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RESEARCH ARTICLE

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Engineering students' perceptions of the role of work industry-related activities on their motivation for studying and learning in higher education

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ABSTRACT

A number of key graduate outcomes related to industry-based interventions and work-industry-related activities (WIA's) are specified by the Swedish Higher Education Ordinance for all Engineering Degree Programmes. A paucity of research regarding student perceptions of these WIAs and their role in student's motivation for learning motivates the current study. Understanding student perceptions of WIA is critical to ensuring the effective integration of WIAs into engineering education. This study explores the perceived motivational effects of WIAs with which students engage through the lens of self-determination theory. Semi-structured interviews were conducted with nineteen master's students studying in two research-intensive Swedish universities. Six themes emerged from thematic analysis. The themes describe the impact WIAs can have on student motivation in terms of their perceptions of (1) relevance for the development of knowledge and skills, (2) influence on the student's future profession identity, (3) utility for gaining industrial experience, inclusive of research experience, (4) relevance to student's programmes of study, (5) industry marketisation agendas, and (6) alignment with industry needs over the student's own needs. The motivating and demotivating aspects of WIA's based on these themes are discussed to improve the collaboration between industry and academia in engineering education.

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Motivation; engineering education; work industry-related activities; semi-structured interviews; thematic analysis

1. Introduction

Industry engagement activities are pedagogically critical in engineering education as a means of improving students' learning experiences (Rodrigues 2004). Academia-industry collaboration provides students with opportunities to engage with up-to-date industry practices, learn more about their profession, and develop skills and competencies to be more effective in the classroom (Herrmann 2013). Over the past two decades, work-industry-related activities (WIAs), such as guest lectures and internships, have been used as pedagogical interventions to support students in gaining an understanding of how engineering education learning outcomes are applied in real-world situations (Isomöttönen et al. 2019; McDermott et al. 2018). While different kinds of WIAs have been investigated to determine their impact in terms of learning and knowledge application (Patil et al. 2012; Schambach

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and Dirks 2002; Smith et al. 2009), little research has been conducted regarding their effect on students' motivation for studying and learning in engineering education. Drysdale and McBeath (2018) highlight the importance of industry collaboration with higher engineering schools for positively impacting students' achievement, and educational developers in engineering education regularly try to reform curricula to include industry experience. However, research has shown that this process is often perceived as not being conducted in a way that is most appropriate for meeting student and industry needs (Alboaouh 2018; Male and King 2014; Wallin et al. 2014).

Previous research demonstrates that increased student motivation can significantly increase student retention, levels of educational achievement, and professional success (Flowers and Hermann 2008; Woods 1995). However, there are many factors that can influence students' motivation that universities and educators often overlook (Koca 2016; Lumsden et al. 1994; Sogunro 2015). One way to achieve a positive impact on student motivation is to integrate industry experiences into education (Brooks, Freiburger, and Grotheer 1998; Dev 1997). Similarly, the broader culture of higher education institutions can affect students' motivation to study and learn (Peterson and Spencer 1990; Tierney and Lanford 2018). According to Schunk, Meece, and Pintrich (2014), institutional culture components such as task and work practices, authority and management structures, grouping practices, assessment practices, time use, recognition and reward structures, and climate have a strong influence on student motivation, behaviour, and learning outcomes. When ideologies, beliefs, patterns of organisational behaviour, and shared values of higher institutions are contradictory to students' expectations and beliefs, their motivation to study and learn can be negatively affected (Abdulcalder 2015; Al-Otaibi, Yusof, and Ismail 2019; Nupke 2012).

Despite the efforts and close collaboration between Swedish engineering universities and industry to develop a common strategy for students', there is a lack of evidence relating to students' perceptions of WIAs. To our knowledge, no systematic investigation of student perceptions of WIAs has been conducted about how Swedish students' perspectives of industry affect their motivations to learn engineering. Moreover, the institutional culture of engineering schools and its impact on students' motivation is often not included in much related empirical work. Thus, the purpose of this study is to gain insight into Swedish students' perceptions of WIA's insight into motivation for studying engineering.

An important clarification is how this relates to the research on work-integrated learning (WIL). The work on WIA's reported here does overlap with research concerning WIL, however, a key distinction is that WIL usually takes place physically in host organisations external to the higher institution, for instance, in the form of work placements and internships, and is associated with, for example, training implementation, learning assessment, and curricular design (Tran and Nguyen, 2018; Rowe and Zegwaard, 2017 as cited in Nguyen Thi Ngoc Ha 2022). Therefore, WIA as it is conceived in this study is a broader construct in that it also includes academia-industry collaboration which takes place within higher education institutions, such as guest lectures or industry-delivered seminars. The work intends to contribute to the body of empirical evidence which supports the pedagogical use of WIA's helping to better align their design with student needs, with specific emphasis on motivational needs. The central research question which guided this study was:

RQ1. How do engineering students perceive WIA's to affect their motivation to engage in their studies?

As this study involved qualitative inquiry with a sample of engineering students, a sub-question was needed to associate the necessary context with the insights gained through RQ1:

RQ2. What WIA's had the sample of engineering students engaged in during their studies?

