Professional learning in engineering internships: What do supervisors learn from their student supervision practices?

Abstract

In order to graduate as professional engineers in Australia, engineering students undertake internships as part of their degree programs. The heart of a productive internship program is the relationship between the workplace supervisor and the student, yet there are significant gaps in the knowledge about the nature and type of professional learning which takes place. The aim of this research is thus to develop a clearer understanding of industry supervisors' practices and perceptions of their student supervision, and the types of learning that take place.

This study was conducted with industry supervisors of students from the Faculty of Engineering and IT in an Australian university. It adopted a qualitative research approach using semi-structured interviews and an online survey. The data were analysed through the lens of practice theory perspectives. Our results show that learning was generally confined to the learning of students. Supervisors generally did not position themselves as potential learners in the internship experiences. The deeper understanding gained from this study calls for more purposeful, relational and values-based learning practices in supervisor-student interactions.

Keywords: supervisor, supervision practices, internship, professional learning, practice theory

Introduction

This paper is positioned in engineering education and focuses on engineers who supervise university students in their workplace. It explores their perceptions as educators, what mentoring practices and approaches they are using and to what extent they see supervision as an opportunity for their own professional learning. Student supervision in the workplace are internships. They are an educational partnership between students, university and industry that help university students prepare for the workplace and develop their professional practice capabilities. The educational partnership has been recognised as a central element of quality internships (Billett, 2009; McHugh, 2017; Universities Australia et al., 2023). Within this partnership the professional relationship between supervisor and student has been recognised as a

decisive factor for student success (Billett, 2009). The body of literature of supervision practices of supervisors is surprisingly limited (Martin et al., 2019), given their important role in internships. This supervision role is complex and includes inducting, administrative, mentoring, managing and coordinating skills (Proctor, 1986). "Good workplace supervision requires supervisors to have, or develop, their own mentoring, management, and leadership skills" (Martin et al., 2019, p. 239). There is limited scrutiny how supervisors are prepared for this role and to what extent, supervisors expect to learn from their students (Martin et al., 2019). Furthermore, there are often limited opportunities for engineering supervisors to be supported to learn how to supervise student learning (Trede & Mahinroosta 2018). Supervisors have reported the need for role clarification and a shared expectation of each internship partner (Martin et al., 2019).

Another overlooked aspect is the potential for supervisors, and their organisations, to learn from their student interns. Supervision is not a neutral and unproblematic practice due to the power differentials between supervisor and student and Manathunga (2007) warns that internships should not be supported at all costs. The recently revised Australian National Higher Education Work-integrated Learning Strategy states that partner organisations need to be committed to "preparing staff to engage with students, effectively supervise, mentor, provide meaningful feedback and complete assessments (where relevant)" (Universities Australia et al., 2023, p.10). The responsibility of ensuring professional learning for supervisors is reduced to a commitment and it is encouraged for universities to support this. However, there is no scrutiny of this, at least in the Australian context where this study was conducted.

There is a range of options and positionings in how to supervise interns. Wang and Odell (2007) identified three supervision categories: the humanistic approach where supervisors help students to pass, a situated apprenticeship model which provides support, and a critical constructivist perspective which encourages intern self-development through reflexivity and peer mentoring. These three categories align with Habermas's theory of knowledge-constitutive interests (Habermas, 1972). According to him there are three interests, technical, practical and critical. The technical interest aligns with helping students to pass, the practical aligns with supporting students to deliberate wisely and act prudently in given practice situations, and the critical aligns with enabling students to develop their own reflexive professional identity within a wider perspective about the nature of their professional work in the world. Table 1

illustrates the three human interests and implies the roles and scope of supervisors and students. The way supervisors understand their role has implications for what interests and purposes they pursue; and it has impact on the possibilities and opportunities for student learning.

Table 1: Supervision models seen through the human interest lens

Domain of Interest	**Role of supervisor**	**Role of intern**	**Scope**
Technical	Expert Master	Apprentice To be formal, nice Not responsible	Fit in Enculturate and assimilate Perpetuate existing practices
Practical	Supporter, mediator	Student learner To be appropriate Somewhat responsible	Humanistic Collaborate and regulate Socialising
Critical	Facilitator, responsive and critical	Pre-Professional Peer learner To be inquisitive and agentic Responsible	Bringing out the professional self Boundary crossing Self-development Enabling

In this paper we explore professional learning in the context of internships, and more specifically, from the perspective of engineering practitioners who supervise engineering university students in their workplace, hereafter called supervisors.

