

Emerging student-centred perspectives on work placement as a component of mechanical engineering technology education

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Abstract

The paper reports on a qualitative study that explores how work placement experiences of mechanical engineering students affect perceptions of their own competency development. The study focuses on twelve information-rich cases. Data for the study was collected using semi-structured interviews that were conducted with students at the end of their placement period. It was transcribed, coded and analysed. Resulting themes and categories were then compared with the core concepts of social cognitive theory. Seven distinct category themes were identified from the analysis: student work actions, organisational contextual factors, mentorship structure and quality, personal factors, social networks, competency development, and work tasks. Organisational culture emerged as a regulator of the triadic reciprocal causation of learning in the workplace. Two types of organisational culture were discovered in the study: rigid culture and affiliative culture. A rigid culture limits student access to both authentic tasks and appropriate mentoring. The reciprocal effect of students' approach to work solicitation, personal agency and self-efficacy are of lesser strength in a rigid culture. The dominance of organisational culture falls away either when there is a formalised mentorship scheme or in an affiliative environment. It was found that in the latter culture, student approach to work allocation is a major influence on competency development.

Introduction

Since 2014, South African Universities of Technology (UoTs) have had an option of offering a 240-credit diploma which does not prescribe work integrated learning (WIL) that includes work placement or a 360-credit diploma that includes six months of work placement as a component of WIL (Council on Higher Education, 2011a). Availability of the first option was mainly in response to the many challenges around work placement of students. One key challenge faced by the UoTs is the growing resource constraints as there is a dwindling pool of companies that are willing to host an ever-increasing number of students (Council on Higher Education, 2011b). Student headcount in South African public universities is rapidly increasing, with growth by 23% reported between 2008 to 2013 (Council on Higher Education, 2016). The increased enrolments have placed a huge administrative burden on universities to place, monitor, support and assess students. For the second option, the duration of work placement was reduced from twelve months, as is the case in the current diploma, to six months to accommodate new subjects.

WIL encompasses a diversity of curricular practices such as job shadowing, industry based projects, apprenticeships, service-learning, scenario-learning, work placement and others that

share the pedagogical goal of integrating formal learning and workplace concerns (Council on Higher Education, 2011b). For this paper, WIL is limited to work placement. Despite the implementation challenges, WIL is considered to provide substantial benefits to students, universities, and industry (Lock, Bullock, Gould, & Hejmadi, 2009). According to Keleher, Patil, and Harreveld (2011), WIL facilitates the transition from graduate to worker by supporting the development of employability attributes of graduates. In addition, Brooks & Youngson (2014) stated that employers have positive views of graduates that have had appropriate work experience during their studies. Students who have undergone some form of work experience during their studies are more likely to gain graduate level work upon graduation (Brooks & Youngson, 2014).

In a UK study by Lock et al. (2009) on mechanical engineering students' work placement experiences, most of their respondents reported a positive perception of work placement. The students recognised the role that work experience gained during placement was likely to have in enhancing their career progression and post-graduation employment prospects. The students claimed that work placement increased their confidence, maturity, interpersonal skills, and aptitude for learning. These findings were supported by an institutional-wide study at the University of Huddersfield by Brooks and Youngson (2014). While the latter study did not find any statistically significant difference between employment rates of work and non-work placement students, they reported that 80.8% of work placement and only 53.8% of non-work placement students managed to secure appropriate graduate level jobs upon graduation. Similar employability benefits and positive student work placement experiences have been reported in studies from other Organisation for Economic Co-operation and Development (OECD) countries.

A study by Reinhard, Pogrzeba, Townsend, and Pop (2016) claimed that work placement benefits, such as those reported in the Lock et al study, might not be present in South Africa as its industry might not be able to readily provide sufficient opportunities for students. This scepticism is shared by some South African researchers such as Mutereko and Wedekind (2015) who doubt the efficacy of South African industry as learning places. They suggested that since workplace conditions in host companies are not heterogeneous, student placement experiences vary in terms of their educational value and quality. Mutereko and Wedekind (2015) claimed that this diversity in experience undermines the value of WIL as an educational practice. They also reported that there is a perception that South African employers use WIL students as a source of cheap labour. However, other South African studies by Du Plessis (2010) and by Jacobs (2015) have reported positive experiences by work placement students. They reported that South African companies prefer to employ WIL student upon graduation than non-WIL students mainly due to their perceived knowledge of the work environment.