2. Theoretical background

2.1. Motivation and student learning

There are multiple definitions and theories regarding the nature of motivation. Schunk, Meece, and Pintrich (2014, 5) define motivation as 'the process whereby goal-directed activities are instigated and sustained', further elaborating that motivation as a process is not directly observable, but rather it is inferred from actions. Another definition comes from Bomia et al. (1997, 1) who refer to 'a student's willingness, need, desire and compulsion to participate in, and be successful in, the learning process'. One of the most prominent motivation theories and the lens through which motivation is considered in this study is Self-Determination Theory (SDT). SDT argues that humans are inherently inclined to develop psychologically through interaction with others. These proactive interpersonal tendencies are not considered automatic in that they require strong supporting preconditions. Specifically, SDT claims that this development requires support for three basic psychological needs; autonomy, competence, and relatedness (Ryan et al. 2019).

In SDT, motivation is categorised as intrinsic and extrinsic. Intrinsic motivation 'pertains to activities done "for their own sake" or for their inherent interest and enjoyment' (Deci and Ryan 2000 as cited in Ryan and Deci 2020). Intrinsic motivation can be a significant factor in the primacy of lifelong learning as opposed to forced external learning and instruction (Ryan and Deci 2017). Despite the important role of intrinsic motivation in learning and development, research from several countries has shown that it seems to decrease over time between school years (Gillet, Vallerand, and Lafreniere 2012; Gnambs and Hanfstingl 2016; Scherrer and Preckel 2019). Specifically for school-related activities this declining trend in intrinsic motivation is associated with decreasing psychological need satisfaction (see Ryan and Deci 2020) – a phenomenon which this study also explores relative to WIA's in engineering higher education.

In contrast to intrinsic motivation, extrinsic motivation relates to behaviours that are done for reasons apart from people's inherent satisfaction. SDT posits four major subtypes of extrinsic motivation including integration, identification, introjection, and external regulation, and there is also amotivation, all of which concern a lack of intentionality. In education settings, amotivation can arise from either a lack of interest or value in activities or a lack of perceived competence to perform, and can negatively affect learning, wellness, and engagement (Ryan and Deci 2020).

According to SDT, intrinsic motivation and internalisation can be enhanced by psychological need supports resulting in higher achievement, whereas attempts to control learning outcomes primarily through extrinsic sanctions, rewards, and evaluations generally lead to lower quality motivation and academic performance (Ryan and Deci 2020). Internalisation is a natural process wherein people transform and integrate values, social practices, and regulations into personally held values (Deci and Ryan 2000; Ryan and Deci 2000). This process can be expedited or impeded by specialised factors associated with the support of the three basic psychological needs. The development and adoption of more autonomous types of extrinsic regulation can be expedited by social context factors that support competence, relatedness, and autonomy. However, when people feel controlled, incompetent, or alienated from stakeholder's internalisation can be negatively affected, resulting in people remaining prone to more controlled, external, and introjected types of extrinsic regulation (Ryan and Deci 2019).

2.2. Institutions and modes of engineering education

In the nineteenth century in Sweden, several technical engineering schools started to invest significant effort into a process of transformation towards a structure and role more similar to that of the 'academic' universities. This 'academic drift' (Christensen 2012) has been defined as the process of 'academisation' of engineering education (Lundren, 1990). Since learning is viewed here through a social context in which stakeholders and educators become important actors as social models (Bandura 2012), an understanding of university natures and their modes of engineering education can provide an explanatory framework for students' motivation to study in higher education.

Barnett (2011) describes *scientific* universities, *entrepreneurial* universities, and *ecological* universities as three types of higher education institutions. The scientific university emphasises fostering intellectual or logical thinking and aims to produce knowledge in the basic and applied sciences rather than cultivating practical skills for using knowledge. The entrepreneurial university emphasises students' development of competencies in entrepreneurship (Tryggvason and Apelian 2012). An entrepreneurial university is presented as being well poised to deal with engineering challenges that highlight processes, skills, and collaboration with industries and which have an applied scope (Barnett 1994). The ecological university in contrast takes all aspects of sustainability, economics, and society into account (Jamison, Kolmos, and Holgaard 2014). In addition to these types of universities, Jamison, Kolmos, and Holgaard (2014) conceptualise three contending modes of engineering education, *academic*, *market-driven*, and *integrative*, which reflect different perspectives of engineering knowledge, intentions, and pedagogical approaches (Harwood, 2006; Jamison and Heymann 2012).

