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Times of Change in the Engineering Industry: Practising Engineers, Undergraduate Students and Mentoring

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Abstract

This presentation reports on a mentoring trial that was implemented by the University of Canterbury's College of Engineering and School of Educational Studies and Leadership (EDSL) in partnership with the local branch of the Institute of Professional Engineers of New Zealand (IPENZ). Drawing in the expertise of leadership lecturers from EDSL, the mentoring trial trained seventeen practising engineers in aspects of effective mentoring. Students studying civil and natural resources engineering in years three and four were matched with the engineers. The pilot included pre and post-pilot surveys, training, and provision of supporting resources. Both mentors and mentees found that the experience was rewarding and beneficial. The mentoring program fostered an environment where students felt motivated to continue in their studies because they could now envisage their future in the changing engineering landscape.

Keywords

mentoring; engineering; university industry partnerships

1 Introduction

Internationally, vocational mentoring has increasingly become a feature of undergraduate engineering courses. Mentoring has been used for research training (Balster, Pfund, Rediske, & Branchaw, 2010), service learning (Hui, Mickleborough, & Chan, 2014) and building skills for culturally-diverse workplaces (Berry & Walter, 2013). Research has explored the benefits for young women of mentoring them into STEM subjects (Pisimisi & Loannides, 2005), the role of mentors in raising young women's persistence (Jackson, 2013) and their retention at a higher levels of non-traditional disciplines (Poor & Brown, 2013). A positive impact of mentoring on career planning in STEM disciplines has been found for students with disabilities (Sowers et al., 2017). Undergraduate students benefit from mentoring school students making tertiary choices (Gray & Albert, 2013) and undergraduate peers (Simpson, van Rensburg, & Benecke, 2017), indicating retention benefits for both mentees and mentors (Monte, Sleeman, & Hein 2007). A systematic approach to the development of undergraduate mentoring

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programmes is recommended (Gannon & Maher 2012), one that is attentive to both mentor and mentee benefits (Crisp & Cruz 2009; Koehler, Matney, Lavelle, & Robbins, 2007). Research offers the opportunity to enhance awareness of how mentoring can beneficially contribute to VET, particularly as young people transition to employment in the context of less linear career paths.

A wide variety of mentoring topics have been analyzed in previous studies more specific to engineering and STEM subjects, and consideration of earlier literature reinforced the potential of our trial to contribute to the experiences of undergraduate students. Related research on faculty mentoring of STEM students suggests ‘non-intrusive’ mentoring practices are effective in sustaining motivation and building a sense of autonomy (Lechuga, 2014). Non-intrusive practices are those that are based in a notion of self-determination; the role of the mentor is not to direct mentees but, rather, to support them in arriving at their own solutions and ideas. In attaining this form of mentoring practice mentors require ‘qualifications’ that go beyond their technical background. These might include attainment of a professional level and training expertise, willingness to help, communication skills and other individual characteristics (Pisimisi & Loannides, 2005). Research on a project similar to our own reports overwhelmingly positive educational impacts for undergraduate civil engineering students (n=345) in offering them role models, enhanced adaptation to industry, behavioral and attitudinal changes concerning CPD and additional access to vocational placements (Gannon & Maher, 2012; Murray, Ross, Blaney, & Adamson, 2015). However, as this paragraph suggests, mentoring also has the capacity to contribute to a range of strategic concerns that go beyond educational impacts including supporting initiatives around recruitment to the engineering as a career and, in particular, recruitment of higher numbers of female students and students with disabilities.

Mentoring makes a contribution to the ongoing continuing professional development (CPD) of both mentors and mentees, whatever their industry. Yet, key components of mentoring that have been identified in the literature are often unfamiliar at the level of practice. The intent of mentoring is that mentees, in our case the engineering student, arrive at their own solutions through a process of reflection facilitated by their mentor and it was this intent that drove the design of the mentoring pilot reported in this paper.