It is evident from the above that there is no consensus in South African literature on whether or how work placement promotes competency development of engineering students. This paper explores this by focusing on experiences of mechanical engineering students during work placement, and how these experiences affect their perceptions of their own competency development and employability. The perceptions of other stakeholders such as employers and academics will be reported on in later work.

Theoretical framework

Martin et al. (2014) claimed that social cognitive theory is one of the most influential theories that are used to explain mechanisms of behavioural change resulting from public health or mass media campaigns. Applicability of social cognitive theory is not limited to the above fields, it can also be used to explain learning within other social contexts such as the workplace (Snowman, McCown, & Biehler, 2012). Central to social cognitive theory is the bi-directional interaction of behavioural patterns, personal factors, and the physical and social-structural environment (Bandura, 1986; Ormrod, 2016). A student's personal factors, behaviour during placement, and organisational contextual factors at a particular workplace interact in a triadic reciprocal causation system for competency development and employability (Bandura, 1986). The bi-directional influence of the above three elements is called triadic reciprocal causation and can be represented as shown in Figure 1. Bandura's triadic reciprocal causation model posits that a person's learning is a result of interactions among personal, behavioural, and environmental factors.

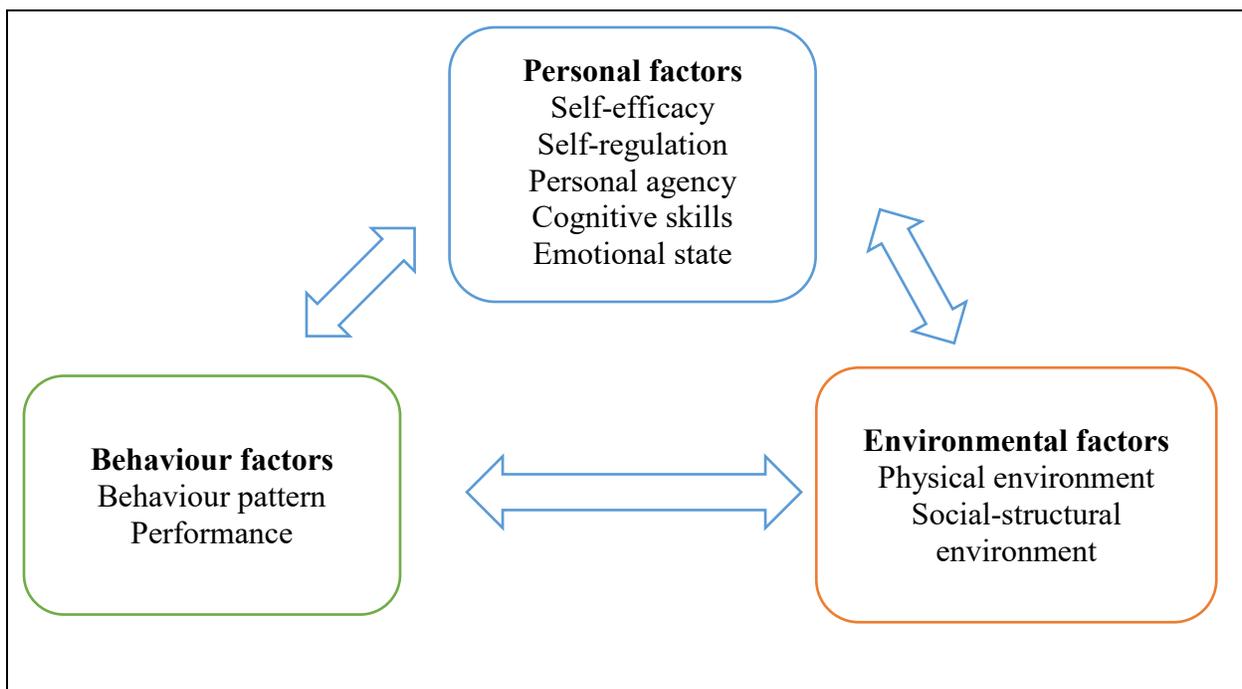


Figure 1. Bandura's triadic reciprocal causation model (adapted from Snowman et al., 2012)

Causal elements in Bandura's triadic reciprocal model do not necessarily exert influence of the same strength (Bandura, 1986; Ormrod, 2016; Snowman et al., 2012). The relative strength of a particular causal element depends on context. Also, the elements do not act simultaneously. It takes time for causal factors to exert influence and to activate reciprocal response from the other causal elements. Bandura's triadic reciprocal causation addresses both the development of competencies and the regulation of human action (Olson & Hergenhahn, 2013).