According to Jamison, Kolmos, and Holgaard (2014), the academic mode emphasises '*the imparting of scientific, theoretical, and disciplinary knowledge to engineers-to-be through a propositional-based educational process consisting largely of book-learning*' (263). In the academic or theory-driven approach, teaching and learning processes are based on transferring or translating theories from the basic sciences into an applied context through behaviourist pedagogical approaches (Jamison and Heymann 2012). The market-driven mode builds upon the approaches to engineering education at entrepreneurial universities. It is based on practical knowledge that involves technological innovation that can be used for solving authentic discipline-specific problems. Jamison, Kolmos, and Holgaard (2014) argue that 'the social role of the engineer is that of the entrepreneur or business manager who turns technical inventions into marketable innovations' (264). Finally, the market-driven approach, according to Jamison, Kolmos, and Holgaard (2014), is 'centred on acting and especially company interaction with focus on supplying the companies with engineers having the needed know-how to operate technical systems and artifacts' (264). Thus the educational process is based on different constructivist pedagogical approaches, such as 'learning by doing', for students to learn computer-aided design, programming and simulation, knowledge management, and marketing (Jamison, Kolmos, and Holgaard 2014; Jamison and Heymann 2012). Finally, the integrative mode builds upon the approaches to engineering education at ecological universities and tries to highlight the more socially relevant form of engineering education. It mixes social, technical, environmental, and scientific capacities of engineering in a comprehensive form of education, where students are educated to face both internal and external challenges in terms of 'situated learning' (Jamison, Kolmos, and Holgaard 2014). In the integrative approach, the educational process is based on a blend of learning by doing and 'book learning' (Jamison and Heymann 2012). In other words, the approach consists of a mix of traditional, constructivist, and innovative pedagogical approaches for teaching and learning through education for sustainable development.

2.3. Work industry-related activities (WIAs)

Although there are different perspectives on the role that companies should have within higher education, particularly in Engineering education, academia–industry collaboration is generally regarded as an important component of the successful preparation of engineering students for their future professional careers. This collaborative relationship empowers students to engage in contemporary industry practices, learn more about their field, and develop skills (Herrmann 2013). As previously discussed, WIAs as a concept relate to many types of collaboration both within and outside the scope of higher education institutions, unlike WIL experiences which typically take place in industry settings. A nuanced understanding of different WIA's is important to advance our insight about such activity. To that end, and as a background to our discussion we provide a brief overview of empirical findings relating to internships/cooperative experiences, industry tours/field trips, guest lectures, summer schools, and career fairs.

Internships are defined as professional learning experiences in a workplace, in which students are gaining authentic work experience that can be accompanied by classroom learning (Smith et al. 2009). Previous studies regarding internships and cooperative experiences with industry have shown that students who experienced an authentic workplace environment and culture gained motivation to learn and work, had valuable experiences of real-world problem-solving, and developed their interpersonal and communication skills (Butler 2014; Cates and Jones 2000; Fleming and Eames 2005; Schambach and Dirks 2002).

Industry tours/field trips, for example visiting a production plant in person, are the most typical learning experiences that take place away from the classroom (Kisiel 2006). Several studies have described positive student learning outcomes from industry tours, such as students observing a production environment and engaging in workplace culture. (Hanh and Hop 2018; Patil et al. 2012; Townsend and Urbanic 2013).

Guest lectures are defined as lectures delivered in higher education settings by external guest speakers who may be subject matter experts or hold significant industrial work experience (Goldberg et al. 2014; Riebe et al. 2013; Rodrigues 2004). Guest speakers offer the potential for enhancing the students' experience and supporting their learning in higher education (Bridges 1999; Taylor 2003). However, while students often believe that guest lectures are enjoyable, they do not necessarily find them challenging (Karns 2005). Additionally, the traditional format of guest lectures, where there is limited time for questions from students at the end, can reduce the potential impact on learning (Dalakas 2016; Taylor et al. 2004).

Summer schools in higher education are defined as schools or programmes generally provided by universities and/or sponsored by private companies, that offer courses and activities during students' summer vacation and can offer the opportunity to gain extra higher education credits. Student participation in summer schools has been shown to have substantial positive impacts on learning (Cooper et al. 2000). Industry-oriented summer schools for engineering students, in particular, have been identified as useful for the development of teamwork, flexibility, leadership, and communication skills (Larsen et al. 2009).

In general, a thesis or dissertation is an obligatory task typically undertaken at the end of a programme of study wherein the student should demonstrate knowledge and the ability to conduct independent work within an area of study. In this study, only engineering students' thesis work in collaboration within the industry is explored, where either a company contacts a university department and suggests a thesis topic, or where ongoing cooperation between a company and the department leads to a collaboratively derived thesis topic.

Lunch seminars are events on a university campus that are delivered by speakers from the industry and are named as such as they are usually delivered during a lunch or break period. Similarly, and finally, industry-related information can also be delivered to students through career fairs. During career fairs, students have the opportunity to explore potential employment opportunities by engaging with recruiters (Breaugh and Starke 2000). The aim of career fairs is not only to recruit but also to educate and foster interest within students (Payne and Sumter 2005; Reilly et al. 2007; Roehling and Cavanaugh 2000). Silkes, Adler, and Phillips (2010) found that university students studying in the field of hospitality and tourism management perceived career fairs to improve their overall level of knowledge about the field and enhance their overall level of interest in the industry. However, research on students' perceptions of career fair experiences and their potential impact on learning, specifically within engineering education, is limited.