Theoretical framework

When investigating professional learning in the context of industry supervisors and engineering interns, we explore theoretical ideas that address the relational nature of supervision practices in the context of supervisor-student relationships. This has led us to consider practice theory perspectives, as they work to uncover 'deeply embedded beliefs and taken-for-granted discourses' (Salamon et al. 2014, p. 1) which underlie many practices. Uncovering these practices and making them more visible can provide opportunities to challenge or rethink practices that are unhelpful or damaging. The emphasis on practices rather than on practitioners can allow a new way of looking at the elements of a practice, and can shift the focus away from individual practitioners while still acknowledging their agency. Having practice as the unit of analysis acknowledges the situatedness of practices – that they belong to a particular place and time, and unfold

in ways that are shaped by specific conditions (Kemmis et al. 2014, p. 33) or arrangements (Schatzki 2012, p. 19). Furthermore, 'practices...entwine people, technologies, spaces, time and artifacts' (Rooney et al. 2012), so the analysis of a practice involves developing an understanding of complex interactions of these arrangements. As noted earlier, supervisors are not always attuned to their supervision practices: practices can often be difficult to locate or invisible, even to the practitioners themselves. Thus, a lens is needed that can reveal what is usually taken for granted, such as expectations, interests, values and assumptions as well as the local conditions and the larger landscape of the internship. Such a lens is provided by the theory of practice architectures (TPA) (e.g., Kemmis et al., 2014). TPA is a site ontological practice theory, so the focus is on the site of practice as the locus of analysis and interpretation. A practice in the context of TPA is defined by Mahon and colleagues:

> A practice is understood as a socially established cooperative human activity involving utterances and forms of understandings (sayings), modes of action (doings) and ways in which people relate to each other (relatings) that 'hang together' in characteristic ways in a distinctive 'project' (2017, p. 8).

The sayings, doings and relatings of a practice are enmeshed (Kemmis et al. 2014) in the dynamic interactions that take place within a site of practice. In addition to providing a lens to analyse practices and what lies behind them, TPA also provides the language to discuss the complex interplay of forces that create conditions in which certain practices are constrained and other practices are enabled. It does this by identifying three different kinds of arrangement that exist simultaneously in a site of practice, and which hold those practices in place: cultural-discursive arrangements (which shape the sayings of a practice), material-economic arrangements (which shape the doings of a practice) and social-political arrangements (which shape the relatings of a practice). These three kinds of arrangements combine to form the practice architectures that shape practices in a site. Using TPA, researchers can focus on a site of practice, such as an engineering supervisor's practices of supervision with their intern. They analyse the practices within that site, consider the arrangements enabling and constraining practices in the site, and recognise the agency of the practitioner. TPA can allow investigators to see not only what is happening in a practice, but how this has come to be and why certain practices become 'the way we do things around here'. In order to disrupt unfruitful practices, or to effect change, it is necessary to understand first how such practices have come about. As previously mentioned, practice

theory perspectives can assist in uncovering the unspoken narratives that run beneath 'the apparently durable features of our world' (Nicolini 2012, p. 6).

Focusing on the practice allows researchers to consider the interactions of objects, organisations, people, processes, relationships, rules and specific situations when developing an understanding of dynamic practices. A practice needs to be understood within its particular spatial and temporal location, which shapes the practice and is shaped by it. The TPA foregrounds the dynamic interplay between the site of a practice, the practices within that site, the conditions which enable and constrain those practices, and the project or purpose of the practices. Practices 'consist of the practitioners' sayings - their language and thinking; doings - their actions; and relatings - their relationships with others' (Wilkinson 2019, p.23). The conditions (or practice architectures) are the cultural-discursive, material-economic, and social-political arrangements which enable and constrain practices.

For example, the practice architectures of supervisor practices can include cultural-discursive arrangements in the form of supervisors' discourses in which student interns are referred to interchangeably as interns, employees and staff. The material-economic arrangements can include conditions under which the internships are paid or not; and the social political arrangements can include a variety of interpersonal and professional kinds of relationships between the supervisors and student interns. These practice architectures will enable some practices, such as regarding student interns as junior employees, while constraining others, such as emphasising the learning of student interns.

We have used the theory of practice architectures (TPA) as a theoretical lens through which to understand the practices of our industry participants as they supervise their interns; to see how their sayings, doings and relatings interact with their local contexts both to enable and to constrain different ways of learning.

