



MASTER THESIS

PROFESSIONAL SOCIALISATION IN THE ENGINEERING CURRICULUM

A COMPARISON BETWEEN THE FORMAL AND EXPERIENTIAL
CURRICULUM

Erlijn Oprins

Educational Science & Technology

EXAMINATION COMMITTEE

1st Supervisor: dr. N. van Hattum – Janssen

2nd Supervisor: prof. dr. M.D. Endedijk

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Abstract

Society is becoming increasingly dependent on technology, which results in an ongoing high demand for highly educated technical professionals. However, many STEM graduates decide to work in non-technical jobs. Having an underdeveloped professional identity contributes to this development. Therefore, it is important that STEM students develop their professional identity by gaining professional socialising experiences. This study focuses on the role of professional socialisation in the formal curriculum and the experiential curriculum. The formal curriculum is studied by performing a document analysis. The experiential curriculum is studied by conducting focus group interviews. As part of the analysis, the formal curriculum is compared to the experiential curriculum.

The results of the formal curriculum revealed that all four study programmes included in this study offer professional socialising experiences on all four levels of engagement (i.e., knowledge acquisition, exposure, interaction, reflection). However, there are some differences between programmes. What stands out is that the university of applied sciences programmes offer more professional socialising experiences on the level of knowledge acquisition and interaction than the research university programmes. The analysis of the experiential curriculum provided a broader and richer view, which indicates that it is useful to research this aspect of the curriculum as well. Comparing the different curriculum domains indicated that there are discrepancies between the formal curriculum and the experiential curriculum. This study contributes to the literature and is valuable for engineering programmes at higher education institutions.

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1. Problem Statement

Nowadays, society is becoming increasingly dependent on technology. These technologies need to be developed to remain economically competitive in a global market (Thibaut et al., 2018). This results in an ongoing high demand for highly educated technical professionals (Bakens, Fouarge, & Peeters, 2018). Currently, there is a shortage of engineers in the technology sector in the Netherlands (van der Aalst & van den Beuke, 2017; Thibaut et al., 2018). Therefore, attracting students for engineering education and retaining engineering graduates for the technology sector is important. In recent years, efforts have been made in attracting students for science, technology, engineering and mathematics (STEM) education. For instance by promoting STEM education among pupils to increase the number of students choosing a study programme in the STEM field (Techniekpact, 2020). Despite all initiatives in attracting more STEM students, there is still a lack of engineers. Therefore, it is relevant to focus attention on retaining STEM graduates for the technology sector. Although there are many opportunities for STEM graduates to find a job in the technology sector (Techniekpactmonitor, 2019b), 38% of highly educated STEM professionals under 35 years old work in a non-technical profession (Techniekpactmonitor, 2019a). The substantial number of STEM graduates choosing a non-technical job contributes to a shortage in the technology sector. To reduce the shortage of technical staff, more STEM graduates must opt for a career in the technology sector.

Meijers, Kuijpers, and Gundy (2013) concluded that a students' professional identity influences career choices and career development. Furthermore, research concluded that having a more developed and stronger professional identity as an engineer increases the chance of a choice for a career in the technology sector (Cech, Rubineau, Silbey, & Seron, 2013). Thus, to retain STEM graduates for the technology sector, it is important that STEM students develop their professional identity. Professional identity evolves around the questions 'Who am I as a professional?' and 'To what extent do I feel connected to my (future) profession?' (Ashford, Harrison, & Corley, 2008; Pratt, Rockmann, & Kaufmann, 2006). Professional identity is formed by socialising experiences (Higgs, 2013; Smith & Hatmaker, 2014). Professional socialisation is the process of committing to a professional career and gaining the knowledge, skills, attitudes, values, and beliefs of a profession (Richardson, 1999; Weidman, Twale, & Stein, 2001). Education plays a key role in providing students with professional socialising experiences. Examples of professional socialising experiences are on-the-job training, exposure to role models, or opportunities to interact with experienced members of the profession (Smith & Hatmaker, 2014).