3. Research methodology

3.1. Approach

Due to a lack of knowledge relating to the impact of different WIA's on student motivation (Swedberg 2018), an exploratory, inductive, qualitative study was conducted. Specifically, this study explored how Swedish higher-level engineering students perceived WIA's with which they had previously engaged as having affected their motivation for learning. In this study, Swedish students refer to people studying in Sweden, both Swedish and international nationalities. Semi-structured interviews were used to gain an in-depth understanding of the participating students' perceptions of what they saw as relevant and important (Bryman 2016). Data was collected in two consecutive phases from two Swedish universities, henceforth referred to as University A and University B. An inductive thematic analysis was conducted on data collected from University A (phase 1 of the research). However, a degree of deduction was involved since the researchers tried to establish the conditions in which interpretations will and will not hold. According to Bryman (2016), this strategy is often described as 'iterative: it involves a weaving back and forth between data and theory' (23). Following this, data was collected from University B (phase 2 of the research) and coded deductively using the phase 1 themes as a basis, however, novel insight warranted inductive engagement as well which resulted in the emergence of new themes.

3.2. Participants and selection process

In identifying participants, both context and demographic characteristics of individuals within the population were considered (Bryman 2016). Two universities, one in Stockholm and one in Gothenburg, were purposively selected based on their size and provision of engineering programmes. Further, these two institutions have broad collaborations with industry in Sweden and abroad as well as an array of WIAs are integrated into their educational programmes. Specifically, University A is a traditional public-owned technological university that focuses on gender equality, internationalisation, digitisation, and sustainability, providing a more holistic model of teaching and research. According to the literature on modes of engineering education, University A is considered by the researchers to be reflective of an integrative university. Whereas, University B is a university owned by a foundation and it has been acknowledged for entrepreneurial activities and technological research, which offers opportunities for commercialisation. As such, University B is considered representative of the entrepreneurial university.

Participants from both universities were selected based on three criteria. First, they had to be enrolled in a 5-year long engineering programme, or an equivalent. Additionally, they had to have participated in more than one WIA during their studentship. In Sweden, most engineering programmes follow a 3 + 2 model, where the first three years are offered at Bachelors level and the final two years are offered as Master's level. A third inclusion criteria was that participation in this study was restricted to students who had completed the requirements of the Bachelor level phase of their programme of study, and were either within or just about to begin the Masters level phase. This criterion was applied to ensure a breadth of experience with WIA's which would be gained within the student's first 3 years of study. A snowball sampling technique was followed in which the researchers first interviewed three students who met these criteria and then these sampled students suggested other students who had the characteristics or experience relevant to the study (Bryman 2016). The researchers also sought to achieve a maximum variation of students' perspectives for the range of WIAs by identifying key aspects of variations such as field of study, gender, and nationality and then finding cases that differ from each other (Suri 2011). Data collection halted, and thus the sample size was determined, when theoretical saturation was deemed to have been reached. Saturation was considered as the point in which no new insights were apparent in the most recent data collection(Sandelowski 2008).

In total, 19 participants were interviewed, of which 10 were from the University A and 9 were from the University B. Eleven students were male and 8 were female. Twelve participants were international students and 7 were native to Sweden. The participants were between 23 and 32 years old. Finally, they were studying across a range of Master's programs in the areas of electrical engineering, production engineering and management, sustainable technology, human–computer interaction, mechanical engineering, energy and the environment, applied mechanics, infrastructure and environmental engineering, engineering physics and mathematics, environmental engineering, and mechatronics.

3.3. Data collection

The data for this study were collected using semi-structured interviews to gain insight into individual perceptions of WIAs in higher engineering education. Open-ended questions and sub-questions based on thematic categories were developed and the interview protocol is located in the Supplementary Material. Each interview lasted approximately 45–50 min, and all participants were interviewed in English. All interviews were audio recorded and transcribed verbatim for analysis.

3.4. Data analysis

Data collected in phase 1 from University A was analysed using a thematic analysis, where the six phases outlined by Braun and Clarke (2006) were employed. NVivo software was used for the qualitative analysis. First, the primary author, who was also the interviewer, listened to the audio recording several times, and reviewed the transcripts to immerse in the pool of data. The second phase, which was executed by the primary and secondary author involved the initial inductive identification of emerging and compatible codes. Preliminary exploratory insight was gained through an examination of the most frequently occurring words within the dataset. This was followed by the identification of initial codes that were bounded by the research question and stemmed from points of interest identified through the interview process (Saldaña 2013). In the third phase the authors applied descriptive codes to the dataset (Saldaña 2013). This was done both independently and collectively to ensure further rigour, with the authors consolidating a single set of descriptive codes. A codebook (see Supplementary Material) was created based on this preliminary coding of the transcripts, the overarching research questions, theoretical background, and challenges identified in previous studies. Concepts, key issues, and themes began to emerge which signified the inception of a thematic framework. In the fourth phase, pattern coding (Saldaña 2013) was employed to incorporate the descriptive codes into themes, and a thematic map was created to aid in visualising and understanding the relationships and links between them and in the fifth phase names were ascribed to themes which reflected the data. This was first done by the primary author and reviewed by the second author, where there was collaborative discussion concerning the validity of the established themes. Finally, data extracts that correspond with the essence of each theme were identified for presentation in this manuscript (Braun and Clarke 2006; Clarke and Braun 2013; Jackson and Bazeley 2019). For data collected in phase 2, a deductive approach was used whereby the data was coded into the themes which emerged from phase one, again by two of the authors working in an iterative and immersive process similar to the process described for phase 1. However, new insight was gained and therefore a similar inductive approach was applied where required.