About professional learning

Supervision practices are human social practices that are enmeshed with learning and practising. They can be thought of as nested: at the micro level is the supervisor-student relationship, at the meso level is the relationship between learning and supervision, and at the macro level are the university-industry partnership practices.

Professional learning has been described through various pedagogies. Here we mention learning through boundary crossing and situated learning (Lave and Wenger, 1991), learning through professional identity development and professional agency, learning in

and from teams (Hager and Beckett, 2019), learning from time and place constraints. Professional learning for supervisors is located within the interdependent relationships of the sayings, doings and relatings. Learning in our study is concerned with supervisors' professional learning. Supervision practices can range widely according to self-perceived or assigned roles and purposes, as illustrated in Table 1. Technical supervision practices perpetuate practices and reinforce supervisors' roles to help students assimilate and be enculturated; practical supervision practices locate learning to practise within socio-cultural perspectives and reinforce supervisors' roles as brokers; critical supervision practices change practices and facilitate transformative learning in all participants. Based on our conceptualisation of what is involved in the practices of supervising students on engineering industry placements, we developed the following research questions: *RQ1: What are supervisors' commitments to help students learn? RQ2: How do supervisors understand the expectations and responsibilities of their role? RQ3: Do supervisors expect to learn from their students?*

The paper exclusively explores possibilities for supervisors to learn to practise differently through their supervision practices.

Methodology

Context, participants and data collection strategy

This study was conducted in an Australian university which offers a five-year Bachelor of Engineering that includes a Diploma of Professional Practice. The Diploma comprises two six-month internships which are spread across the 5-year curriculum. Although these internships do not strictly follow semester terms, the first internship is typically scheduled around the second year and the second internship around the fourth year. The internships can be in a wide range of engineering workplaces (e.g., large corporations, small to medium enterprises, local government), within or beyond the metropolitan area. Students are assisted to find their internships through the Faculty engagement team. On placement, students are assigned a supervisor with whom they are expected to liaise during the period of their internship; however, the details of the supervision are left to the engineering company to determine. For this study, participants were recruited via email invitations from the faculty engagement team using the industry data base from the university's faculty of engineering and information technology. The two inclusion criteria were that supervisors had supervised engineering students from this university in their workplace and were an experienced engineering professional. The participants were invited to participate in one-off, semi-

structured, face-to-face interviews (Minichiello et al., 2008). Due to the volume of responses from potential participants, it was pragmatically decided (Feilzer, 2010) to conduct an online survey as well, using the same questions that the interviewees were asked. Approval to conduct this study was granted by the university human ethics committee, and all participants provided informed consent that their de-identified responses could be used, in accordance with the protocols of the university's human ethics process. The online survey did not collect identifiable data from participants. The data collection instrument consisted of 18 questions comprising four sections: demographics, supervision practices, industry-university relationship and perceived needs to further develop as supervisors (see Appendix 1 for the interview/survey questions). The research team designed the questions based on a study of engineering supervisors' expectations of a preparation program (Author, 2018). Question types included closed and open-ended questions; for example, participants were asked to list their highlights of supervising students. A total of 29 supervisors participated in this study; eight participants were interviewed, with the length of interview ranging between 40 and 80 minutes. Twenty-one participants completed the online survey. As noted previously, the survey and interview questions were the same. The interviews were recorded and transcribed verbatim. All participants were located in the metropolitan area of Sydney. Participants' demographic details are listed in Table 2.

Table 2. Participant demographics

n = 29: 8 interviewees; 21 survey respondents

Engineering practice experience: 6 participants had up to 10 years practice experience 7 participants had between 11-20 years practice experience 10 participants had between 21-30 years practice experience 6 participants had over 30 years practice experience
Student supervision experience: 3 participants had no prior experience 3 participants had 1-3 years' experience 23 participants had more than 3 years' experience
Number of students in the workplace at one time: 21 participants supervise between 1-3 students 3 participants supervise between 4-6 students 2 participants each supervised approximately 10 students in their company 3 participants did not complete this question

Data analysis

The interview transcripts of the eight participants who agreed to be interviewed were de-identified, and the participants were given pseudonyms. The data analysis strategy was informed by pragmatism as a research paradigm, which supports the use of a mix of modes of analysis and a continuous cycle of abductive reasoning, while being guided primarily by the researchers' desire to produce socially useful knowledge (Feilzer, 2010). In abduction, researchers "move back and forth between induction and deduction" (Morgan 2007 in Feilzer 2010).

