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Students' Views Of Taught Professional Competencies: Investigating The Impact Of Previous Work Experience

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STUDENTS' VIEWS OF TAUGHT PROFESSIONAL COMPETENCIES: INVESTIGATING THE IMPACT OF PREVIOUS WORK EXPERIENCE

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ABSTRACT

The ability of Engineering graduates to function as successful professionals depends not only on technical disciplinary knowledge but also on a wide range of professional competencies. Students' reactions to the teaching and assessment of these competencies are often negative. An ongoing study by the authors has been exploring the nature of these reactions and in particular, the various factors that contribute to students' views on the teaching of professional competencies. A preliminary factor analysis showed that students' level of professional experience was a key factor in shaping variations in their views. In this paper, we explore this issue in more depth. For example, when asked on the pair of survey questions "do you agree or disagree that each competency type [professional / technical] should be a core component of your Engineering degree program", the impact of increasing professional experience on the average response was only marginally greater for professional competencies than for technical competencies. In contrast to this, when asked the pair of questions "for each competency type [professional / technical] indicate whether it is easier to learn it at University or at work", the analysis of the responses shows that as the level of experience increases, there is a small shift for technical competencies towards being taught at University, whereas for professional competencies, there is a significantly greater shift towards being taught in work environments. We explore these, and other related findings, and consider their implications for the design and delivery of engineering degree programs.

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1 INTRODUCTION

1.1 General Context

It has long been recognised that the ability of new Engineering graduates to function as successful professionals depends not only on their technical knowledge, but also on a wide range of “professional competencies” (Scott and Yates 2002). Consequently, most Engineering degree programs have at least some focus on the teaching of these competencies. Indeed, the Washington Accord (and hence the various national accrediting bodies) explicitly include related learning requirements (e.g. ABET 2011; Engineers Australia 2018; UK Engineering Council 2014).
Beyond just a need for specific professional competencies, there is also a growing recognition that graduates need to integrate their technical expertise and their broader professional skills development into a coherent integrated whole (Crosthwaite 2019; Passow and Passow 2017). This has been acknowledged in various reviews of Engineering Education (e.g. Graham 2012; King 2008) and is also reflected in the emergence of a range of “integrated engineering” programs into engineering curricula (Bates et al 2022).

1.2 Professional Experience

Possibly the most common approach to developing an integrated professional capability within engineering programmes (across a wide range of disciplines) has been the use of internships, practicums, or industry placements (Ryan, Toohey and Hughes 1996). This is potentially related to both accreditation requirements and the long history of related research into the impact of exposure to, or engagement with, professional practice. In terms of the former, accreditation bodies often suggest (either explicitly or implicitly) that time spent directly in industry settings are a preferred approach. For example, the Engineers Australia (EA) accreditation criteria refer specifically to “workplace placements” (without making it mandatory):

> *“Student engineers need in addition to knowledge, formative experiences of how engineering professionals: a) Think, work and continually learn … EPP must culminate in a set of meaningful experiences that result in the habituation of professional working styles. … The outcome should be that student engineers are able to aggregate different experiences towards their portfolio of EPP. … The overall EPP experiences should enhance a graduate’s capacity to move with ease into a professional workplace.” (Engineers Australia 2018, 17-18)*

There is also significant research that explores the value of explicit industry engagement. In many cases, this goes further and argues that full development of professional expertise can only be developed in “practice” and hence academic programs on their own will not be sufficient (Dall'alba and Sandberg, 1996; Lenihan et al 2020).

1.3 Effects of Professional Experience on Student Views

There is a relatively large body of research (e.g. Martin et al 2005) into the impact of exposure to professional practice on student development of competencies. One significant gap relates to understanding the effect of this exposure on students’ *views* regarding the development of different competencies. There is significant evidence that suggests that students can react negatively to this development (Brookfield

2017). If students do react negatively, then it can lead to reduced student motivation and engagement, and hence inhibit achievement of the intended outcomes.

In designing educational activities related to the development of professional competencies, academic staff and programme leaders often make assumptions regarding why students might respond in certain ways. These assumptions can then drive (either explicitly or implicitly) our pedagogic approaches. As an example, if we were to assume that students largely believe that professional skills are important, but that they are better learnt in practice settings, then we might work to ensure that our educational approaches, beyond the inclusion of industrial placements, prioritise authenticity in practice activities.

In responding to these issues, the authors have been undertaking a large scale study exploring factors that influence student views on the learning of professional competencies. This research showed that students' level of professional experience had a significant impact on students reactions. It is therefore useful to analyse this specific driver in more depth. If we can understand the impact of professional experience in more detail, then we can potentially use this understanding to shape when and how we approach the development of these competencies.

Given the above observations, in this paper we explore the following question: to what extent do students' level of professional experience affect their views on the learning of professional vs technical competencies?