3.5. Trustworthiness

Multiple processes were followed to strengthen the reliability and validity of this study. The entire research process is described in detail to ensure sufficient transparency (Buckley et al. 2021) and uncut quotations from the participants' responses are used in the presentation of findings. Trustworthiness was also supported through participative data analysis, debriefing, and continuous feedback of data interpretation by all authors, as they reviewed and refined the emerging themes to make the findings credible and dependable (Bryman 2016; Lincoln and Guba 1985). The expert assessment process by Creswell and Clark (2007) was also followed to ensure confirmability. Finally, all procedures from the research design to enactment and presentation were assessed by three experts in engineering education and the social sciences who provided continuous feedback throughout.

3.6. Ethical considerations

The research aims and objectives of the study were explained in detail to participants and written informed consent was obtained from all the participating students (Bryman 2016). All research data and personal identifiable information were collected, coded, and stored according to both Universities' ethical policies and data management plans. The findings are presented without participant names to preserve anonymity.

4. Findings

4.1. Which WIAs had the participants engaged with?

To contextualise the themes which emerged relating to the effect of WIA's on the participating students' motivation, they were asked to detail the types of WIAs that they had engaged with during their programmes of study to date. Participants from both institutions had engaged with guest lectures, industry tours, dissertations in collaboration with industry, internships, summer schools, carrier fairs, and lunch seminars delivered by people from the industry. Concerning the dissertations completed in collaboration with industry, these related both to dissertations completed at the end of the students' third year of studies before entry to the Master's phase of their programme, and their 5th year Master's dissertation.

The findings showed that each of total 19 students participated in at least two different WIAs during their studies. Table 1 illustrates each student from University A and University B in which WIA's had been participated.

4.2. Motivation factors of WIA's

Six core themes emerged from the thematic analysis with respect to the impact of WIAs on motivation to study and learn in engineering education (Table 2).

It is crucial to point out that aspects of students' narratives overlap across WIAs. These themes therefore should be seen as an interpretation of understandings and attitudes in general, which are not isolated perceptions and beliefs, but which are all relative to each other.

Table 1. Students and WIA's that had been participated.

		WIAs						
Student	University	Internship	Industry-tour	Thesis work	Career fair	Guest lecture	Summer school	Lunch seminar
1	A		●				●	●
2	A	●		●		●		
3	A			●	●	●		
4	A	●		●		●		
5	A			●		●		●
6	A		●	●		●		
7	A			●	●	●		
8	A		●			●		
9	A		●	●		●		
10	A			●		●	●	
1	B		●	●				
2	B		●	●		●		
3	B	●		●		●		●
4	B		●	●	●			
5	B		●	●		●		
6	B	●		●		●		
7	B	●			●	●		
8	B		●	●			●	
9	B		●	●		●		

Table 2. Motivational themes of WIAs.

Theme	Participant description of WIA	Interpreted predominant motivational effect
Development of knowledge and skills	Seen as supporting the development of, practice-oriented knowledge and communication skills.	Motivational
Future professional orientation identity as inspiring engineers	Seen as offering opportunities to gain authentic work experience supporting the development of students' engineering identities.	Motivational
Research insight and collaboration with industry	Seen as supporting research collaboration between academia and industry, however, there can be a lack of ideal research conditions and experienced researchers and staff.	Both motivational and demotivational
Relevance for academic study	Seen as both relevant and lacking relevance by students regarding their studies.	Both motivational and demotivational
Marketisation of higher education	Seen as industry marketing opportunities that contribute to 'Marketisation' of higher education	Demotivational
Perceived alignment with industry rather than student interests and needs	Seen as placing emphasis on too narrow industry requirements with pre-determined research topics and learning outcomes	Demotivational

4.2.1. Development of knowledge and skills

The development of knowledge and skills through WIA's was generally deemed motivational. Most students stated that internships were the most appropriate WIA due to the immersive and authentic nature of the experience. During an internship, students felt like professional engineers who could have an impact on society and utilise the knowledge obtained from their studies.

> *The internship makes you a better person professionally speaking and it helped me to develop my soft skills, how to talk, behave, etc.*
>
> *University A student 4*

Participating in summer schools and guest lectures provided opportunities to develop communication skills through meetings and discussions with industry personnel. Furthermore, in summer schools, students participated actively in real-world problem-solving, developing communication and collaboration skills, and gaining knowledge relating to computing and programming.

> *During the summer school, I took a project from start to finish, started from scratch with the conception of an idea to some actual deliverables, and presented it in front of a business jury with investors, so this whole procedure and some tight time constraints was extremely helpful and I enhance my skills in problem solving, conceptualizing, working with other people/collaboration.*
>
> *University A student 10*

Students noted that WIA's such as industry tours and summer schools could be great opportunities to gain practice-oriented knowledge. These activities were seen as useful as they benefited future industry employability. This practical experience was seen as motivating for students in terms of becoming an engineer as it gave insight into future professional activity and prospects. However, when asked how this practical knowledge affected their motivation for subsequent university studies, the students responded that there was little or no impact on their motivation, since this knowledge was not needed for the theoretical tasks that their courses required.