In the initial phase of data analysis, Concordance software (Watt 2011) was used to identify frequently occurring terms which could then be examined to create categories. Once the categories were identified, we moved back and forth between interview and online survey responses, searching for themes, paradoxes and answers that stood out following Miles and Huberman's (1994) clustering and condensing method. Having narrowed and classified the categories into themes, we then critically compared and discussed findings until agreement on the final analysis was reached. During our analysis, we noted the following differences between the interview responses and the online survey responses. With the interview responses, the participants were more likely to answers to the questions that they thought they were asked, or the answers that they wanted to give, or tell the stories that they wanted to tell. The participants seemed less willing to express negative opinions, for example about the students they were supervising. In the online survey, respondents answered the questions they were asked; not surprisingly there were fewer stories told in their open-ended answers. The respondents seemed more comfortable about expressing opinions that might be confronting, such as making critical comments about the lowlights of supervising students. The following table lists some of the major themes that were identified in the thematic analysis.

Table 3: major themes in interview and survey data analysis

Theme	**frequency**	**context**
learning	39	Different types of learning: learning what vs learning how; learning skills, learning the company rules, aspects of the job that can't be learned at university
Managing interns' work	23	Assign work; check they are up to date in their work; monitor how they work; what they want to work on; don't want to work; students assign work to themselves; assess their competency before we assign projects; being on top of their workload; quality and quantity, work on aspects of their performance (e.g. interactions with others)

Inclusion in team	15	Team assign work to individuals; be/become part of the team; team leaders assess/monitor; work with a team
Feedback	11	Provide feedback; positive feedback (to interns); feedback from other staff/team members; We do as with all employees a review after 3 months of work
Responsibility/ies	4	Giving them responsibilities; responsibility commensurate with their authority
Mentoring coaching	46	How to be an effective mentor; mentor programs; being mentored by previous supervisors; formal mentoring courses; formal coaching courses; coaching on workplace practices; responding to coaching; be a coach rather than a supervisor
Confidence	9	Giving them projects + the confidence to build them; give them time to work on a problem and detailed feedback

Findings

The findings of our study showed that the majority of participants did not make nuanced differences between supervising students and supervising employees. Their sayings, doings and relatings suggested that they mostly valued students as workers and regarded them more as employees than as learners. The findings further suggest that the university-industry partnership predominantly focuses on procedural issues, with little space for professional development to advance shared purposes of internships and mentoring capabilities. The cultural-discursive, material-economic and social-political arrangements between the university and the workplaces of the supervisors constrained opportunities for discussion or for exchanges of ideas or advice. The practices of accessing information via an online portal enabled smooth transactions, but constrained dialogue and engagement between supervisors and academic staff at the university. Although participants reported having contact with the university, this was mainly conducted through monological email correspondence with professional staff with oversight of transactional internship processes. In the following paragraphs we explore these key findings in more detail and in response to the three research questions. Participant comments include survey responses [SR] and interviewee responses [pseudonym].

RQ1: What are supervisors' commitments to help students learn?

Supervisors are generally committed to help students learn to become engineers, but the type of learning appears to be influenced by the technical interest of the human interest model of supervision (see Table 1) and by the constraints and enablements of paid

versus unpaid internships. The language analysis using Concordance revealed the predominant occurrence of the term ‘work’ in answer to the question: *What do you do in your workplace to help students to develop their confidence as novice engineers?*
The terms ‘work’, ‘task’, ‘job, and ‘workload’ occurred most frequently, particularly in the context of ‘actual projects’ and of allocating, monitoring and checking, for example ‘check they are up to date in their work’ [Perry]. These terms correspond to the “technical” role in the human-interest model of the supervisor, where the supervisor is the Expert, the student is the Apprentice, and the scope is: Fit in; Enculturate and assimilate; Perpetuate existing practices (Table 1).
The way supervisors see themselves influences the opportunities available to the student for certain types of learning. The following comment exemplifies this view and approach: ‘We treat them just like an employee in terms of saying you know here's your task, you need to report back on how you're going. We expect them to deliver, you know’ [Pablo].
The high frequency of terms such as responsibility/responsibilities; confidence; feedback highlights that our participants privilege the ‘practical interests’ of supervision. The following comment from one of the interviewees shows how the supervisor’s practices are trying to scaffold their student’s understanding about responsibility and authority:
‘A person's responsibility needs to be commensurate with their authority and if they don’t have authority over something they can't have responsibility for it. So I'll say to them, look, that problem is person X's problem, you need to brief them on what the issue [is]’ [Claus]. Claus has a hierarchical concept of responsibility and reduces dialogue and shared responsibilities to briefing others. The following response from the survey is an indication of how the arrangements of the site of practice determine the sayings, doings and relatings of the practice of developing students’ confidence:
‘Provide regular reviews and discussion with management. Provide a range of tasks in different areas of the business. Show them how others have progressed and become successful. Assign them to a manager(s) for clear direction’ [SR]. Much of the supervisor’s approach appears to be influenced by the policies and procedures of the respondent’s workplace. In this response, the opportunities for reciprocity, for student agency, seem to be constrained by practices that take a hierarchical and managerial approach to the supervision of interns.

