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Exploring emerging engineering identities: the potential of possible selves

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ABSTRACT

CONTEXT

The theory of "possible selves", first proposed by Hazel Markus and Paula Nurius (1987), has been used in higher education as a way to understand how an imagined future impact on present behaviour. When future selves are embodied and personalised in identity, they have the potential to become powerful motivations for behaviour. While the concept has been widely used in higher education research, little work has been done in engineering education.

PURPOSE

There is growing interest in engineering education in the ways in which engineering identity is developed. However, sound theoretical and methodological approaches to researching identity formation are lacking in published research. In this paper we explore the potential of the lens of possible selves as an analytical tool for understanding the development of an emerging engineering identity.

METHODOLOGY

The paper draws on data collected from an international longitudinal study at six universities in three countries (UK, South Africa and the USA) over a period of four years. Semi-structured interviews, covering a range of topics, were conducted annually with chemical engineering students at each of the institutions, transcribed and initially coded into broad sets of categories, using qualitative software. For the work described in this paper, we returned to full transcripts to benefit from the longitudinal nature of the study. A qualitative analysis of themes linked to the theory of possible selves was conducted and links between themes were developed.

OUTCOMES

The conceptual framework of possible selves allows researchers to explore the varied ways in which engineering students clarify conceptualisation of their future professional roles. In addition, the theory enables consideration of a temporal aspect of identity development: the notion of a well-developed future self has the potential to impact on current behaviour and make sense of the past.

CONCLUSIONS

Engineering education is about more than the transfer and acquisition of specialised knowledge and skills. In this study the theory of possible selves is applied to gain insight into chemical engineering students' development of an identity as an engineer over the course of their academic careers. We consider a recommendation concerning the potential impact of including intentional opportunities in the curriculum for students to reflect on aspirations for a future as an engineer, in addition to the technical knowledge and skills they gain.

KEYWORDS

Engineering identity, possible selves, motivation

Introduction

In recent times there has been a growing interest in understanding the process whereby engineering students begin to develop a professional identity as engineers. Having been exposed to the sciences (such as chemistry and physics) during their high school academic journeys, students enter higher education with some understanding of the scope and nature of these subject fields. Very few of them initially have a conception of what is involved in being an engineer, and it can be argued that one of the tasks of an engineering education programme is to expose students to technical knowledge, activities and ways of thinking that will enable them to come to 'inhabit' an engineering identity, or at least the inception of one (see the work of Elliot & Turns (2011) on student portfolios). The question for researchers becomes how to access the ways in which students come to identify themselves with the idea of being an engineer. One of the promising conceptual approaches to understand the development of identity is the notion of possible selves – it has been described as a mechanism and catalyst (Ibarra, 1999) for the development of identity.

Over the last thirty years, the notion of possible selves has been widely used in educational research. However, relatively little work has been done in engineering education research. Furthermore, while there is an interest in engineering education in the development of an engineering identity, research literature reveals a lack of sound theoretical and methodological approaches to researching engineering identity formation. This paper reports on a longitudinal study of a group of engineering students as they move through the four years of their degrees.

Hazel Markus and Paula Nurius (1986) first proposed the idea of "possible selves" more than thirty years ago, and it has been used in higher education to think about the way in which a future, imagined view of the self can impact on present behaviour. In the context of university studies, and here specifically engineering studies, the possible self can be linked to a view of success and qualifying as an engineering graduate, or, conversely, being unsuccessful and failing to graduate.

Literature and theory

Identity has been defined in different ways in the literature: being recognised as a certain kind of person (Gee, 2000), as the meanings an individual attaches to themselves and, in particular, as linked to self-concept (Erikson, 2018; Ibarra,1999; Markus & Nurius, 1986). A professional identity deals with the identity in relation to a profession. In his review article on engineering identity, Morelock (2017) describes an engineering identity as the identification with engineering as a profession and with the ways in which it has been defined as a profession. We recognise that engineering students do not leave higher education with a fully-fledged engineering identity (which continues to evolve in professional practice), but, potentially with an inception of an emerging professional identity. In this paper we focus on the notion of possible selves as a catalyst for the development of an emergent engineering identity.