2 Methods

In designing the mentoring trial, we used a five-factor mentoring framework, drawing on the education literature (Tolhurst, 2007). This focused on building rapport, active listening, effective questioning, clear expectations and a framework of goal setting. The framework for goal setting drew on the 4C mentoring framework of challenge, choice, creative solution, conclusion established by Engineers Ireland (Harney, 2010). While Engineers Ireland had used an adult learning framework for their mentoring initiatives we choose to focus on skills of listening and questioning. Our goal in introducing mentoring to the educational experience was to foster the ability of the student to imagine himself or herself as a contributing and reflective member of an international industry even before making the transition to that industry.

2.1 Pilot process

Local professional engineers were contacted by IPENZ and a list of 17 volunteers (3 women) was developed. The ages of the mentors varied greatly with four aged 20-30, and three over 60 years of age, with an average age of roughly 42 years. Concurrently, third and fourth year university students in civil and natural resources engineering were invited to submit an expression of interest in the trial, commenting on their professional interests and goals, and what they hoped to gain from the mentoring. Within 12 hours, 20 expressions of interest had been returned, and another email was sent requesting no further applications.

One application was declined because the student had not provided a genuine attempt to describe career goals or the value of mentoring. Nine third-year students were selected (five women), and eight fourth-year students (three women). Roughly 25% of the overall student cohort for the combined years were women, so the representation by women in the mentoring trial was relatively high. Because of time constraints, the pilot was limited to eight weeks, at the end of the students' spring semester. The three women mentors were paired with women students, though five of the eight women students were paired with male mentors. Where possible, students were paired with mentors having professional background matching their declared professional interest. One mentor needed to leave the program after the pairing and pre-trial questionnaire, but before the first meeting.

A cross-disciplinary team from two university schools (Engineering and Educational Studies & Leadership) and a local leading practicing engineering manager organized the trial. A resource pack for participants was prepared by the academic from education studies; this drew on a range of literature on mentoring in education, and on prior research on mentoring for engineering and related disciplines. The resource pack included an introduction of the literature related to aspects of effective mentoring, along with record sheets that could be used to clarify goals and record meetings using the 4C mentoring framework of challenge, choice, creative solution, conclusion (Harney, 2010). This 4C model provides the framework for effective questioning by the mentor. It draws on ideas we were introduced to by Engineers Ireland and helps the mentor to keep the conversation on track and focused on questions around the professional development goals of the mentee, their options to achieve those goals, the identification of the best option of those available, and the identification of what 'quick wins' and next steps should be agreed. The information pack also provided a mentoring agreement template.

Three days before the meet-and-greet between the mentors and mentees, there was a 90 minute evening mentors training session that was run by one of the authors who is involved in teaching coaching and mentoring. This was a chance to inform the mentors on what would happen at the meet-and-greet session, to clarify our expectations of what a mentoring relationship should and should not be, and also answer any questions. The two-hour meet-and-greet session for mentors and mentees was held three days later. It included lecture content and exercises in building rapport, active listening and effective questioning. Mentors and mentees were paired early on, and each of the three exercises for the pairs was preceded by some background discussion to the group as a whole. The breakout sessions allowed for a highly-interactive evening and a strong sense of energy.

Mentors and mentees were asked to complete pre-trial and post-trial on-line surveys. The pre and post-trial surveys examined the expectations and reservations of participants in order to develop guidance on how best to communicate about a mentoring relationship with both students and practicing engineers. In addition, the nine third year students were surveyed late in their fourth year to reassess their longer-term views on the mentoring experience.

3 Results

Participation rates for the surveys are shown in Table 1. 18% of the mentees had been mentored before, while 78% of the mentors had been mentored before. Half of the mentors had been mentors before. The surveys showed an average of five meetings of 30-60 minutes between the mentors and mentees during the trial.