A contrasting perspective is provided by the following comment, where the emphasis is more on mentorship and learning: ‘We run junior technical forums once a month: a lunch where students and graduates rotate discussing something they've learnt recently. We also encourage students to ask a lot of questions and work with people of all levels within the company’ [SR]. This forum, where students and graduates can discuss what they have learned, enables reciprocal learning practices, as does the practice of encouraging students ‘to ask a lot of questions’. However, we note that these reflective forums are labelled ‘technical’.

As mentioned earlier, the practice of paid or unpaid internships appears to shape the nature and type of student learning in the workplace. In our study, over 95% of internships were paid, although some responses indicated that this depended on the nature of the role being advertised (in both the survey and interview responses). ‘This one is paid... In this case, we had very specific work that we needed them to do’ [Alex]. Alex made a conscious decision about paid and unpaid internships based on the type of work offered. Other comments about paid internships indicate that the supervisors see the internships as an employment relationship rather than a teaching/learning relationship: ‘They do real work and they get paid for it’ [Claus]. Claus was an advocate for paid work and felt this was the respectful and equitable way to treat students. Jemma said that students are ‘Paid at the market rate’ [Jemma].

Her comment strongly suggests a contractual relationship with the student, leaving little space for learning.

When a student is paid to do an internship, the landscape shifts: the language changes and expectations change. This impacts the intended outcomes of an internship.

The arrangements (cultural-discursive, material-economic, and social-political) of paid internships interact with the practices of the sites so that the students are spoken of, paid as, and treated as, employees rather than as learners. This can then constrain learning opportunities for both supervisors and students, as the practice architectures of a paid internship enable technical types of learning such as how to do a specific task, and may also constrain opportunities for supervisors to learn from their students. The following comment exemplifies how the university processes for recruiting students for internships can set up expectations that the student is to be treated as an employee rather than as a learner: ‘There's a [university] form that... basically lists the expectations in terms of the number of hours, the kind of work, the kind of competencies that they're looking for’ [IR].

These are missed opportunities of the university to address requirements and capabilities of supervisors. When the internships are unpaid, the focus is more on the learning that the student is experiencing in the workplace. The practice architectures of unpaid internships appear to enable practices which have greater emphasis on student learning, and on the role of the supervisor as guiding/coaching. In the site of practice where the internship was unpaid, the supervisors spoke of 'joy', and of the satisfaction they experience in seeing students grow in their learning. There was a sense of satisfaction in seeing students enjoy their work: 'I think my joy is to see the intern in a position that they actually like' [John]. John continued to state that a 'Technical skillset is always static knowledge, know-how...to learn new skills is dynamic. They are here to learn the dynamic skillset…These are all the skills that we would like...to see them to grow in this - during this whole program' [John].

John emphasises the emergent nature of learning to practise that cannot be predicted and structured. Matthew frames the student-supervisor relationship as coaching and learning that 'starts right from the day they start to write to us before they step through our door…' [Matthew]. John and Matthew exemplified a student-centred approach where self-development of their students was more important than the acquisition of technical skills.

RQ2: How do supervisors understand the expectations and responsibilities of their role?

Most participants have had some internal training by their employer about management, leadership and coaching. These training programs reflected the company culture and vision, indicating that supervision practices were replicated without change. 'We have a structured approach to supervising students. We use our own system' (SR). These programs attenuate learning and reflective practice and focus on company interests. None of our participants had participated in university-led, specific professional development training for student supervision. There was limited dialogue with the university beyond transactional processes and no clear understanding of what the university's expectations were of them. 'Not sure, cannot remember, normally we get guidelines, complete a survey about students' (SR). Our participants reported that they learnt how to be a mentor from their own experiences as a mentee. Participants had their own expectations about their supervision role which is exemplified with this quote: 'I sort of calibrate and adjust my responses and my method by talking to people, talking to my peers in the management here, talking to experienced student engineers' (Claus).