2 METHODOLOGY

A large scale survey of undergraduate and postgraduate students, and alumni, was carried out at The University of Sydney and University College London. The design of the survey was informed by existing literature on student reactions to professional practice, as well as an analysis of student feedback and reflections on the existing programs at the lead author's University.

Questions were framed around a set of 4 professional competencies and 4 technical competencies:

- Technical competencies
    - Understanding of underlying mathematics and science foundations
    - Technical knowledge associated with your particular field of engineering
    - Ability to clearly define and creatively solve open-ended problems
    - Ability to apply a systematic design approach addressing multiple perspectives
- Profession competencies
    - Understanding of how other disciplines (including business, law and social sciences) intersect with engineering
    - Skills in communicating in both technical/non-technical and both written/verbal forms
    - Ability to work effectively as a member of a team
    - An understanding of professional/ethical obligations and an ability to manage your own development

Specific question domains included seeking students' views on each of the following, with respect to these competencies:

- The quality of teaching of each competency
- The respondents' degree of interest in each competency
- The degree of difficulty in becoming capable in each competency
- Whether each competency should be taught within degree programs
- The respondents' perceived level of capability (both now, and at earlier stages)
- The importance of each competency at varying career stages
- The extent to which each competency is underpinned by rigorous theory
- Where it is easier to learn (academia vs industry) each competency

An initial survey was designed and then pilot tested with an initial cohort of 30 respondents. These respondents were then interviewed to assess their interpretation of the questions (assessing the construct validity). The survey was refined based on this evaluation, before being disseminated to students. The participants were recruited through broadcast announcements on student forums. Participation was anonymous and voluntary.

The resultant survey data was then analysed using an exploratory factor analysis (Costello and Osborne, 2005) to attempt to identify the underlying factors that were most significant in accounting for the variations in students' responses. (The detailed results of this analysis are currently being prepared for journal submission elsewhere). The exploratory factor analysis identified a set of dominant factors, but also suggested several patterns that warranted deeper investigation. One key area related to variations in student responses based on their level of previous professional experience.

3 RESULTS

3.1 Preliminary Analysis

After removing responses that contained incomplete data (e.g. where the survey was abandoned whilst incomplete) or erroneous data (e.g. where a respondent had clearly responded with the lowest response to all questions), this left N=339 responses. Demographic data on these respondents is given in Table 1.

Table 1. Demographic data on survey respondents.

	20 or younger	21 to 25	26 or older
Age	55.8%	38.4%	5.9%

	Female	Male	Other/rather not say
Gender	40.7%	58.4%	0.9%

	None	<1 month	1 month to <3 months	3 months to <12 months	1 year to <3 years	3 years or more
Level of (cumulative) exmployment experience (any type of employment)	14.8%	15.6%	17.1%	26.0%	17.4%	9.1%
Level of (cumulative) exmployment experience (professional employment)	69.0%	11.8%	5.9%	7.4%	1.5%	4.4%

In terms of participants' views, they were asked a series of questions about both technical and professional competencies, as follows:

Q1. Please indicate whether you agree or disagree that each competency type should be a core component of your Engineering degree program. (Likert scale: 1=Strongly disagree, 5=Strongly agree)

Q2: Indicate for each competency whether it is easier to learn it at University or at work. (Likert scale: 1 = Much easier at university; 2 = A little easier at university; 3 = About the same; 4 = A little easier at work; 5 = Much easier at work).

Q3: Theory vs practice: Put the list of 8 competencies given below into order starting at the top with the one that most needs an understanding of formal theory (rating=1), and ending at the bottom with the one needs the least amount of formal theory (rating=8).

Table 2 provides a summary of the results for these questions.

Table 2. Student views on professional vs technical competencies, and how this varies with increasing levels of professional practice.

*Q1: * Average score on likert scale (1=strongly disagree to 5=strongly agree);*
*Q2: ** Average score on likert scale (1=much easier at Univ to 5=much easier at work)*
*Q3: *** Average rank of competencies (1=most needs theory to 8=least needs theory)*

	Level of Professional experience					
	<1 month (N=274)	1-12 months (N=45)	>12 months (N=20)	<1 month	1-12 months	>12 months
	Professional competencies			**Technical competencies**		
Q1 * (should be core in degree)	4.28	4.49	4.50	4.53	4.71	4.70
Q2 ** (where easier to learn)	3.34	3.64	3.90	2.50	2.51	2.24
Q3 *** (does it require theory)	5.51	5.51	5.87	3.49	3.49	3.14

3.2 Students' views on whether technical and professional competencies should be core in the degree?

Looking at Q1 in Table 2, these results suggest that all students have a slightly stronger belief that the development of technical competencies should be a core component of their degree, than for professional competencies. This result is not particularly surprising. Similarly, this result shows that students with a greater level of professional experience tend to see greater importance of including both technical and professional competencies in their degree. Again, this may not be particularly surprising, and can probably be attributed to an increasing awareness by students of the need for various skills that arise from greater experience with professional practice. It is worth noting though that the level of professional experience required to change students' views is relatively low (1-2 months), and additional experience (>12 months) doesn't appear to lead to further change.