Personal factors include personal agency, self-efficacy, self-regulation, cognitive skills and emotional states. Personal agency is the capacity for one to exercise control over one's own thought processes, motivation and action (Bandura, 1989). Social cognitive theory provides a framework that recognises that people act as agentic operators in their lives (Bandura, 1986). They are not merely onlookers of brain mechanisms destined to respond to environmental events (Bandura, 2006). Neither are people's actions and behaviour solely the product of internal processes nor are they mechanistic responses to environmental stimuli (Bandura, 1986). Although not autonomous, people are contributors to their own destiny, their thoughts serve a determinative function (Bandura, 1986; Snowman et al., 2012). Social cognitive theory posits that people, and not environmental forces, are the predominant cause of their own behaviour (Bandura, 1986).

Research design

The study focused on twelve information-rich cases that were selected using maximum variation purposeful sampling. Suri (2011) and Benoot, Hannes, and Bilsen (2016) recommended maximum variation purposeful sampling for qualitative studies that seek holistic understanding of patterns and essential features that cut across variations of a phenomenon such as work placement experience. Participants were sampled across nationality, type of host company, prior exposure to work experience, and race. One of the WIL coordinators who is responsible for placing, monitoring, and assessing WIL students served as a key informant for the study and assisted in identifying potential participants who fit the study criteria. An individual student served as a unit of analysis.

Patton (2015) warned that a trade-off between breadth and depth of a study often dictates the smaller sample size for an in-depth study. For studies such as the one reported here, Flyvbjerg (2006) recommended a sample of three to four cases that are different in one dimension or another in order to ensure in depth understanding of the studied phenomenon. The sample comprised one international student and eleven South African students who were enrolled at a single university of technology. Four students had been placed in engineering consultancy firms, two in research institutions and six had been placed in manufacturing companies. Six students were black, five were white and last one was coloured. Two students had prior work experience, one in an administrative role, another in an engineering consultancy while the rest had none.

Data collection was through semi-structured interviews. The students were interviewed on campus after they had completed twelve months of work placement. The data was analysed inductively using qualitative methods of coding to establish categories and themes. These themes were compared with the core concepts of the theoretical framework. Five cases were used to develop themes and categories. Another seven cases were used to check for theoretical saturation (Flick, 2014).

Results

Seven distinct category themes were identified: student work actions, organisational contextual factors, mentorship structure and quality, personal factors, social networks, competency development, and work tasks. Each category theme had subthemes as indicated in Table 1 below. According to social cognitive theory, student work actions constitute behaviour. Mentorship

structure and quality, social networks, and organisational contextual factors are environmental factors. Work tasks are learning activities.

Table 1. Category themes and sub-themes

Theme Number	Category theme	Sub-theme
1	Organisational contextual factors	Inter-departmental mobility Organisational culture Appropriate mentorship Poor mentorship
2	Mentorship structure and quality	Third party mentorship Formalised mentoring scheme Semi-formal mentoring scheme Informal mentoring
3	Student work actions	Approach to task allocation Pattern of working Participation Emotions and perceptions Outcome expectations
4	Personal factors	Self-efficacy Self-regulation Personal agency
5	Work tasks	Non-diploma level tasks Appropriate level tasks Basic training
6	Competency development	Competency gap narrowed Competency gap retained
7	Social networks	Family centred networks University centred networks

Theme 1: Organisational contextual factors

Organisational contextual factors regulate access to learning opportunities during placement. In the study, organisational contextual factors comprised inter-departmental mobility and organisational culture. In some organisations, WIL students were assigned to one department. In others, they rotated amongst the organisation's engineering oriented departments. The departments served as a component of the physical environment. The other organisational contextual factor, organisational culture, was an element of the social-structural environment. Two types of organisational culture were discovered in this study: rigid culture and affiliative culture.

In rigid culture, there was emphasis on standardised procedures and processes, and deviations from norm or mistakes were not tolerated. Performance targets drove operations. In this culture, there was a belief that standardisation, not people, was responsible for meeting performance targets. Rigid culture was often associated with a hierarchical structure. In a hierarchical structure, employees mostly focus on their assigned tasks. In such an environment, mentors and other employees consider student guidance as a distraction. Rigidity in an organisation's culture affects

mentorship and the nature of work tasks that are given to students. In the study, fear of costly mistakes drove mentors to give students peripheral tasks. Mentors often had to balance the time and energy that they spent guiding students and their business-related obligations. Their response to the challenge depended on how the company culture limited their flexibility. A rigid culture limited mentor flexibility. Sometimes mentors responded to the rigidity by either delegating their mentoring responsibility down the company's hierarchy or limiting the time they spent guiding students. As shown in comments below, students experienced poor mentorship in such a culture.