This study aims to investigate to what extent professional socialising experiences are embedded in the engineering curriculum. To this end, formal engineering curricula are studied to map the professional socialising experiences that contribute to the development of students' professional

identity. Furthermore, this study aims to explore how the professional socialising experiences of the formal curriculum are experienced by students. The research outcomes can be used to analyse engineering curricula and, ultimately, design engineering curricula that contribute to the development of students' professional identity with the aim to retain students for the technology sector.

2. Theoretical Framework

This chapter presents literature that is of importance for this study. This chapter first elaborates on professional identity since this is an important concept for retaining STEM graduates for the technology sector. Professional identity is formed by socialising experiences (Higgs, 2013; Smith & Hatmaker, 2018). Therefore, professional socialisation is presented next. Furthermore, this chapter elaborates on the role of the curriculum since formal education plays a crucial role in providing professional socialising experiences (Richardson, 1999; Weidman et al., 2001). Next, a framework for the analysis of professional socialising experiences in STEM curricula is presented. Lastly, the central research question and sub-questions are formulated.

2.1 Professional identity

Meijers et al. (2013) concluded that a students' professional identity influences career choices and career development. Furthermore, research concluded that having a more developed and stronger professional identity as an engineer increases the chance of a choice for a career in the technology sector (Cech et al., 2013). So, to retain STEM graduates for the technical sector, it is important that STEM students develop their professional identity.

Definition. In a broad sense, professional identity can be defined as “the sense of being a professional” (Paterson, Higgs, Wilcox, & Villeneuve, 2002, p. 6). It provides an answer to the questions ‘Who am I as a professional?’ and ‘To what extent do I feel connected to my (future) profession?’. The professional identity consists of a set of personal characteristics, interests, and competencies (Ashford, et al., 2008; Pratt, et al., 2006). Professional identity can be described from a personal perspective, a social perspective, or both. Scholars that identify professional identity as both personal and social, state that professional identity is a double-sided process (Holland, Lachicotte, Skinner, & Cain, 1998; Skinner, Valsiner, & Holland, 2001; Stevens, O’Conner, Garrison, Jocuns, & Amos, 2008) and refer to professional identity as positioning oneself and being positioned by others (Stevens et al., 2008).

Definition from a personal perspective. From a personal perspective, professional identity is defined as “the relatively stable and enduring constellation of attributes, beliefs, values, motives, and experiences in terms of which people define themselves in a professional role” (Schein, 1978, as referred to in Ibarra, 1999, pp. 764-765). This definition is in line with Erikson’s understanding of identity as the definition is described as relatively stable and refers to the individual’s view instead of how others see them and their profession. Although the personal construct of professional identity is described as relatively stable, it is assumed that professional identity develops over time, especially early in one’s career (Ibarra, 1999).

Definition from a social perspective. From a social perspective, professional identity consists of the social norms, values, and rules from the professional context (Ashford, et al., 2008; Pratt, et al., 2006). This definition acknowledges that professional identity is formed and maintained through interactions individuals have with others about their profession (Caza & Creary, 2016). Individuals learn who they are as a professional by seeing themselves in the eyes of others (Cooley, 1902, as referred to in Caza & Creary, 2016; Roberts, Dutton, Spreitzer, Heaphy, & Quinn, 2005). Furthermore, through interaction, we learn how others expect us to perform in a certain role and may try to adapt or move away from these expectations (Caza & Creary, 2016).

Professional identity development. To retain STEM graduates for the technology sector, it is important that STEM students develop their professional identity. Identity development is an ongoing process of interpreting oneself and relates to the question 'Who am I at this moment?' (Beijaard, Meijer, & Verloop, 2004). Professional identity is developed throughout our lives, but especially during university (Pratt et al, 2006). According to Ibarra (2004), the development of professional identity consists of three basic processes. First, engagement with professional activities. When individuals engage in actual activities associated with a professional role, individuals can identify with aspects of the role that they either enjoy or at which they excel. Second, developing social networks. Since the development of one's identity is often seen as an inherently social process, social networks can be helpful in developing a professional identity. Building social networks around professional roles allow individuals to gain knowledge about the domain and the role. Third, sense-making. In this process, individuals are checking whether the demands and opportunities of the professional role are in line with their interests. Thus, sense-making is about self-discovery, defining personal and professional goals, and finding new interests.