In their seminal 1986 paper, Markus and Nurius describe possible selves as one of the domains of self-knowledge where individuals think about their potential and about their future:

> *"Possible selves are the ideal selves we would very much like to become. They are also the selves we could become, and the selves we are afraid of becoming" (Markus & Nurius, 1986, p. 954).*

In his work on motivation in higher education, Erikson (2018) draws on the theory of possible selves as a useful way to think about student motivation – what matters to students and directs their behaviour. Erikson (2018) agrees with Markus and Nurius (1986) that the theory locates discussions of student motivation in the context of multiple working self-concepts – self-knowledge accessible in thought and memory that helps us make sense of our world and includes visions of ourselves in the future. Possible selves are animated in interplay with self-concept, and, in turn, moderate self-concepts. The more elaborate of these self-schemata guide the selection and processing of stimuli from the environment in which students find themselves and so become important regulators of behaviour (Markus & Nurius, 1986). Possible selves allow a focus on the future-oriented dimension of self-actualisation – in the context of this paper it refers to the

development of an emerging engineering identity as a student moves through their academic journey.

Figure 1 represents our conceptualisation of relations between the environmental stimuli, the self-concept, possible selves and an emerging engineering identity. The notion of a possible self also allows researchers to account for the social and cultural contexts of students that potentially circumscribe the pool of possible selves available to the individual – possible selves are not simply *any* set of imagined roles but are contextual and salient to the individual. It considers both positive and negative conceptualisation of the future in terms of emotional valence (positive and negative emotions evoked), which can be quite complex – many possible selves have both positive and negative dimensions associated with their outcome.