You only have a limited number of questions and everybody is so busy. So, you have to kind of fit your way in. I think supervision was the biggest problem (Student 3).

They will not take you along. They will be so focused on that thing that they'll just get skilled people to fix that thing as soon as possible and they would have you do some other work and stuff (Student 1).

Though I was working with the project engineer. I was not even present at most meetings... (Student 2).

In an affiliative culture, hierarchical boundaries are blurred. Employees often work with others who occupy different positions on the company hierarchy. In such a culture, WIL students have access to people and non-position specific tasks. In this culture, mentors did not struggle to provide appropriate training to students even in the absence of formalised company training programs. Examples of students' positive experiences in an affiliative environment were highlighted in the comments below:

It was a very friendly working environment so you would approach your fellow engineers if you needed information on something (Student 4).

The company suggested that they are going to move me around in the departments and also send me to outside companies to get more training in fields that are more related to engineering (Student 5).

Theme 2: Mentorship structure and quality

Nature of mentoring is sometimes dependent on host company organisational culture. Appropriate mentorship was associated with the existence of a formalised mentorship scheme or an affiliative culture. Poor mentorship was associated with a rigid culture. There was a causal link between poor-party mentorship and third-party mentorship. With third party mentoring, the substitute mentor does not often have access to WIL student learning guidelines. Consequently, the substitute mentor might assign non-diploma level tasks to students unintentionally. Student 2 comment below highlights some of the challenges of third party mentoring.

Most of the time the people who were allocated to us would tell us that you are going to be working with this artisan today. ...the artisans... would just be sending me to places ...I was not really working (Student 2).

Students indicated that the limitations of rigid culture were mitigated by the presence of a formalised mentorship scheme. In a formalized mentorship scheme, students were assigned to departments and given specific performance targets. This facilitated learning although it

compromised the authenticity of assigned tasks. Student 10 and student 11 reported that they spent six months in a formalized mentorship scheme that had an assessment at the end. Renewal of their contracts for the next six months depended on their performance in the assessment. They reported that this eased the transition into the workplace.

Theme 3: Student work action

Student work action comprised student approach to work allocation, nature of participation, and the pattern of working. These elements influenced learning during placement. Some students were proactive in seeking work allocation, while others waited for their mentors to allocate tasks to them. Those that were proactive tended to be more involved in authentic activities and took less time to integrate into the work environment. Even in a rigid culture, proactive students tended to be involved in more activities than those provided by their designated post. In such a culture, students were usually allocated a specific post resulting in limited exposure to position specific tasks only as illustrated below. Requests for access to other tasks were often rejected.

I was responsible for all the testing of materials, welding procedures, the works. I was in the test lab basically... Before I left, I wanted to learn to become a welding engineer, however they rejected my request (Student 3).

The pattern of working influences student learning. Students who worked in a team moved from peripheral to core participation in work activities faster than those who worked mostly alone. Findings from the study indicate that working in a team was influenced by organizational culture, the student's approach to work allocation and personal agency. Proactive students attached themselves to workers whom they admired. A proactive student who wanted to learn non-destructive testing of welds outlined his strategy below:

I built relationships with these people. Probably after the first seven months, we had lunch and coffee together... I asked them if I can do it because it's there. Of course, they will be supervising me. I was just doing it to learn basically so that I have experience (Student 3).

On the other hands, students who preferred work alone took longer to integrate into the work place

Theme 4: Personal factors

Organization context has an affective and cognitive influence on students. Reciprocal students' influence on the organizational context was mostly through the exercise of personal agency. Personal agency is often exercised through intentionality and forethought. Prior to work placement, students developed a mental picture of what constituted the work of a mechanical engineering technician. The resulting mental picture influenced the students' intentions and their expectation-outcome contingencies. The students' intentions resulted in cognised goals and their execution strategies. This affected the students' personal agency. Personal agency was manifested in the way students solicited work tasks. Students with high personal agency actively sought tasks that would assist them in moving from peripheral observers to active core participants in work activities. One such student summarised his goal of achieving core participation below:

I am the type of individual that likes to be involved in major activities. I wasn't comfortable with being below and not knowing the whole picture of what was happening. I wanted to be involved in all aspects of the design (Student 4).