2.2 Professional socialisation

Professional identity is formed by socialising experiences (Higgs, 2013; Smith & Hatmaker, 2018). Socialising experiences can take place prior to, during, and after formal education (Miller, 2013). It is considered a dynamic, interactive, and lifelong process (Cornelissen & van Wyk, 2007) and entails being socialized to professional behaviour (Richardson, 1999). According to Richardson (1999), professional socialisation is the process of committing to a professional career and gaining the attitudes, values, and beliefs of a profession. Weidman et al. (2001), refer to professional socialisation as gaining knowledge, skills, and values of a profession. The socialisation experiences prior to formal education are classified as primary socialisation while the socialisation experiences during formal education are classified as secondary socialisation (Cruess, Cruess, Boudreau, Snell, & Steinert, 2014). In contradiction with Cruess et al. (2014), other scholars argue that professional socialisation also

occurs prior to formal education, indicating that professional socialisation can also occur during earlier life stages (Goodson, 2016; van Hattum-Janssen & Endedijk, 2020; Miller, 2013).

Core elements of engagement. Weidman et al. (2001) identify three core elements of engagement for professional identity formation: knowledge acquisition, investment, and involvement. Knowledge acquisition refers to obtaining sufficient cognitive knowledge and skills, as well as effective knowledge about the future professional role. Investment reflects the commitment made to a professional role, for instance in terms of time and money. The last core element, the so-called involvement, is about the level of participation, for instance in terms of how extensively students immerse themselves in their programme or connect with teachers and fellow students. Weidman et al. (2001) argue that the university is responsible for the socialisation processes. Thus, according to Weidman et al. (2001), the three core elements of professional identity formation take place during university education. Knowledge acquisition for instance takes place during lectures where a teacher transfers his professional knowledge and skills on to students. Investment includes enrolling oneself into a programme, attending lectures, and studying for exams. Involvement includes actively taking part in lectures, forming a study group, and doing an internship where a student directly involves himself with the profession.

Professional socialisation in medical and teacher training education. Professional socialisation is mostly studied in medical education (e.g., Kay, Berry, & Coles, 2019; Monrouxe, 2010) and in teacher training education (e.g., Beauchamp & Thomas, 2009; Flores & Day, 2006). Medical and teacher training programmes are known to have a specific occupational focus (Kennedy, Billet, Gherardi, Grealish, 2015); if you are in nursing school, you are trained to be a nurse, and if you are in teacher training school, you are trained to be a teacher. Furthermore, medical and teacher training programmes are known to involve a sturdy amount of practice-oriented learning (Kennedy et al., 2015). These aspects are likely to influence the professional socialisation process. Engineering programmes are not known for their specific occupational focus and sturdy amount of practice-oriented learning. Consequently, there could be a difference between the professional socialisation process in medical and teacher training programmes compared to engineering programmes.

Gaps in literature. From 2000, professional socialisation becomes more prominent in literature. As stated previously, most literature focuses on the medical (e.g., Kay et al., 2019; Monrouxe, 2010) and educational field (e.g., Beauchamp & Thomas, 2009; Flores & Day, 2006). From 2010, some literature on professional socialisation addresses the engineering field (e.g., Keltikangas & Martinsuo, 2009; Spencer, Sriraman, Talley, & Ortiz, 2018; Polmear, Simmons, & Clegorne, 2020). What stands out from the existing literature is that the importance of professional socialisation is indicated. Furthermore, it is acknowledged that formal education plays a crucial role in providing professional

socialising experiences, especially during university education (Richardson, 1999; Weidman et al., 2001). However, research does not study in-depth how universities can provide meaningful professional socialising experiences. The operationalization of the process of professional socialisation is still an understudied area. For instance, the different levels of professional socialisation have not yet been thoroughly studied.