> *I would say although we learn more theory at the university, practical knowledge is more appreciated in the industry … So I got some practical knowledge through summer school.*
>
> *University A student 1*

> *… because summer school was mostly practical, and most courses at the university are theoretical, it doesn't really carry over that well. So, I don't really feel that I learned anything during that activity that came back useful when I came back...*

University B student 8

Students stated that many lunch seminars had been offered by different companies at their university. These seminars and career fairs were seen as appropriate and valuable WIAs, both for developing interpersonal skills and for gaining awareness of future career opportunities after graduation. However, during these activities if the presenter advertised or emphasised the product more than they focused on the students learning this was seen as de-motivating. With this, the potential negative impact of industry marketisation became apparent.

They have some lunch seminars organized … they try to advertise their goals, their topics.

University B student 1

4.2.2. Future professional orientation identity as inspiring engineers

Students explained that work experience during their studies was rewarding as they were able to better understand the companies' remits, desires, and expectations. From this, they became more motivated to define subfields of interest and to position themselves professionally for the future. These experiences further saw students changing direction during their studies. Internships and industry tours were predominantly noted by the students in this regard.

However, if I hadn't done the internship, I am pretty sure I would have decided to try and become the programmer because would have thought that this is the direction that would give me more job opportunities in the future. However, after doing the internship I realized I don't care if programming gives me better opportunities in the future, I want to do design. So, it helped me take the right decision, and this could be reflected in my focus in the next semester at the [university A].

University A student 2

Students also claimed that these WIAs inspired them to explore and take part in production processes in industries. The engineers they engaged with also acted as and further informed students of people who were considered role models, contributing to a developmental impact on their engineering identities.

Having industries integrated from the first year already … as it inspires students about what actually happens in the industries … Role models, is a good idea for motivating kids and students. People like Mark Zuckerberg or Elon Musk, that are super inspiring changing the world with engineering solutions. Guest speakers talk for them …

University A student 3

It was cool to actually see what is happening in the process and the production … it was more going to the office and being inspired by what they were doing and meet a lot of people.

University A student 8

4.2.3. Research insight and collaboration with industry

Students expressed how important and motivating it is for them to spend time with Doctoral students or/and researchers who are working in industry within Research & Development (R&D) departments but noted in the WIA's they engaged with there was little time for this.

So, focus on R&D departments, they must do that, it is very important, but they never do at least in my case. I can't speak for everyone … In big companies, the R&D department, normally students don't get to meet those people.

University A student 9

Some students believed that there should be more WIAs in their master's programs to provide this opportunity, such as field trips to meet researchers in R&D departments. Negative aspects of industry collaboration in terms of research activity were also expressed. These included contradictory goals between industry and academic thesis supervisors leading to disagreement or stemming from misunderstanding and a lack of engagement from industry supervisors.

> *… the goals of the company were very different from the goals of the institution. So, the company wanted me to implement a special algorithm within their framework … that it's not used anywhere else … they wanted me instead to explore different angles and aspects of my research …*
>
> *University B student 2*

A negative experience of industry within such a direct interaction had an explicit negative impact on student motivation.

> *No help from them … No, they didn't make me want to continue studies in a higher level.*
>
> *University A student 5*

4.2.4. Relevance for academic study

Students argued that there were WIAs, such as industry tours and guest lectures, that were explicitly relevant to their studies and courses. This alignment appears positively related to their motivation and they expressed enthusiasm for these activities.

> *… in each one of the places we went there was one like group that was going to have a project on that. And yes, we were trying to take photos from the field to add afterwards in our assignment, and questions, a lot of questions. They gave us a lot of information themselves without asking.*
>
> *University B student 4*

On the other hand, students claimed that there were WIAs which lacked relevance. Some students had participated in several guest lectures, lunch seminars, and study tours, and the lack of relevance caused feelings of boredom and frustration. Where there is disconnect between students' expectations and the reality of engineering as it is presented in these WIA's the experiences were discussed as being demotivational.

> *I think some of them were boring … it was not relevance with my interests and what I am studying at all.*
>
> *University A student 4*
>
> *We didn't really get the responses that we assumed we were going to get...*
>
> *University A student 5*

The negative impact on their motivation is more apparent when this lack of relevance induces stress relating to their conceptions of engineering practice.

> *Usually there are a few guest lectures in a few courses. Like, some people from industries come to one of the lectures … However, this is not related to the course or to the topic that we should learn … I remember some of my classmates felt stressed and anxiety.*
>
> *University B student 2*

4.2.5. Marketisation of higher education

Many students noted that many WIAs, such as guest lectures, lunch seminars and career fairs, were advertisements for future employment with companies that were presenting. This was seen as a particularly negative aspect of WIA's in that the students wanted higher education to be free from any commercial influence.

> *… Exactly, they need to have better speakers and engage with the audience and put expert people there and I think that they shouldn't just talk and advertise themselves like a TV show …*

University A student 7

… I want the education to be free from commercial influence basically. I don't want the things I learn to be influenced by whatever company is paying or having influence over the school …

University B student 3

4.2.6. Perceived alignment with industry rather than student interests and needs

Some students argued that WIAs were too narrowly focused in terms of their alignment with the industry. They felt as though there was insufficient emphasis on general scientific knowledge. It was noted that programmes of studies appeared to be based more on narrow industry requirements than on a broader holistic education.