Supervision was perceived by most as a people-skill. Key attributes mentioned by our participants included being a leader, providing structure and nurturing development. The supervisor as a leader has confidence based on experience, is decisive, and provides support and challenge. The importance of providing clear tasks and individualised feedback on performance was underscored by most responses. The intent of providing structure ranged from being a technical expert with a focus on skill mastery to a student-centred facilitator of scaffolded learning. Supervision practices ranged from highly controlled approaches to treating interns like novice employees. 'We actually show them to do things the right way and what they should not do. We actually would allow them a bit of room to complete a task, but after that, we actually will check their work. So, until such time we feel that they are competent and we actually sit back and we just want the intern to naturally develop their own confidence. It depends on the student actually how much you actually - how in-depth you want your training to be' [Matthew]. Matthew's emphasis on supervision is teacherly, personalised and based on the need to trust students before giving students more responsibility. Although this approach might appear as micromanagement it can also be seen as a scaffolded approach with the longer-term intent to foster student agency. Student-centred supervision qualities included giving students their time and attention, 'manage them to their strengths' [Claus], 'listening, caring, following through' [SR], exercising 'patience and an interest in the students' work' [SR]. Other participants were more interested in students' skill acquisition and performance: 'I treat these interns pretty much as my full-time employees. I don't treat them any different and they know that. I say if I'm going to reprimand you, I'll reprimand a full-time employee in the same way. I'm not going to treat you any different, so think of yourself as an employee for all purposes' (Pablo). Treating everybody the same is a competitive approach that does not nurture personalised learning and attenuates the role of mentoring. It can be argued that this approach is a strategy to foster professional identity development because students are treated like other professionals. A similar understanding of their role as a supervisor was discussed by Alex who describes his 'break them down and then build them up' approach: 'The first code review with our juniors was brutal. It was brutal; pages worth of comments. There were red marks all over it. The advantage of that is they now know what the standard is. The next time it was nowhere near as brutal. Now, the code reviews go through with almost nothing' (Alex).

Learning was referred to as high challenge and high support in acquiring a skill. The supervisor as expert who is the authority permeated throughout the data collected. 'I'm an expert in the field I ought to be able to point out anything that they're doing and show them what is going on' (Isaac). Expertise and skills were privileged over questioning, learning and experimenting. However, some participants unpacked the complexity of student supervision by discussing the need for a fine balance between guidance and freedom. One survey responded offered their three supervision principles:
'1. provide guidelines, then allow freedom to creatively do the work, review the work after an agreed time, 2. know the intern's constraints, including their current level of understanding, 3. be firm but not grumpy' [SR]. They portray a scaffolded and relational approach that was clearly steered by the supervisor. Some participants discussed good supervision as promoting learning as personal growth including the value of emotions, creativity and failure: 'Provide ideas and assist in projects as a way of providing leadership. To create excitement around projects and provide enough freedom to allow the individual to be creative. To encourage the individual to explore a wider range of ideas where some will likely fail, but ensure ideas are evaluated quickly and efficiently. To understand an individual's strengths and interests and target work that develops these skills while providing training in areas of potential growth' [SR]. This survey respondent is attuned with students' professional reasoning processes and provides feedback and guidance. The importance of giving feedback was mentioned by a few and related to being relevant and constructive. There was no elaboration offered whether this feedback was about technical, social or critical skills.

RQ3: Do supervisors expect to learn from their students?

The overall responses from the participants focused mostly on what students were expected to learn, rather than an expectation of supervisors learning from their students, or from the experience of supervision. Several comments indicated that the supervision practices were based on what the supervisors had experienced when they were interns: 'Having myself gone through the same process in the early 80ies when at NSWIT (except longer duration) I think overall it [internship] works very well as long as the employers have got well planned roles' [SR]. This comment underscores the likelihood of perpetuating yesterday's supervision practices. There was no mention of the urgent need for professional learning so that learning improves for all involved in supervision practices . There was pride in seeing students improve, and disappointment when they did not progress: 'Mentoring in general is actually the thing that gives me the most job

satisfaction these days. Seeing other people become better than they were before. … I was trying my best to help someone out, they still weren't ready ...I don't know what I'd do yet differently ... I haven't asked myself that question yet' (Alex).