What is possibly more surprising is that the increase in the ratings are relatively similar for the delta between <1 month experience, and >12 months experience: 0.22 for professional competencies (statistically significant at $p=0.024$ using an unpaired t-test). vs 0.17 for technical competencies ($p=0.038$).

An argument that is often made is that exposure to professional practice will likely have a significant benefit in terms of assisting students in understanding the importance of professional competencies within their practice. These results suggest this impact may not be as significant as expected, and may not be substantially different from the impact on their understanding of the importance of technical competencies.

3.3 Students' views on where is it easier to learn technical vs professional competencies?

Considering Q2 in Table 2, the results for this question show a much more significant difference between professional and technical competencies. As the level of experience increases, there is a small shift for technical competencies towards being easier to be taught at University (though this is not statistically significant, p=0.24), whereas for professional competencies, there is a much greater shift towards believing that they are easier to learn within work environments (this shift is statistically significant, p=0.0073) . It is also worth noting that this shift occurs much more as the level of professional work experience increases (especially beyond the 1 year level). Of the 20 respondents with more than 12 months of professional experience, only 1 of them rated technical competencies as being easier to learn in a work environment, whereas 18 respondents rated professional competencies as being easier to learn in the workplace. It would be informative in a future study to investigate if the in-depth and fundamental learning of technical competencies at university as opposed to the more practical application of technical competencies often supported through the use of software tools in the workforce contributes to the small shift in technical competencies being easier to learn at university.

Table 3. Student views on where it is easier to learn professional and technical competencies

Average score on likert scale (1=much easier at Univ to 5=much easier at work)

	Level of professional experience		
Professional Competencies	**<1 month**	**1-12 months**	**>12 months**
Interdisciplinary Connections	3.60	4.04	4.20
Communications	3.02	3.40	3.55
Teamwork	3.26	3.42	3.85
Professional / Ethical Development	3.48	3.71	4.00
Technical Competencies	**<1 month**	**1-12 months**	**>12 months**
Underlying maths and science foundations	1.58	1.27	1.30
Technical eng sub-discipline knowledge	2.32	2.04	2.20
Define and solve open-ended problems	3.07	3.04	3.10
Apply a systematic design approach	3.09	2.93	3.05

Another interesting implication of the above results is that it suggests that greater exposure to professional practice might not lead to increased engagement in the development of professional competencies within degree programs. It is possible (though untested in this study) that the more students work the less they believe the

University context to be authentic (perhaps due to a lack of the tacit requirements, expectations and consequences inherent in the workplace), leading to a strengthening belief that professional skills need to be learnt in industry. This would be a valuable avenue for further exploration. Drilling down to the 4 specific professional competencies that were surveyed (see Table 3), we can see that whilst there are some variations, the same pattern occurs across a range of different competencies.

3.4 Which competencies require a greater understanding of theory

Considering Q3 in Table 2, this question explored students' views regarding the extent to which different competencies required an understanding of associated theory. As expected, there was a significant trend to perceiving that technical competencies required a strong theoretical foundation than professional competencies. Possibly more surprising, however, is that increasing levels of professional experience tended to strengthen these views rather than weaken them, and this pattern is consistent across the individual competencies. For example, for respondents with <1 month of professional experience, the average rating (from 1 to 8) for teamwork was 6.34 (where 1=most needs theory and 8=least needs theory) whereas for respondents with greater experience, the average rating was 6.73.

4 SUMMARY AND ACKNOWLEDGMENTS

As noted in the introduction, understanding students' views regarding the development of professional competencies is important in terms of informing the ways in which engineering educators design engineering programs. The research reported in this paper suggests that it is flawed to assume that greater exposure to (or participation in) professional practice will lead to greater recognition by students of the value of professional competencies and hence engagement by students in our educational programs that focus in this area.

If we are to enhance our learning outcomes for students with respect to professional competencies, then it is likely that we will need a more nuanced understanding. Whilst this research has provided some useful insights into students' views on the development of professional competencies, it is clear that further investigation is needed to identify what drives the formation of these views. This is especially true with respect to what it is about professional practice that leads students to feel that their professional competencies should be developed in industry rather than University. Potentially this relates to perceptions of value and authenticity (especially in University contexts that lack the tacit requirements, expectations, and consequences inherent in the workplace), and it is this area that particularly warrants further investigation.

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