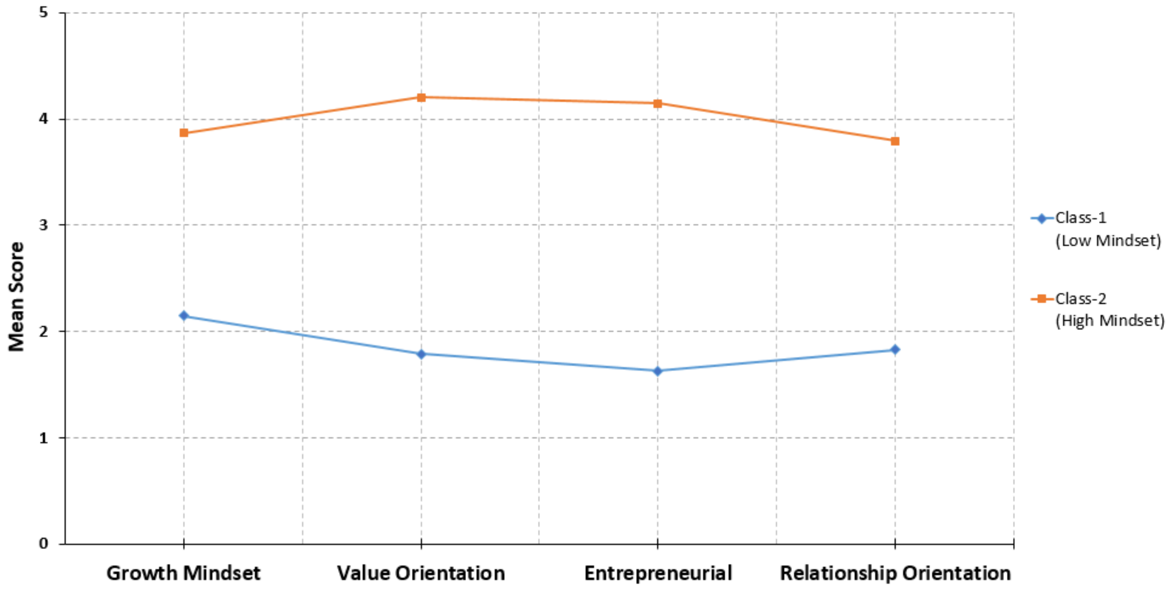

Figure 2: Mindset as a predictor of class membership

Table 3 compares alumni with different mindset profiles with respect to the three employment outcomes. Alumni with the *High Mindset* profile (M= 3.27, SE=.14) reported greater *Career Clarity* than alumni with a *Low Mindset* profile (M= 2, SE=.28). This difference was 1.27, BCa 95% [.60, 1.81], *t*(76)= 3.85, *p*<.01, Cohen's *d*= 1.14 [.53, 1.74].

Alumni with the *High Mindset* profile (*M*= 3.66, *SE*=.16) reported greater *Getting a Job* scores than alumni with the *Low Mindset* profile (*M*= 2.21, *SE*=.38). This difference was 1.44, BCa 95% [.58, 2.21], t(76)= 3.754, p<.01, Cohen's *d*= 1.11 [.50, 1.71].

Alumni with a *High Mindset* profile (*M*= 3.81, *SE*=.13) reported higher *Job Performance* than alumni with a *Low Mindset* profile (M= 2.5, SE=.33). This difference was 1.31, BCa 95% [.68, 1.92], *t*(76)= 4.152, *p*<.01, Cohen's *d*= 1.23 [.61, 1.83].

Table 3: Comparisons of employment outcomes according to mindset profiles.

Employment outcomes	High Mindset *M (SD)*	Low Mindset *M (SD)*	*p*-value*	Cohen's *d* (95 % CI)
Career clarity	3.27 (1.13)	2.00 (1.04)	<.001	1.14 (.53, 1.74)
Getting a job	3.66(1.28)	2.21(1.42)	.002	1.11 (.50, 1.71)
Job performance	3.81(1.04)	2.50(1.22)	<.001	1.23 (.61, 1.83)

Note: SD =Standard deviation; CI–BCa bootstrap confidence interval; *t-Test with bootstrap.

Discussion and conclusion

99 alumni of the subject CIE at the University of Melbourne were classified as low or high mindset, depending on the extent to which they said that they changed four mindset components as a result of taking the subject. Those in the high mindset group reported that the subject experience helped them clarify their career aspirations to a greater extent (p<0.01), that the subject helped them in the process of getting a job to a greater extent (p<0.01), and that the subject helped them to be effective in the workplace to a greater extent (p<0.01).

This allows us to draw two important conclusions. First, consistent with prior theorising, helping students develop a mindset (or grow a pre-existing mindset) compatible with desirable employment outcomes leads to higher performance on key measures of employability. We presume that students become more motivated to learn the skills because they are more confident they can learn them (in the case of a growth mindset) and because the skills become more meaningful (for the other three). Also, because professional skills are generative – people recreate them whenever they enact them – having a well-embedded mindset makes it easier to enact and improve them.

Second, the study demonstrates the viability of a particular pedagogical approach for overcoming an obstacle we posit obstructs learning professional skills. While students will say they value learning professional skills, they value other things more. Those other things obstruct attempts to teach professional skills. Therefore, rather than teaching the skills directly, we teach them about something else that they value highly (innovation). At the same time, we make it much harder to succeed without demonstrating those skills, and give them resources and activities to scaffold self-directed learning. At the same time, we teach the relevant mindsets to help students make sense of their experience and motivate their learning.

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