I feel that the knowledge which I learn here is limited. Where they make you ready for the industry here, it's like applied … and they design a course structure based on the industry requirement.

University B student 1

This type of reasoning is also apparent in regard to the students master's theses, in which the projects which were pre-determined by collaborating industries, were misaligned with the students personal interests.

I don't know if they are doing with your interest or they find something based on their interests and they are doing or … I don't know, I am confused. But what I feel like I want to work what I am interested in.

University B student 8

5. Discussion

5.1. Summary of findings

The focus of this study was to explore how WIAs were perceived by engineering students to have affected their motivation. Six themes emerged from a thematic analysis of semi-structured interviews conducted with 19 students from two Swedish universities. These related to (1) the development of knowledge and skills, (2) students' future professional identity as engineers, (3) research insight and collaboration with industry, (4) relevance of WIA's to studies, (5) marketisation of higher education, and (6) a perceived alignment with industry rather than student interests and needs. Although the participating students engaged with a range of WIAs, the WIAs engaged with were too vaguely defined and the sample size and methodology prevent distinct links from being drawn discretely between themes and specific WIAs. Therefore, in this study, the analysis was conducted holistically, and the themes are considered general.

Evidence of all six emergent themes can be found within the literature to varying degrees which suggests validity in the insight gained from this work. The finding that students believe they learn more in terms of practical knowledge skills rather than theoretical knowledge through WIA's such as internships, industry tours, and summer schools is in line with previous studies (Butler 2014; Cates and Jones 2000; Fleming and Eames 2005; Schambach and Dirks 2002). Previous work also indicates that role models are used to increase motivation in WIAs and that perceived relevance to studies is a recurring issue (Morgenroth, Ryan, and Peters 2015). Motivational or demotivational effects of the marketisation of higher education and students' perceptions of WIA's aligning too much on industry needs above their own are phenomena discussed less frequently within the pertinent literature.

5.2. Motivation and demotivation

Across the six themes, both motivating and demotivating aspects were identified. Motivation seemed to increase through authentic educational experiences and when students perceived the WIA's intent as aligned predominantly with their educational needs. This finding is in line with previous studies such as Townsend and Urbanic (2013) who claimed that active participation in WIAs and immersion in workplace culture are paramount for effective WIAs. Students also found WIAs to be motivating when a positive image of the engineering profession was presented. This could be achieved through active immersion, such as taking part in a production process, or passively, for example by being inspired during a guest lecture. WIAs provide the opportunity, during a programme of study, for students to develop their engineering identities. This can result in increased confidence in a subsequent choice to pursue engineering as an area of study, and hence an increased level of intrinsic motivation (Dev 1997; Entwistle 1988). Importantly, according to SDT, the more internalised the motivation for a particular type of activity becomes, the more that activity becomes part of a student's identity. Further, research has shown that basic need for a feeling of satisfaction is linked with increased engagement and higher performance in Science, Technology, Engineering, and Mathematics (STEM) courses, but also increased engineering identity (Skinner et al. 2017 as cited in Ryan and Deci 2020).

Within this study, it is important to consider that the sample were all either current Master's students, or about to begin Master's level study. This context may be the reason for the strongly expressed desire for increased interaction with researchers within R&D departments in the industry during study tours and academic researchers such as doctoral students engaging with contemporary, relevant research. Active engagement with current and perceived future engineering problems was presented as a motivating factor, and a differentiator between WIAs which focused more on the presentation of general skills and knowledge which needed to be developed. SDT research has shown that when students are in learning environments that facilitated autonomy and social relatedness support, such as research activity similar to that undertaken in their Master's thesis work, they usually express more enthusiasm indictive of volitional engagement with the activities (Streb et al. 2015 as cited in Ryan and Deci 2020). Students' desire for more autonomy and relatedness-supportive research environments could enhance their intrinsic motivation and perceived competence and this may be an approach which is actionable to increase the efficacy of WIAs.

In addition to describing the motivational aspects of WIAs, the students noted demotivational characteristics. At a basic level, WIAs were viewed as demotivating if there was perceived misalignment with the students' programmes of study, or if students could not see value in the knowledge, they were developing through them. Similarly, WIAs could be demotivating if there was a lack of challenge, a phenomenon also noted by Karns (2005), or a lack of a support structure that includes clear goals and expectations, and effective feedback on their engagement. Specifically, within SDT the absence of structure has been empirically associated with lower intrinsic motivation, higher anxiety, and less use of self-regulated learning approaches (Ryan and Deci 2020).

The students also expressed that they respond negatively when companies participate in WIAs with the main goal of marketing their own company. In these situations, the students perceived the companies as viewing them as consumers within their education. This marketisation of higher education is a growing phenomenon based on neo-liberalist ideology which currently exerts considerable pressure on higher institutions' structures and cultures globally (Ball 2007; Burch 2009), and can also negatively affect students' motivation and performance, usually in unintended ways (Ryan and Deci 2020). Molesworth, Nixon, and Scullion (2009) claim that particularly for technical universities a marketed higher education context may undermine and negatively impact students' intrinsic motivation as this context focuses explicitly on job-related skills. This may not have been demotivating for students who themselves identify as consumers within higher education, however, these students may already have lower levels of intrinsic motivation. For example, King and Bunce (2020) note that students who identify as consumers in higher education appear to display lower levels of autonomy, relatedness, and competence, as a consequence less internalised intrinsic motivation.