Theme 5: Work tasks

The nature of work tasks that students undertake in the work place has a huge influence on their perceived self-efficacy and perceptions of career prospects. Participation in authentic work activities was associated with high task self-efficacy and narrowing of the student and practitioner competency gap. An authentic activity is one that meets both organisational and student learning needs. For a task to be authentic, it must be like those performed by full-time technicians in the organisation and require using similar cognitive and physical tools. For example, Student 4 comments indicate participation in authentic tasks whereas Student 2 comments indicate use of different tools by practitioners and students.

From the workshop, I was given an office with a computer with drawing software and everything that I needed to start doing some drawing work on concept designs on the projects that were ongoing in the company (Student 4).

Filing a block of metal, carrying a file and filing. The workers there, if they are doing the same thing. They would go about it a much easier way. For example, machine it but us they would want us to file it (Student 2).

Theme 6: Competency development

The employability benefit of WIL is primarily due to competency development during work placement. Students' perception of their employability improves if they think that the competency gap between themselves and practitioners has been narrowed. The students' perception of whether they have narrowed the competency gap was influenced by the nature of the work tasks and their participation in the workplace. They associated task self-efficacy with general career self-efficacy. The students associated the performance of similar tasks with practitioners with narrowing of the competency gap. In the study, all students who thought that their task competency gap had narrowed believed that they were work ready. Student 5 corroborated the above assertion as follows:

If there were projects, they would give me one or ask me to help with a project. We were kind of doing the same things with the engineers who were working full time... Now I am more confident and I know that I can tackle any project that is given to me (Student 5).

Theme 7: Social networks

Students use the social networks to find solutions to their workplace challenges. The students turned to their social networks, family members and university classmates, to solicit for help and advice. The students also used these networks to be linked with industry professionals who might offer insight on their current work assignment or challenge. In doing this, the students learnt the value of professional networks. Student 6 aptly summarized the benefit of social networks below:

I had to consult with my dad to get the number of a mechanical engineer. You do not have contacts in the industry, you do not know where to go in the industry and knowing where to go helps you quite a lot (Student 6).

Another student tapped into his social networks for assistance on how to deal with friction with his mentor.

I did not know how to deal with it...we were not taught to handle conflict...I would have been going out, not knowing what to do...my father suggested that I talk to him [a manager in another division of host company]...he told me to go and discuss the matter with him [mentor] (Student 9).

Discussion

The findings suggest that organisational culture has a dominant influence on learning for competence development during work placement. In a rigid culture, mentor non-availability caused poor mentorship which was associated with third-party mentoring. Student 2 aptly summarised the causal chain when he said, “I had to find my own people.” The prevailing culture influenced the students to seek help from non-technicians who could only provide access to non-diploma level tasks. At the same time, the environment caused students to fear for their career prospects. Fear of ruined career prospects started the push back chain of personal agency exercised through self-regulation. Students actively associated with work colleagues to attempt to remedy the shortcoming. This exercise of personal agency was not always successful. For example, Student 2 grew despondent and had to leave the host company. Thus, personal factors can influence student behaviour. In this culture, students’ behaviour exerted reciprocal influence on personal factors, but it had minimal influence on the imposed environment. Organisational culture’s influence was almost one-directional (see Figure 3 below). Social cognitive theory acknowledges the existence of unequal strength in the causal elements (Ormrod, 2016; Snowman et al., 2012).