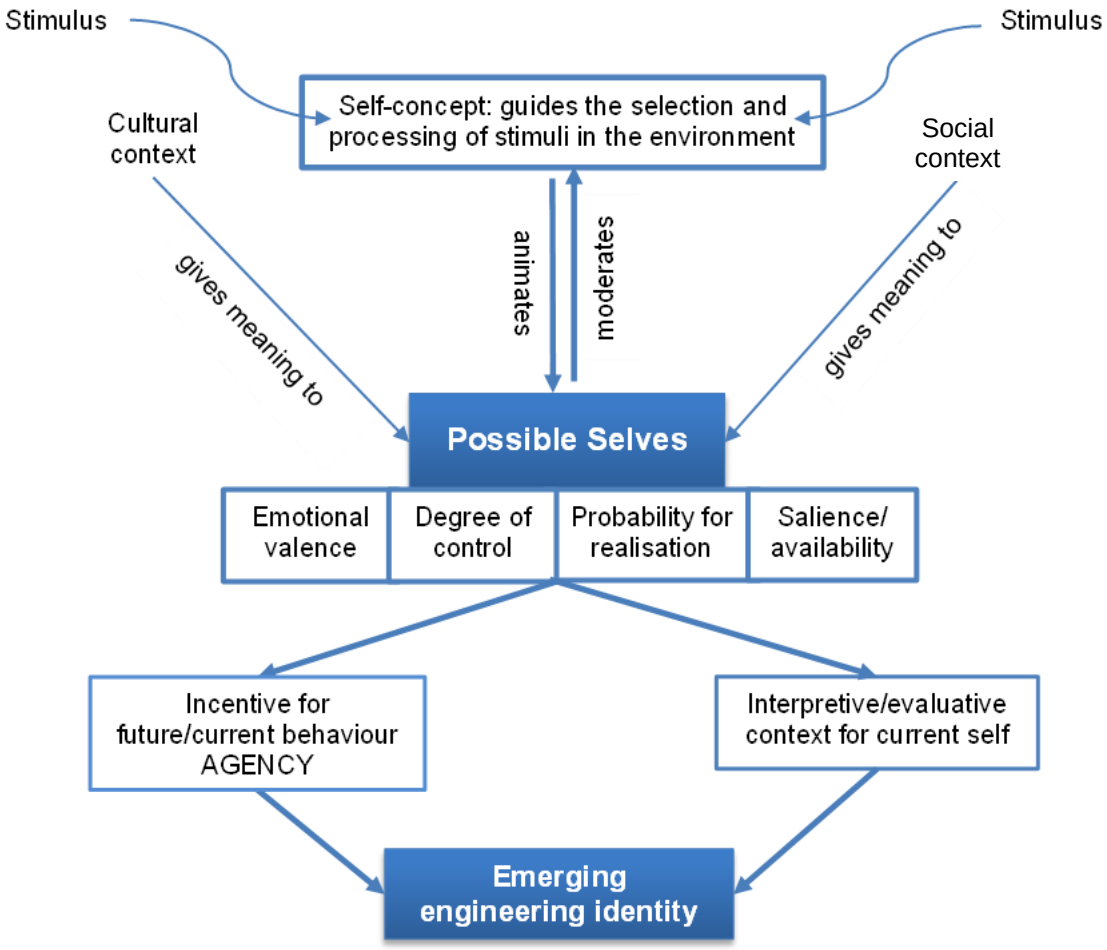

Figure 1: Possible selves: catalysts for an emerging engineering identity

Markus and Nurius (1986) make a two-part argument that pulls together temporal aspects of possible selves. First, possible selves are incentives for current and future behaviour. Secondly, they provide the context against which current selves are interpreted and evaluated. We argue that this demonstrates how possible selves become the catalyst for developing an emerging engineering identity.

Incentive for behaviour

Possible selves form the cognitive bridge between present and future (Markus & Nurius, 1986): when faced with challenges to a (current) self-concept, students draw on possible selves to decide how to act (see also the work of Verdin and Godwin (2015) on role identity, here an engineering identity, promoting agency as students engage with disciplinary content). The extent to which possible selves motivate behaviour depends on a set of conditions: the intensity of the emotional

valence (positive/negative emotions evoked by the possible self), the extent to which the student believes that they have control over attaining or avoiding the possible self, the probability of realising the possible self and the salience (or availability) of the possible self. The future-orientation of possible selves frames and guides current behaviour in the form of motivation and promotes student agency.

Evaluative and interpretive context for present self

We recognise that student identities and self-conceptions are multiple and developing; they are neither 'free-floating' nor fixed. They come with a history and are influenced by experiences in the environment where students live and work. There is a constant re-positioning of the self in relation to the past, present and some imagined possible future self. Although possible selves are distinct from current selves, they interact with present selves by providing an interpretive and evaluative context for current experiences (Markus & Nurius,1986). They also link to past selves with the potential to become a future self, for example, when a student reminds themselves that, "I once got the best grades in my class". This interconnectedness of the self across time explains how the possible self becomes a standard against which the current self is evaluated and understood.

Methodological issues

Future-oriented aspects of lived experience are often neglected in research: in her work on timescapes, Barbara Adam (2008) suggests there is a troubled relation between research and the notion of the future: the past is accessible through memory and historical records. The present can be accessed via perception, observation and mediated through technology. The future, however, tends to feature mostly in research associated with forecasts and planning policies. And yet, our lives are embedded in a future time modality. We project thoughts about the future on acts in the present: we decide based on risk assessment; we hope and plan and worry about possibilities – "the future is therefore an inescapable aspect of social and cultural existence" (Adam, 2008, 11).

Two questions come to mind: First, can the theory of possible selves give us a way to investigate aspects of a future orientation? Secondly, if the future is abstract and intangible as suggested, can the theory help us account for the varied and personalised experiences of students in their journey towards an engineering identity, which, in many ways is an aspirational identification rather than reality at the time of their university studies? How do we access the possible selves of students?

Sfard and Prusak (2005) argue that learning is central in identity formation. In the context of the work presented in this paper, engineering students' academic journeys then take on significance as they interact with technical knowledge, skills and ways of thinking about problem-solving in the disciplinary field. The authors make a further compelling case for a "narrative rendering of identity" (p.17) as a set of reifying, significant, endorsable stories people tell about themselves. There are other scholars who agree with the notion of a narrative rendering of identity: Ibarra & Barbulescu (2010) have argued similarly that a coherent sense of self is formulated in narrative. Anthony Giddens (1991) believes that identity has to be self-reflective, and that biographical narratives involve "integrat[ing] events which occur in the external world, and sort[ing] them into the ongoing 'story' about the self" (p.54).

In this paper we therefore draw on an understanding of identity-as-narrative to explore the usefulness of possible selves as a research approach to examine emerging engineering identities.