Table 1 Participation Rates for Surveys

Group Surveyed	Survey Type	Total Number	Number of Responses	Response Rate (%)
Mentors	Pre-trial	18	18	100
Mentors	Post-trial	17	16	94
Mentees	Pre-trial	17	17	100
Mentees	Post-trial	17	13	76
Third-year Mentees	One-year follow-up	9	4	44

Of the various components of the trial, both the mentors and mentees found the meet-and-greet session worthwhile. Of the three skills taught and practiced at the meet-and-greet session, the mentors found the skill of “effective questioning” to be the most difficult to master.

Other methods of support were less valuable to mentors. In relation to the forms provided, 31% used them, while 44% did not, and the remainder tried to use them, but found the format ineffective. The on-line resources, messaging, and chat room that had been established within the university Virtual Learning Environment were not used. The workbook was seen by mentors as a useful resource to call on when needed, but mentees did not make use of it.

The mentors and mentees both were positive about entering into future mentoring, and that their mentoring skills had improved from the trial. Both mentors and mentees were asked before they started about their reservations. For mentees, the top reservations were about ‘knowing what to talk about in the mentoring conversation’ and ‘ensuring I have sufficient time for the meetings with my mentor’. For mentors, the top reservations were about ‘mastering the skills of listening and questioning’ and ‘being able to establish rapport with my mentee’. After the trial, the mentors were asked to identify which reservations were justified, with the most justified being ‘finding time to meet with my mentee’. Most reservations could be countered by careful design of the mentoring program. The survey noted that we had not done enough to explain what information it would be appropriate or inappropriate to share during the mentoring. The other challenge we had underappreciated was the demands on student time, particularly at that time of year.

A common issue for students was their desire for a strong match of professional issues, while mentors and the program organizers did not see this as much of an issue. One student commented before the meet-and-greet session:

Was surprised to find I had been placed with a mentor who worked in a field nearly opposite to what I am hoping to go into (communications/electrical vs transport/civil). Unsure if this is on purpose or not, and partly worried we may not have much in common due to the differences in the industry, nevertheless still interested to hear about his experiences and how he excelled his career etc. Too early to tell if it will be an issue but was something I assumed would be based on matching mentors based on mutual career interests etc.

Two students commented in the post-trial survey on the issue of matching professional interests, with one responding:

One comment I would make is that if it is possible, it would be most effective to pair a mentor and mentee who are in the same specialisation (eg. structural engineering) as this provides a common ground for discussion on professional matters.

On the other hand, one student (not the same student) who responded a year after the trial wrote:

For me I had thought that I wanted to do structural engineering so I was paired with a structural engineer mentor. However I soon realised that structural engineering wasn’t what I wanted to do. The mentoring experience helped me think more concretely about my career goals and how the discipline I choose would influence my goals.

The program organizers and the mentors agreed with this assessment. To the more experienced, the role of the mentor is to help the student find their own answers while counselling in ways to avoid problems that may be associated with student misconceptions (Marra & Pangborn, 2001). There could be a risk that some students will see the role of the mentors to be to make contacts for them or otherwise help them directly in their job, rather than help them in developing skills to succeed.

One women student commented in the immediate post-trial survey that

“I know I am a person of few words but I very often found it difficult to get any words in as the mentor kept talking.”

The program organizers noted, during the meet-and-greet session, more than one pairing that seemed to have the potential for difficulty because of a talkative extrovert matched with a quiet introvert. The effect on mentoring of a mismatch was worse in mixed-gender pairs, but seemed to be a potential issue in all matches. Here, being familiar with participants is valuable in developing coaching dyads.

In the pre-trial questionnaire for mentors, many mentors noted that they expected to gain from the mentoring experience through a contribution to their CPD record. Although this opinion was more muted after the trial, we recognize that many potential mentors appear to be drawn to mentoring for CPD reasons. Our experience with the trial supports a conclusion that mentoring schemes should develop the CPD benefits –could be through a formal recognition of CPD benefits or through university coursework credits. However, as a group the mentors were very positive about the trial, with all 16 respondents agreeing that they would be interested in acting as mentor in the future. Mentors saw great benefit in their own professional and personal development by being trained in mentoring, participating in mentoring, and then reflecting on the experience. This comment from a mentor on our trial is representative,

‘Stick at it, it would be good to see this evolve - I think it has so much potential to help mentees and mentors alike!’