2.3 Curriculum

As stated previously, formal education plays a crucial role in providing professional socialising experiences, especially during university education (Richardson, 1999; Weidman et al., 2001). Therefore, it is important to consider the role of the curriculum.

Definition. According to the Oxford Advanced Learner's Dictionary (n.d.), the term curriculum is of Latin origin and refers to “the subjects that are included in a course of study or taught in a school, college, etc.” In literature, a distinction is made between prescriptive and descriptive definitions. Prescriptive definitions have a future orientation and usually refer to a plan or something that ought to happen in a course of study. The developer proposes a ‘prescription’ and, in the end, the teacher decides whether the ‘prescription’ will be followed (Ellis, 2004). An example of a prescriptive definition of the term curriculum is proposed by Taba (1962): “A plan for learning.” Another example of a prescriptive definition is formulated by Oliva (1997, as referred to in Ellis, 2004): “A plan or programme for all the experiences that the learner encounters under the direction of the school.” In contrast, descriptive definitions attempt to inform us of what happens when the planned curriculum is engaged. Descriptive definitions focus on the actual experience in the classroom and are therefore also called the experiential curriculum (Ellis, 2004). An example of a descriptive definition is proposed by Caswell and Campbell (1935, as referred to in Ellis, 2004): “All the experiences children have under the guidance of teachers.” Another example is formulated by Hass (1987, as referred to in Ellis, 2004): “The set of actual experiences and perceptions of the experiences that each individual learner has of his or her programme of education.”

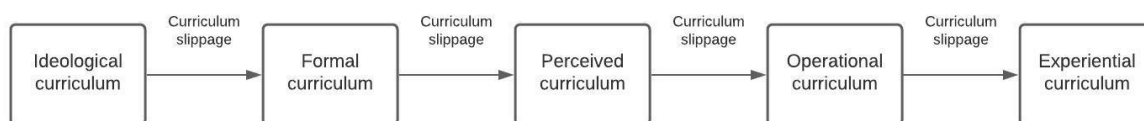
Types of curricula. In line with Ellis’ reasoning, Goodlad, Klein, and Tye (1979) identified five different types of curricula: ideological, formal, perceived, operational, and experiential. The ideological curriculum refers to the scholar’s view of what ought to be included in the curriculum and how it ought to be developed. The formal curriculum contains the officially approved plans and consists of written statements of what should be done. These statements are derived from society and consist of such things as national policies, school board policies, and course manuals. The perceived curriculum is how teachers, parents, and others perceive the curriculum. The most significant perceptions are those of the teachers as they adapt the formal curriculum based on their own values, beliefs, and

competencies. The operational curriculum is about observing what actually happens in the classroom. The experiential curriculum consists of two facets: 1) learner perceptions of the curriculum and 2) what is actually learnt – student outcomes.

Curriculum slippages. Goodlad et al. (1979) recognized that there might be discrepancies, or so-called slippages, between the different types of curricula (i.e., ideological, formal, perceived, operational, and experiential). These curriculum slippages are depicted in figure 1 (adapted from Sanders & Makotsa, 2016). Due to these slippages, elements of the formal curriculum do not always find their way through to students, or aspects are added. For instance, a teacher can add personal experiences into the curriculum, which in turn might be experienced as valuable by students. Discrepancies between the ideological and formal curriculum might occur because government, schools, and parents translate the ideological curriculum into their own words as they formulate their plans. Discrepancies between the formal and perceived curriculum mostly arise because teachers have different values, beliefs, and competencies. Thus, the teacher’s background is of great importance in determining how a teacher perceives the formal curriculum. Especially when considering that the policy documents that represent the formal curriculum do not provide many details so much is left to the interpretation of teachers. Discrepancies between the perceived and operational curriculum arise because what teachers perceive the curriculum to be might differ from what they actually teach. And finally, the discrepancies between the operational and experiential curriculum arise because what is taught might differ from what is experienced and learned by students.