Methodology of the study

We draw on data collected from an ongoing international longitudinal study at six universities in three countries (UK, South Africa and the USA) over a period of four to five years. Semi-structured interviews, covering a range of topics, were conducted annually with around ten chemical engineering students at each of the institutions. Anonymised interviews were transcribed and initially coded into broad sets of categories, using qualitative software. For the work described in this paper, the team returned to full transcripts to benefit from the longitudinal nature of the study and follow the trajectories of a selection of students as they develop their disciplinary knowledge

and skills and grow in understanding of what it means to become an engineer. Our focus here is the responses of students to questions on why they chose to study engineering, what they think chemical engineering is, where they see themselves in ten years' time, and how engineering differs from other sciences, amongst others. A qualitative analysis of themes linked to the theory of possible selves was conducted.

Although the student narratives come from different countries and departments with different curricula, teaching methods and philosophies, the 'outcome' of a chemical engineering degree is similar, broadly speaking. This is evidenced in the fact that the professional engineering bodies in all three countries are signatories of the Washington Accord and recognise each other's graduates as competent to work across international contexts. Engineering knowledge is hierarchical in nature (Bernstein, 2000) which means that, similar to other knowledge structures in science, technical engineering science knowledge builds complex and ever more abstract ideas on simpler ideas. One of the implications of this argument for a hierarchical knowledge structure, is that this results in a remarkably similar understanding of what chemical engineering graduates 'look like' – the valued technical knowledge, skills and attitudes that every graduate should have – an understanding of how engineers approach problems in general, and what constitutes a typical chemical engineering problem.

In this paper we discus three of the students, without claiming representativity of the accounts. The data analysis of the three accounts serves as exemplars to investigate the analytical potential of the notion of possible selves as a theoretical the lens to explore variance in the development of a sense of identity as engineering students and future professionals.

Findings and Analysis

Looking at the longitudinal data for individual students through the lens of possible selves shows how academic trajectories influence a gradual expansion of self-conception. We found interesting variance in student accounts of how identity emerges in relation to the disciplinary knowledge and philosophy of an engineering approach. Raheema starts out looking for stable employment. In the end she has developed a confident view of herself as a female role model for women in engineering. As Thomas becomes more familiar with his discipline, he shifts from an instrumental, but perhaps unformed, intention to work in water purification, to a more comprehensive understanding of powerful problem-solving approaches to his world. Jordana grows in her understanding of what chemical engineering is about and her relationship to the discipline.

Raheema

Raheema is a female student at Europium university. Because of weaker A level results her family suggests she rather considers apprenticeships after high school. Her social context thus constrains to some extent her options for a possible future self, but it also acts as stimulus for her:

> *I was like, no. I had my heart set on uni. And I guess it helps with seeing your parents…just how hard they worked without a degree*

In her first year she is uncertain about where her degree will take her, but she hopes for a possible self in "[a] good, stable job".

Her third year is a lab-based placement year and she works in quality control of over-the-counter pharmaceuticals. This experience convinces her that working in a chemistry lab is a possible self she wants to avoid: "I'm glad I didn't choose chemistry…". She is clearer about a future in engineering: "I would… like to work in some plant… something more engineering-focused".

In Year 4 Raheema speaks confidently about her role in a group design project. Individual students take responsibility for different reactor designs, and the group presents a plant site layout with safety assessments and commissioning considerations. Her possible career self as a chemical engineer remains fairly non-specific – she has no strong preference for a particular industry:

> *I've kind of removed that pressure where I'm like, 'Oh, I need to get a job like this.' I'll take what I can get. But wherever I am, I hope there's room for progression*

This desire for space to grow in future is an idea that carries positive emotional valence for her, and it extends to her familial social-cultural context:

> *I just want to show the younger females in my family… that we can go places… with my background, traditionally… females don't go as far as men do… So, it's kind of for that as well, [as well as] just for myself. It's a nice validation, isn't it, when you get promoted*

By Year 5 Raheema is enrolled in a Masters degree. The changing economic landscape following the pandemic years raised uncertainties about the job market she would have graduated in to, and she decides to study further. She looks back at her earlier difficulty to describe the discipline:

> *Initially, I didn't quite understand what we did because it was so broad… Whilst it was traditionally more petroleum focused, as societal needs change and as we advance in technology… [chemical engineering]'s ventured into different industries like the pharmaceutical industry… and biochemical industry... But I guess, at the core of it, it still involves doing something to a process*

She identifies with the industry and includes herself in a description of an engineering possible self: "We design, we make, we improve processes… we focus a lot on health and safety…" Her possible self has become elaborated and the probability of realising it has become stronger. She sees possibilities for action – reading a professional magazine has made her aware of gender disparities of engineering salaries in industry, and she now speaks of a need for ambition:

> *…last year I would have been happy to get into any job and taking anything. But, I guess, reading the Chemical Engineer.... Whilst I was complacent before, I now want to do something. I'm not sure which career path I'll go down, but I do want to do a lot more*

Raheema looks back over her 5 years as a chemical engineering student: "I feel like I've matured a lot. I've grown a lot... a lot more resilient".

Thomas

Thomas studies chemical engineering at Sodium university. His socio-cultural context gives meaning to his view of himself in his first year: "I think I want to… [work in] water purification…" He explains the link between his hope for a future self and his past self in his family of origin:

> *My dad is a farmer, so the drought — there's often drought. Water is — it is hard to describe how important it is, and for me to be able to ensure that there is more water or [better] quality water is a big thing that I can do, I feel, for humanity*

He looks beyond himself to a future self that contributes to infrastructural needs in his country.

It is important for Thomas to excel in his studies – he has been told that any

> *chemical engineer[ing student] that completes [their studies] in just 4 years is seen as a genius… it's very, very difficult*

This spurs him on: "I really want to finish in the minimum time… I want to be able to attempt anything that I want to do…". He has a clear focus of this goal that carries strong positive emotional valence for him. He believes he has some control over this possible self, and that it represents a realisable goal. Thomas describes how he sees himself as fairly relaxed about many things, but sets high standards for his academic performance, almost "in an unhealthy way" – his possible future self of a successful graduate pulling off graduation in minimum time becomes the interpretive context against which he measures his current self, all the time.

By year 2 Thomas has a much clearer understanding of what is involved in chemical engineering:

> *last year I did not even know chemical engineering is mainly about engineering … plant design… management… control. And how one does it… it's also more business[-like] than what I expected because [of] the economic, financial business aspect of … how we make it on a big scale*

He starts making sense what problem solving (in a general, abstracted way) means in the context of engineering:

> *it's problem solving, [to] see something, to have the idea to solve it and use what is at hand. It sounds very simple but there's a quite a technique to take what one knows and from there… to solve the problem. Or, if one needs more… [information], to know how to find it*

By year 3 Thomas is on track to meet his goal of completing his studies in minimum time. He strongly identifies with a possible self in which he describes an inherent ability to think differently:

> *… it is not an effort to switch to a problem-solving approach… it's not even… [that] I am forcing myself to immediately think that way… [it] is related to something… that I already had in the back of my mind*

He expands: "It's about noticing relationships… we see the same stuff [as other people do] and… [o]ur thoughts are just about solving problems

In his final year Thomas unpacks the idea that "everything is about money". As a future engineering professional, he sees the link between a profit-making requirement for industry and concerns about safety and sustainability. The fiduciary responsibility of the engineering professional stretches beyond the need to make a profit for a client:

> *To tell the truth, these processes [that] are considered for money, also of course [matter] for the safety of people… One needs to design a plant in a way and build it so that it works as efficiently as possible, with as little waste as possible – that is also good. To minimise waste has financial advantages, as well as for the environment of course*

Thomas completes his studies in the four years that represents minimum time for the degree.

Jordana

Jordana describes her socio-cultural context in her first year of study at Astatine university:

> *… essentially, my family's all doctors. Everyone [in my] extended family. And so, they really, really wanted me to be a doctor*

In light of these expectations, she registers for a degree in biochemistry (as a pre-med option). As the semester progresses, she becomes more interested in chemical engineering, and she changes her major, initially without telling her family. Her possible self of becoming a chemical engineer carries great emotional valence for her, so much so that she is willing to go against her family's wishes. She exercises agency to exert a degree of control over her desire to study chemical engineering. When Jordana's mom finds out, she agrees to the new situation, provided Jordana still keeps her options open: "Just do the bio track so you can go to med school after." Jordana's possible self is a clear goal: she feels strong about it (positive emotional valence) and is willing to go against her family's wishes; she sees it as an available option over which she has some control to make it happen, and she recognises a high probability of realising this self: "… if I do well, she's okay with me not going to med school… I just have to do really well". Her possible self forms the interpretive context for her current (student) self and provides incentive for her to excel.