Specific to collaboration between academia and industry, such as when the students were collaborating with an industry partner for their Master's thesis, students noted that a lack of communication and collaboration could be challenging and demotivating. This tended to relate to a lack of communication between the student and an industry partner, and between the student's academic supervisors and industry partners. It appears that a lack of consistency in the perceived aims of the research project between academia and industry was a primary reason for this demotivation. Previous research has shown that the lack of feedback and interconnection between industry and engineering schools may negatively impact both the professional development and motivation of engineering students (Alboaouh 2018). When this happens students can transition from being more intrinsically motivated to be more extrinsically motivated as their goal shifts to the completion of their thesis. It could be that the basic need for a feeling of competence is not met in such circumstances due to the lack of a structure in the learning environment and subsequently reduced opportunity for the positive feedback. Furthermore, the need of relatedness which concerns a sense of connection and belonging may be undermined here as the lack of consistency between academia and industry can leave students feeling alienated from both due to variances in messages. Finally, students' motivation can be negatively affected, or at least not positively affected, if their thesis project is predefined and their autonomy in choice is undermined.

5.3. An interpretation of how the students' perceptions can be explained

An institution's structure and culture can have an impact on students' motivation (Peterson and Spencer 1990; Tierney and Lanford 2018). As previously described, Jamison, Kolmos, and Holgaard (2014) model of engineering education provide three different modes of provision, the theoretical, the market-driven, and integrative modes which are very closely related to Barnett's (2011) categorisations of scientific, entrepreneurial, and ecological universities respectively. To better understand students' views on the WIAs they have participated in, particularly with respect to the demotivational aspects, Jamison, Kolmos, and Holgaard (2014) model provides an auspicious framework.

Students' motivation is influenced by the university environment and the method taken to study and learn, the institutional culture (Peterson and Spencer 1990), and when ideologies of higher education context are contradictory to students' beliefs and expectations their motivation to study can be negatively affected (Nupke 2012). The participating students perceived the intent of their education as predominantly associated with acquiring theoretical knowledge. They had significant experience of the academic mode of engineering education from within their universities. However, the findings indicate that the companies participating WIA's, and perhaps also some academic faculty who engage their students in WIAs, are perceived by students as aligning more with the market-driven mode. This perceived misalignment had a demotivational effect on the students. This is not to suggest that the information wasn't objectively relevant, but if the usefulness of the activity is not apparent to the student, or the WIA is not perceived to be in the students' educational interests, students view this more negatively than positively. This type of reaction became apparent when the students, for example, described guest lectures which focused on marketing a specific company as a prospective employer, or when on an internship the companies displayed self-interest with the applied scope of entrepreneurship above the holistic education of the student. Additionally, this may explain the impact and the relevance of an entrepreneurial university's learning environment (Barnett 2011) on students' motivation for studying. In general, when students could not reconcile the added educational value of a WIA, our data suggests that they became demotivated, and their motivation changed from intrinsic to extrinsic with a focus on completion rather than on learning. However, when the value of a WIA was apparent and aligned with the students' needs, they were seen as motivational and positive experiences. From this, it appears that the students view on how WIA's should be integrated into their education was through the lens of the integrative mode of engineering education which would typically be cultivated in an ecological university. They expressed that appropriately challenging WIAs including sustainable and societal aspects of learning were important and that there was merit in engaging with industry to obtain a better understanding of contemporary and real-world engineering problems and challenges.

6. Conclusion

This work provides new insights into how WIAs integrated into engineering education affect student motivation. Our results illuminate the nature of WIA's in terms of how they relate to knowledge and skill development, identity development, and offering research insight. Their perceived relevance for academic study, their emphasis on marketisation, and the perceived main beneficiary are shown to have both positive and negative motivational effects. Predominantly students expressed that WIA's that gave them an immersive experience and better insight into contemporary real-world challenges faced by engineers were motivational, whereas WIAs which better served industry over their educational needs lacked relevance. Activities in which there was poor collaboration between academic and industry partners were experienced as demotivational. Furthermore, these motivational and demotivational aspects of WIAs were considered through the lens of SDT, and at a macro level about intrinsic and extrinsic level, and it was apparent that the three basic psychological needs of feeling competent, autonomous, and related are described through the theory provided a useful explanatory framework.

It is important to note that while theoretical saturation was deemed to be reached in the data from both institutions, 'true' or 'absolute' saturation cannot be confirmed. These findings are qualitative and interpretative, and as such should not be generalised beyond this sample. Future quantitative research could further investigate these findings to establish inferences about relative effect sizes of WIA characteristics on motivation. Furthermore, this study could not differentiate between demotivational activities, and those which cause a shift from intrinsic to extrinsic motivation. The nuances between both situations would merit further investigation as a demotivated student would require different educational intervention than an extrinsically motivated student.

From a practical perspective, the primary conclusion is that collaborative discourse is needed between students, academia and industry to achieve WIAs which are valuable to all involved actors, and which are 'ecologically' valid and have clarity of purpose.

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No potential conflict of interest was reported by the author(s).

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