Figure 1

Curriculum slippages



Studying discrepancies between different types of curricula. Due to the curriculum slippages, it is important to study the discrepancies between the different types of curricula. Especially since these differences have not often been studied yet. To this end, the student researcher of this study and a fellow student researcher have studied the formal curriculum of four engineering programmes. The results will be presented later in this study. The perceived curriculum was studied by the fellow student researcher (Jooss, 2021) by conducting semi-structured interviews with teachers. For each study programme, two teachers were interviewed, resulting in a total of eight interviews. An overview of the results is presented in table 1 in appendix A. The results are of interest for this study since the

four engineering programmes participating in the fellow student researcher's study are also the subject of this study.

2.4 Framework for curriculum analysis of professional socialising experiences

Table 2 shows a framework for the analysis of professional socialising experiences in STEM curricula (van Hattum-Janssen & Endedijk, 2019). The framework was developed recently and therefore has not often been used yet. The framework consists of two dimensions: curriculum components and engagement levels. The curriculum components are adapted from Thijs and Van den Akker (2009) and include rationale, aims & objectives, content, teaching & learning, assessment, teacher role, role of professional, facilities & resources, grouping, location, and time. Role of professional was added to the framework because professionals can serve as role models, which can foster the formation of a professional identity (van Hattum-Janssen & Endedijk, 2019). The levels of engagement are based on the core elements of professional identity formation from Weidman et al. (2001) and refer to knowledge about, exposure to, interaction with, and reflection on the profession (van Hattum-Janssen & Endedijk, 2019).

Knowledge acquisition. On the level of knowledge acquisition, students learn about possible future professional situations, the extent to which knowledge is related to professional roles, and norms and values associated with the possible future profession. Furthermore, an image of the future professional is created. At this level, students are not exposed to realistic professional contexts yet. Most of the knowledge construction takes place in educational settings. Examples of curriculum elements at the knowledge acquisition level are acquiring knowledge and skills at a theoretical course or working in a (simulation) project, where students are introduced to different roles (van Hattum-Janssen & Endedijk, 2019).

Exposure. On the level of exposure, students are exposed to professional contexts and start to become familiar with normative role expectations. Students do not play an active role yet at this level, but rather observe. Examples of curriculum elements at the exposure level are being exposed to guest lectures, participating in excursions, study trips, and company visits, and having teachers who have strong links with or are still active in relevant professional contexts outside the institution as role models (van Hattum-Janssen & Endedijk, 2019).

Interaction. On the level of interaction, students become actively involved in the professional context and will start to internalise norms and values as well as written and unwritten rules of professional practice. At this level, interaction between the students and professional role incumbents takes place, which allows the student to adjust his expectations about his professional role. The student will start to see incongruences between the image of himself as a professional and the

professionals with whom he interacts. This interaction not only refers to personal interaction but also to interaction with the physical environment and the degree to which it resembles the professional context. Examples of curriculum elements at the interaction level are interviewing a professional in the work environment or doing an internship (van Hattum-Janssen & Endedijk, 2019).

Reflection. On the level of reflection, students change their existing norms and values towards a shaped professional identity. Students become aware of their initial identity and their current state. De Weerd, Bouwen, Corthouts, and Martens (2006) state that reflection can be seen as a mediator between experience and identity. According to Schon (1983) reflection can take place at several moments: reflection-in-action, reflection-on-action. Examples of curriculum elements at the reflection level are reflecting on an internship or reflecting on where a student sees himself in five or ten years (van Hattum-Janssen & Endedijk, 2019).

Table 2

Framework for the analysis of professional socialising experiences in STEM curricula.