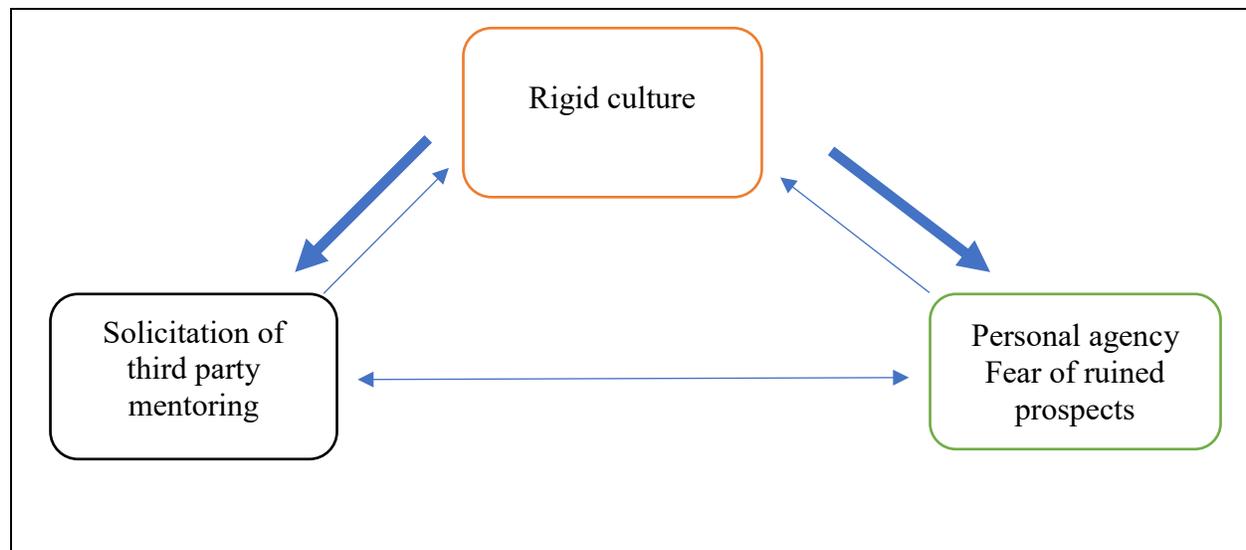


Figure 3. Interaction of causal elements in a rigid culture

Interaction of causal elements highlighted in Figure 3 resulted in the retention of the competency gap mainly due to lack of access to authentic diploma level tasks. Students must participate in authentic work activities that are at an appropriate level for the student-practitioner competency gap to be narrowed (Keleher et al., 2011). Third party mentors who are on lower positions in an organisation's hierarchy are not usually able to provide access to appropriate tasks. Thus, third party mentoring is not usually a solution for poor mentoring. The challenges arising from poor mentoring in a rigid culture can be addressed either by provision of training on efficacious mentorship to potential student mentors or through the development of formalised mentorship schemes.

An affiliative culture provides for reciprocity in causal influence as indicated in Figure 1. Competency development does not solely depend on the existence of an affiliative culture. Personal agency expressed through a proactive approach to task allocation influenced student exposure to authentic work activities. Lock et al. (2009) had similar findings. Students in that study reported that it was expected that students take the initiative in soliciting appropriate experiences in the workplace. Participation in appropriate level tasks promote the development of self-efficacy through the creative influence of performance accomplishment (Bandura, 1997). Presence of a supporting mentor has potential to reinforce a student self-efficacy through social persuasion. Once established, self-efficacy affects students' perceptions, motivation and forethought processes. Students with high self-efficacy are more proactive and resilient in their pursuit of meaningful work experience.

Students who were proactive in soliciting work assignments were exposed to more diploma level tasks than passive students. These proactive students also experienced less challenge in integrating into the work environment at the host company. Even in cases where there were cultural and gender barriers initially existed, proactive students overcame them earlier than students who were passive in their approach to work allocation. It seems that mentors treated proactive students differently. They trusted these students with work activities that required more responsibility and that had more value to the company.

Performance of authentic tasks also assisted students in their self-reflection processes. Sometimes, students' self-evaluation of their capabilities was inaccurate. Participation in authentic activities provided them with opportunities to test the veracity of those self-beliefs. Student 5's comment below illustrates this:

Before in service, I thought I would look for a job and be successful, but when I was doing my in-service I realised that I was wrong (Student 5).

Conclusions

Experiences of mechanical engineering students as they perform work tasks, interact with their mentors and other co-workers and the general work environment affect their perceptions of their own competency development. The study found that student work actions, organisational contextual factors, mentorship structure and quality, personal factors, social networks, and work tasks affect students' perceptions of their competency development. The study also found that organisational contextual factors, particularly organisational culture, regulate access and the triadic

reciprocal causation of learning in the work place. A rigid culture limits student access to both authentic tasks and appropriate mentoring. The reciprocal effect of students' approach to work solicitation, personal agency and self-efficacy are of lesser strength in a rigid culture that does not have a formalised mentorship scheme. The dominance of culture falls away in an affiliative environment or in a rigid culture that has a formalised mentorship scheme. In an affiliative culture, student approach to work allocation is a major influence on competency development. Consequently, the effect of organisational culture, student approach to work placement and social networks on competency development during work placement cannot be ignored.

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