Influences on the Development of Students' Professional Identity as an Engineer

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Abstract: Understanding how an engineering student develops their professional identity as an engineer offers a way of improving engineering education. This paper explores the experiences of some recent graduates and their employers. Initial results presented point to a few major influences on the development of a student's identity as a professional identity including industry experience during their degree (particularly longer term co-op placements), their cohort including the support they received from it, and large contextual projects conducted in their coursework. Further, this research aims to ask different questions, both in terms of what is investigated as well as how.

Context

The demand for engineers and increasing specialisation and complexity of professional practice requires the engineering profession to develop a holistic and robust understanding of the processes that lead to professional mastery and the sense of identity that can accelerate this learning process. However, it is not just the profession that needs to understand the path to mastery, each student need to begin to understand the different ways of being an engineer that the profession offers, to understand her or his personal strengths and weaknesses in relation to these options, and to understand how she or he can use the process of 'induction' into professional mastery to 'construct' the professional identity that is consistent with personal capabilities and goals.

This paper investigates the concept of a professional engineering identity and puts forward the idea that a student's engineering education should be focused on them developing an identity as a professional engineer. This identity not only includes the knowledge and skills usually developed in engineering programs, but attitudes and self beliefs toward being able to practice as an engineer. In this way it is not just about how to improve learning and assessment in a particular class but instead allows more fundamental questions to be asked: What are we trying to educate our students for? How do we know what they need to know and be able to do? What influences their development beyond the very specific learning outcomes in courses? Is the way that we are educating students now best preparing them to practice as engineering professionals?

Theoretical Framework

Identity and identity development is central to understanding the learning and development of students (Lave & Wenger 1991). For the basis of this paper, identity is understood "not as a relatively stable *possession* of an individual, but as an *ongoing project of construction* by a given individual together with the others which whom she comes into contact" (O'Connor *et al* 2007, p1). Gee argues that someone's identity is them being recognised as a certain 'kind of person' (in our case an engineer) in a given context (Gee 2001). In this way the identity of an individual is both how that individual identifies herself as well as how others actively identify her in the social fields she is active. It is an ongoing process of negotiation taking place in multiple settings and timeframes (Stokes & Wyn 2007). As Gee notes "all people have multiple identities connected not to their 'internal states' but to their performances in society" (2001, p99). In the case of engineering students, this multiplicity of identities includes their identity as:

- A student
- A consumer of products offered by the university
- A member of their cohort at CQUniversity (or any other university)
- A member of the cohort of engineering students across universities
- A student member of the engineering profession

as well as many others.

Gee (2001) identifies four ways to view identity:

- nature-identity (a state developed from forces in nature)
- institution-identity (a position authorised by authorities within institutions)
- discourse-identity (an individual trait recognised in the discourse/dialogue of/with 'rational' individuals)
- affinity-identity (experiences shared in the practice of 'affinity groups')

For example someone may be tall and blond (nature-identity), an engineering student at a university (institution-identity), a charismatic person (discourse-identity), and being a gear head working on a racing car (affinity-identity). These four perspectives of identity are not separate from each other but instead interact in a complex way. For this research though, they offer "four ways to formulate questions about how identity is functioning for a specific person… in a given context or across a set of different contexts" (Gee 2001, p101). How then can this help us understand the development of our students' identities as professional engineers? Can this construction of an identity be attained simply by ticking off the ten graduate attributes by the end of the program?

This paper is also based on emerging research on accidental competencies. From their perspective, at student's learning involves the complex interaction of many different elements. These include individual courses, the institutional environment, their interactions with other students (their cohort), their disposition, background and lives external to the university, and other meta-influences (Walther & Radcliffe 2006). An emergent property of this complex system is their professional identity as an engineer, enabling them to practice. A focus on how students develop their professional identity as an engineer will better prepare our students for practice as well as respect and respond to the diversity of the student body, respect diverse talents and ways of learning, • Better engage students with their learning and improve teaching and learning through curriculum renewal around developing an identity.

Figure 1: Identity Concept Framework (Mann et al, 2008)

Methodology

Recent graduates from a regional university in Australia were selected. The program that they graduated from has been recognised as innovative as it is project based learning (PBL) based, has a co-op program and has both internal and external students studying engineering. Interviews with six recent engineering graduates and four of their line supervisors were recorded, transcribed and de-identified. The four supervisors were included to both talk about the graduates experiences as well as to talk about their own experiences of developing as an engineer.

A thematic analysis (Miles & Hurberman, 1994) was then conducted for influences on their development of their identity. Gee's (2001) four types of identity (nature-identity, institution-identity, discourse-identity and affinity-identity) were used as a basis for the coding process. A framework previously developed by the authors (Mann *et al* 2008) was also used to position the responses within the larger complex system of engineering education.

Findings

Initial results point to a few major influences on the development of a student's identity as a professional identity. These are detailed below along with quotes from the participants themselves.

Industry Experience
Industry experience during their degree, particularly longer term co-op placements, was a major influence on the students. Many students commented that they needed to see practice to fully understand it and contextualise their learning, rather than just be told about or simulate practice. The needed to understand the value of what they were learning, and many interviewed felt that they could only do that through actual practice in industry. As Phillip points out, having prior industry experience "makes the transition to work a lot smoother". Alan responds to a question of what has contributed to his success with: "I think that having nineteen months full-time previous experience... has it's advantages".