In this comment, the emphasis was on students' learning, and Alex did not further discuss what he had learnt from this situation and therefore could not yet see how he could have practised differently by sharing the responsibility for improving with the student. The following comment indicates that in this site of practice there is an expectation of personal responsibility on the part of the student: 'We try to be patient, we try to give them multiple opportunities, but at the end of the day, we are expecting them to be grown-up. So, they have to be responsible on what they have done and they have to learn they are liable of their action' (Matthew). Matthew's framing of student agency offers limited space to factor in a mediating responsibility of enabling this agency. His intentions could be boosted with a stronger capacity for self-reflection.

There appeared to be limited opportunities for supervisors to take a reflective approach to their supervision practices. The emphasis was predominantly on students learning by doing rather than learning through reflection. Many of the learning opportunities for the students were seen to be centred on the everyday experience: 'They are to gain practical experience in the day-to-day role of an engineer. Given the opportunity to put theory into practice' [SR]. Other comments revealed the technical/practical role of the supervisor: 'We train the student to be able to do the engineering tasks using the knowledge already gained during their study' [SR].

These perspectives are missed opportunities to educate well-rounded future engineers. However, the following comment highlighted the value of students' research skills to contribute to the workplace: '...we often get the students to work in research and development kind of areas, so we're looking to get people with technical competencies that are up to date and help us to do the work that we need to do as well' [Perry]. Perry was one of few in this study who raised research-based learning and the role of research in internships.

The potential for reciprocity for learning in the supervision/internship experience was identified by some respondents, for example: 'Diverse experience for the student. Exposure to young and brilliant minds for the employer' [SR]. There is a sense of possibilities in this quote but it is not further developed. The two participants whose internships were unpaid saw some of the benefits of supervising interns as the possibility for an influx of new ideas: 'So, therefore, having that type of exposure to our

staff and we did see that, there are a lot of new values, new ideas coming from the academic students that complements and also even incurs some culture change on the traditional practice' [Matthew].

This comment illustrates both the recognition of the value that student interns can add to a site of practice, and the openness of the participant to having new ideas and the potential for cultural change. This openness is seen in the next comment, where both participants saw their site of practice as a site of learning, for the students and for themselves: 'So, it's basically a mutual learning program. We are not coaching. We are also learning. For me as a management, look as a management as well, we also learn from the intern' [John]. 'So, Mr X, basically he is my mentor too. He was the director of Biomed…- I encountered in the past and learning from mentor…' [Matthew]. Matthew saw himself as both a mentor and a mentee, and as such came closest to discussing what they were learning from their supervision practices and from their students as relational learning. Nevertheless, the responses generally focused on students' learning in the workplace. There was a noticeable absence of participants' reflexivity on their supervision practices and a limited sense of seeing student supervision as an opportunity for them to learn with and from their students.

Discussion

What has emerged from our analysis is the opaque nature of the supervision role, and of the hidden, taken-for-granted, assumed practices around supervising engineering student interns. There was a wide variety of roles and responsibilities identified, yet our participants had a sense of responsibility predominantly to help students with technical skill acquisition. Learning by doing was privileged over learning as self-development. The leadership role as supervisors was understood through the expert lens. Listening, communicating and building constructive professional relationships with students was mentioned but with no further reflections. Scaffolding students' progression was seen through a work safety rather than a learning lens. The literature on who is responsible for learning in internships squarely puts this onto the student. 'Ultimately, students have the responsibility to learn. Both educators and supervisors can only provide enabling opportunities' (Bates et al., 2007, 126). The idea that learning is an agentic activity is also supported by Billett (2009). Our findings align with the literature. The language used was not located in learning and mentoring but rather in managing. Our findings affirm the calls for clear role expectations for supervisors (Fleming & Haig, 2017) and the need to expand the supervisor role to encompass the practical and critical interest in

addition to the technical interest. The question of paid or unpaid internships for engineering students is not straightforward, despite the tendency to cast it as either for or against (Lloyd et al. 2019, p. 47). This is borne out in the wider discussion of paid and unpaid internships (Hoskyn et al., 2023), which identifies several variables that can influence student and supervisor experiences of internships. For example, high-risk projects attract "significantly more supervision interest" and paid internships influence the positioning of students (Hoskyn et al., 2023, p.551). There is no simple answer as to how the arrangements of paid or unpaid internships affect supervision practices, but in our study the arrangements of paid internships appeared to shape the supervision practices such that the technical and practical elements of the supervisor model (Table1) were brought to the fore.