4 Conclusion

Of the various components of the trial, both the mentors and mentees found the meet-and-greet session worthwhile. Of the three skills taught and practiced at the meet-and-greet session, the mentors found the skill of “effective questioning” to be the most difficult to master. The surveys showed an average of five meetings of 30-60 minutes between the mentors and mentees during the trial. The workbook was seen by mentors as a useful resource to call on when needed, but was little used by the mentees.

Reservations about the trial were assessed by pre-trial survey. Most reservations could be countered by careful design of the mentoring program. The results confirm prior research on the importance of a structured approach to mentoring, including the provision of training for both mentors and mentees. Both mentors and mentees found that the experience was rewarding. For mentors, the top benefit (rated by all respondents) was a sense of satisfaction in assisting incoming engineers to gain a sense of inclusion in the industry. Other highly rated benefits were enhanced listening and questioning skills and how they could use these enhanced skills not only as professional skills but also in other contexts of their lives. For mentees, the item that was of long-standing value after the trial was an enhanced appreciation of how mentoring proceeds and the development of enhanced questioning skills.

In terms of lessons learned for future mentoring programmes, we note a number of points. The question of the identity characteristics of participants, both mentor and mentee, merits mention. Mentees had a tendency to expect mentors would match their current professional interests and help them directly in their jobs. There is a need to support students to have an understanding of the broader role of mentoring as a process of being supported by a mentor

listening and questioning to construct their aspirations for and through a career. The literature suggests that industry match is not essential, and our pilot supported that position. In terms of gender, many of the female mentees indicated a preference for female mentors. Given the gendered nature of the engineering industry, this was understandable and highlights the need to encourage female engineers to be engaged in mentoring programmes.

From a process perspective, both mentors and mentees expressed little need for support literature, or university-supported messaging and chat rooms. Rather, the practical exercise of face-to-face training and the opportunity to practice their mentoring experience as a group prior to the pilot was considered valuable. In this, participants gained a sense of what mentoring was; this sense was often at odds with their prior experiences of being a mentor. We identified that timing is of the essence and, at two months, the pilot was too short to enable us to test the benefits of a professional mentoring process. However, some of the mentors and mentees continued to meet, after the pilot had ended.

Significantly for the university, the mentoring program was that it fostered an environment where students felt motivated to continue in their studies because they could now envisage their inclusion in an engineering future. The university is considering the potential too for third year student mentees to serve as mentors in their fourth year for second year students. This not only develops their professional skills, but also contributes to the achievement of the UC Graduate Profile. For the engineering industry, the pilot team recognised the potential for such a process to contribute to the further development of industry professionals. On the one hand, this could be through offering mentoring as a course for practicing engineers with course credits that could be applied to post-graduate degrees. On the other hand, there could be potential to develop the programme so that practicing engineers benefit more directly in terms of credit for continuing professional development. Clearly, there is potential to use mentoring as a mutually-beneficial process for structured learning collaborations between the university and the industry. However, from a student perspective, the benefits could be profound:

When doing an engineering degree (especially in the first 3 years) it's really hard to figure out where you're going with it. Most of us don't have an end goal, and we're usually just trying to get one assignment in after another, trying to stay afloat in the cut-throat degree system. ... The mentoring program really helped to make me feel valued. Rather than wondering whether I would get to the end of my degree, I started to look at what I could accomplish after my degree. I didn't really know what I wanted to do after university, so the mentoring helped me to consider different options. I still don't know exactly what I want to do, but I have a better understanding of the system now, so I can make more informed decisions about my future. It's really helpful to have some time to just talk about career paths and goals, even if you don't come to any conclusions. I feel like a lot of adults hit retirement and feel as though they never accomplished what they wanted in their lives. Having a mentor helps us to figure out what we want and point us more in the right direction. It is an invaluable experience.

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Biographical notes

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