Alan goes further, indicating: "I'd say that most of the learning I did at uni was actually learned on the job during the co-op placements". Finally, Alan sums up his beliefs about industrial experience:

> *It's just getting out and seeing it in action. Half of what you learn... a lot of it you don't grasp. They're trying to develop professional attitudes and things... and when you come back from co-op, then it makes sense, what they were trying to teach you. And it's just simple things like being professional in the way you talk to others, being professional and writing and you just learn a lot more professional attitudes... Ninety percent of what I learnt in co-op had nothing to do with the technical side of engineering [but] it makes you prepared so that when you turn up for work your first day as a graduate, you know what you're doing.*

Their Cohort

Their peer network of other students influenced the student's identity development. This included the support they received from each other in facing common challenges as well as being part of something larger than a group of individuals. David talks about drawing on the expertise within his cohort: "look at what each individual person can offer... that made a big difference in the project work".

Mentors

A strong influence through all of the transcripts was the influence that mentors had on the participants. While most of these mentors were senior engineers, often they were others involved in the operations that the students were learning from. Mentors act as both role models, people to aspire to be like, as well as guides, people to turn to for guidance. For example John talked about how he learnt more about road design from the labourers than he did from the engineers, however the hard part was getting them to respect him and open up.

David talked about the role of mentors as guides in his work: "[they're] a big factor definitely. You couldn't sit back and do it without consulting anyone or talking to people... you can bounce ideas off them and learn from them".

Ian talked about a mentor as someone he aspires to be: "You've got to respect that those guys have been doing that job for twenty, thirty years... all the information they've got in their head and I've got to get it out of them".

Social Network

Many participants reported that the social network of where they were learning or working as important to their development. As opposed to individuals in the form of mentors and peers, the larger social network carried with it knowledge of what had been done in the past, which people to talk to and had norms of practice that were specific to that network. Students who had completed two coop placements at different locations reported this difference in practices between the organisations, not in terms of policies of the organisation but rather in terms of the accepted practices of the people in them.

For instance Phillip talks about his second placement, saying: "that's one thing that I've found here rather than at [...] everyone is very knowledgeable and they are more willing to help out and hand out information". Alan also talked about the differences in the social network of the places he worked during his degree: "It gave me a fair spread of engineering experience. Basically just to see what I did and didn't like, and to see how different things operate, between private and public and so forth".

In terms of understanding the social network of the organisation and how it contributes to developing as an engineer:

> *You got to learn who the people were who were going to give you a meaningful answer and who the people were that we going to blow their own trumpet or try to sound smart or spend two hours explaining something that they could give you in two minutes.*

Project Based Learning
Large contextual projects conducted in their coursework influenced the student's identity development. Not only did they have to work in teams and communicate doing real life authentic projects, but they developed different skills, "the world is changing a bit and there is talk of engineers going into project management a few years out. So definitely the skills that were picked up at uni in project management and project group skills I would use" [David]. It should be noted that the participants interviewed were undertaking an engineering program that had project based learning as its core philosophy.

Life Experiences
The idea of growing as a person, as well as a professional was discussed by many of the participants. Generally the participants talked about developing broader life skills as influencing their development. A few of the participants were mature age and had worked in the engineering field before coming back to study engineering. "You're calling on your own sense of judgement of the situation... your own experiences you have had" [David].

What also came through as a major influence was the participants' lives outside of engineering that influenced what they did. David, who was a mature age student, mentioned:

> *"It was a team based decision with my family to do this and so my perspective through uni was very much goal-oriented on getting things done and achieved whereas maybe the younger fellas maybe it wasn't their goal... maybe they were just floating through it"*

From Alan's point of view, becoming a professional engineer follows the life experiences of becoming an adult:

> *I guess you come back from co-op, because you have to out and work in an adult world, you come back, adult. You can spot the difference between the first and the third years who have just returned from co-op. I guess if you didn't have that kind of contact... I got to see a little bit when I was down in [...] last week at a course where you got to see some of the graduates who have just come out of other unis who are still making that transition, and it's like 'Oh, I don't do that anymore'.*

Fundamental Knowledge
Most of the participant's interviews talked about being able to fall back on their technical knowledge then they were unsure of how to proceed. Their technical knowledge became almost a safety blanket, something that makes them sure they are an engineer. Phillip reflects on his experiences and what has helped him: "I guess it's knowing you're as technically based [from] uni".

Feelings of Success
Another major influence discussed by the participants was the feelings of success associated with completing a real engineering project. When they were part of a team that finalised a project they felt a level of self-efficacy toward engineering work. "I think there is a certain sense of responsibility and at the end of it, when it all goes right, you feel pretty good" [Alan].

Academic Staff Identity
The role of the identity of the academics teaching the students influences the students in two ways. Firstly academics act as a mentor however often present a message that is inconsistent with the practice that a lot of students found themselves in. "there has to be some kind of teaching element in it, but consistency, there's no consistency between them" [Alan]. Alongside that, students also commented that many academics that they had did not have any experience at engineering practice and questioned how well they could then prepare students to enter that practice.

Future Directions

These results are part of a larger qualitative study currently being conducted into the ways that different students have experienced their identity development as a professional engineer. This study will include students from across all year levels and use a number of research methods as different lenses on the data, including phenomenography and thematic analysis. The aim of this future research is to ask different questions, both around what is investigated as well as how.

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