In contrast, the arrangements of unpaid internships enabled practices that foregrounded the elements of the critical supervisor (To be inquisitive and agentic) along with aspects of the practical supervisor (Bringing out the professional self). Trede and Goldsmith (2019) explore the implications of paid and unpaid internships in more detail, but with similar conclusions. The complexity of paid/unpaid internships and the impact on learning versus working is further amplified through an equity lens. Unpaid internships can often be out of reach for low socio-economic or international students. We do not wish to simplify the argument that unpaid internships lead to better learning experiences. Instead, we would encourage all supervisors to see the potential learning with and from their students through their supervision practices.

Viewed at a macro or organisational level, from our study it appears that larger companies focus on enabling technical and practical skills. The human resources structures of these larger organisations, such as formalised induction processes and management of internships, enable supervisors to take on expert roles. However, these practices constrain supervisors from seeing themselves as co-producers of new knowledge with their students. The profit/service model of internship in our study suggests that these supervision practices privilege expert/novice roles of supervisors and students respectively. The arrangements enable learning to be focused on technical and practical tasks. These cultural-discursive, material-economic and social-political arrangements constrain opportunities for supervisors and students to talk about different kinds of learning, to see different kinds of learning as part of their activities, or to have reciprocal relationships to co-construct learning. For many sites of practice, this is a missed opportunity to learn new, more emancipatory sayings, doings and relatings in

the workplace. Our study highlights the need for explicit responsibilities of the engineering faculty to foster their industry partners' commitment to professional learning.

This study had its limitations. Of the eight interviewees, six were from larger companies that offered paid internships, while two participants were from a smaller company that offered unpaid internships. This was also reflected in the survey data where over 90% of respondents were from companies providing paid internships.

Conclusion

The prevailing practices in the sites of practice of engineering supervision in our study for the most part do not provide conditions which nourish reciprocal learning practices for both interns and their supervisors. Many of the sites appear to have conditions which enable students to acquire technical learning, but which constrain possibilities for relational learning where supervisors also learn from their students. We suggest that supervisors who do not expect to learn from their students face several risks. These include reproducing practices of outdated apprenticeship models that reinforce unnecessary power relationships. These practices simultaneously constrain opportunities to learn different ways of practising. This also prompts us to consider how relational learning in the workplace can be facilitated, and to explore the kinds of workplace cultures which enhance relational learning where supervisors learn from and with students. Through the lens of the TPA, this can be seen in the arrangements that constrain or enable practices of relational learning, and in the elements which comprise these arrangements. Trevelyan (2020), critiquing the engineering curriculum in Australia, notes that: 'As generations of graduate students become engineering faculty members prioritising research publications, they tend to adopt teaching styles learned through their own years of formal education' (2020, p.828). A similar point can be made about practices of supervising engineering student interns, because unless current practices are challenged or at least examined, there is a strong likelihood that there will be limited opportunities for new and more learning-focused practices of supervision to emerge. Our findings call for the cultivation of supervisors' sense of professional agency. Without the capacity and commitment to learn how things could be otherwise, there is little hope for improved supervision practices. Future research could compare engineering supervisor practices with those in other disciplinary fields such as medical and teacher education. Future research could use action research approaches that

explore the possibilities of relational learning and that enable supervisors and students to co-create new internship practices.

As the world becomes more complex, supervision practices should not be left behind in an historical, hierarchical apprenticeship model, and instead prepare all participants in internships to learn from and with others. Learning in and from internships can be the site of new ways of professional learning. It makes learning ubiquitous, beyond learning to practise as a disciplinary expert (Dalrymple et al., 2014), which can change working and learning practices at the micro, meso and macro levels. Through this approach, the development of supervision practices can provide the impetus for disciplinary and cultural change.

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Appendix 1: interview/survey questions

How many years engineering practice experience do you have?
Age range: under 25, under 35, under 45, under 55
How many students does your company supervise at one time?
Are the internships paid?
Have you done a coaching or professional development or other formal course about mentoring, giving feedback, managing work performances?
What do you think makes a good supervisor?
How did you get information from [the university] about your role/what is expected of you?
Do you know what your responsibilities and rights are as a supervisor/mentor?
How prepared do you feel?
What are the highlights and lowlights for you as a mentor?
What do you understand to be the intended outcomes of a student internship?
What can [the university] do better for you to help you in your supervising/mentoring?
What do you do in your workplace to help students to develop their confidence as novice engineers?
How do you talk to students about their work performance?
How confident would you be in assessing a student's workplace performance?
Anything else you want to share with me about student supervision?