By her third year of studying engineering, Jordana sees chemical engineering as

> *… using a knowledge of chemistry and math to be able to model processes, both industrial and in nature, as closely as possible… to utilize them efficiently or make recommendations based on them, in a safe and efficient or most profitable manner*

She describes a personal engineering approach to problems in terms of her self-conception:

> *The first thing I think is, 'What can I do?' You become much more of a doer rather than a, 'Oh, I'm going to wait until I know exactly what's going on, and then I'm going to attempt it.' You become like, 'I have all the pieces and I'm just going to work my way and keep figuring things out until I get more pieces'… [y]ou just piece together what you can and move on*

She contrasts this approach with those of friends planning to go into medicine who tend to “need to have things perfectly”. She has grown in confidence in her ability to solve problems, even those that are open-ended and ill-defined:

> *… I think, in engineering, you learn to take… whatever pieces you have and put your qualms to the side and just dive in, and that makes you just a much more efficient person, worker, inventor, designer, whatever you'll be in the future*

Eventually, Jordana decides to go on to medical school after her chemical engineering degree. Even though she re-focuses on a new possible self, there is a strong sense that the engineering identity she developed over the past four years was an integral part of her journey:

> *… in engineering, I think there's a much higher emphasis on critical thinking and drawing applications versus any other kind of study that… I've been exposed to*

She looks back at chemical engineering and feels a sense of accomplishment:

> *Part of me just picked chemical engineering because it was the hardest subject… [I am] very satisfied just knowing that I can do it and [even if I]… do something else with my life… I've proved to myself that… everything's attainable if you put your mind to it*

The student examples discussed illustrate three clearly different emerging engineering identities for the students, even though they were inducted into to fairly similar technical bodies of engineering knowledge, skills development and engineering approaches to problem-solving.

Looking at the development of the students in the light of the theory of possible selves allows the researchers to interpret the different student narratives: Raheema’s shift is traced from an employed possible self in a stable job, to a detailed and nuanced engineering possible self with the potential to act as a role model for young women in her family. Thomas enters chemical engineering studies with a vague notion of a possible self working in water purification. Over time he develops an elaborate and rich possible self as a successful engineering graduate, completing his engineering studies in minimum time, and with a clear view of himself as an intuitive problem-solver. The lens of possible selves reveals Jordana’s journey of discovery as she initially resists family pressure to meet their expectations of a future self. She discovers what chemical engineering is about, and relishes in her ability to tackle complex problems, even though she ultimately decides to pursue medical studies in a post-graduate degree.

Conclusion

The theory of possible selves allows exploration of the way in which students' social and cultural contexts shape their conception of a possible future self, and the ways in which these selves become an important interpretive context for the current self. It also allows the researcher to uncover ways in which the possible self becomes an incentive for behaviour towards realising the future self.

An interesting curricular implication for the study is a question about the importance of providing students with opportunities to reflect on their journey – the students in the study agreed to participate in a research project where questions were designed to allow them to look back on experiences and reflect on their development. However, these opportunities are not standard fare in a typical engineering curriculum, and one could speculate that students could benefit from intentional space being created in engineering curricula to allow for reflection on development.

The paper therefore contributes to conversations about the development of an engineering identity as students move through their academic journey. Methodologically, the theoretical framework of possible selves provides researchers with a productive analytical lens to account for granularity in student experience as they make sense, integrate and build a coherent narrative of their process towards becoming engineering professionals. Furthermore, the theory facilitates access to the

temporal aspect (past, present and future) of students' lived experience. It is possible to track the way in which students' conceptualisation of what engineering is about develops during their university degree, and how they grow and change as individuals in relation to the disciplinary knowledge and ways of thinking characteristic of their discipline.

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