Curriculum component	Level of engagement			
	Knowledge acquisition	Exposure	Interaction	Reflection
Rationale				
Aims & objectives				
Content				
Teaching & learning				
Assessment				
Teacher role				
Role of professional				
Facilities & resources				
Grouping				
Location				
Time				

2.5 Research Question

Based on the theoretical framework, this study focuses on improving the understanding of the transition process from engineering education to the technology sector by developing students' professional identity. This study aims to identify the professional socialising experiences of the formal

and the experiential engineering curriculum*. Furthermore, the formal engineering curriculum is compared to the experiential engineering curriculum. The following research question is proposed:

How is professional socialisation embedded in the formal and experiential engineering curriculum?

To answer the research question, the following sub-questions are formulated:

1. How is professional socialisation embedded in the formal engineering curriculum?
2. How is professional socialisation embedded in the experiential engineering curriculum?
3. How do the professional socialisation elements of the formal engineering curriculum compare to the experiential engineering curriculum?

* Goodlad et al. (1979) stated that the experiential curriculum consists of two facets: 1) learner perceptions of the curriculum and 2) what is actually learnt – student outcomes. This study only focuses on the learner perceptions of the curriculum. The other facet (i.e., student outcomes) is not part of this study. Therefore, in this study, the term experiential curriculum refers to the learner perceptions of the curriculum.

3. Method

3.1 Research design

This study adopts a qualitative research approach. For this study, a document analysis was performed and focus groups were conducted. The curriculum documents of four engineering bachelor programmes were analysed to identify the professional socialisation elements of the formal curriculum. The focus groups aimed to get an in-depth understanding of the experiential curriculum. Conducting focus group interviews was considered a useful method because it fosters interaction and discussion (Morgan, 1988), which will have yielded additional and useful results.

3.2 Document analysis – formal curriculum

Study programmes. The first part of this study includes four bachelor programmes. These are a technical bachelor programme and an intersection bachelor programme at a Dutch research university (RU), and a technical bachelor programme and an intersection bachelor programme at a Dutch University of Applied Sciences (UAS). The technical bachelor programmes were selected because they are large-scale technical studies. The intersection bachelor programmes were selected because they are less technical and more on the intersection of technology and management.

Documents. The formal curriculum documents of the participating studies were analysed. These documents include programme documents, curriculum and assessment plans, study guides and manuals, and module/course descriptions. The programme documents and module descriptions of the RU programmes were available online. The programme documents and course descriptions of the UAS programmes needed to be requested through the programme directors. Curriculum and assessment plans, as well as study guides and manuals for all participating programmes, were received through the programme directors. A total of 120 documents were analysed, from which 21 were from the technical bachelor programme at the Dutch RU, 16 from the intersection bachelor programme at the Dutch RU, 43 from the technical bachelor programme at the Dutch UAS, and 40 from the intersection bachelor programme at the Dutch UAS.

Procedure. Permission for conducting this study was granted by the BMS Ethics Committee of the University of Twente. Upon receiving permission, the formal curriculum documents were analysed by using two coding schemes and Atlas.ti software. The curriculum documents of the intersection bachelor programmes were coded by the student researcher, while the curriculum documents of the technical bachelor programmes were coded by a fellow student researcher. This fellow student researcher also focused on professional socialisation in the engineering curriculum, although with a different perspective: the perceived curriculum instead of the experiential curriculum. After coding the

documents, both student researchers reviewed each other's work. Inconsistencies were discussed and if necessary, the coding schemes were adjusted and codings were revised.

Data analysis. The formal curriculum documents were analysed based on a content analysis approach by using two deductive coding schemes and Atlas.ti software. The first coding scheme is presented in table 3 and includes the curriculum components based on Thijs and Van den Akker (2009): rationale, aims & objectives, content, teaching & learning, assessment, teacher role, role of professional, facilities & resources, grouping, location, and time. The second coding scheme is presented in table 4 and includes the levels of engagement based on van Hattum-Janssen and Endedijk (2019): knowledge acquisition, exposure, interaction, and reflection. Although both coding schemes are used, this study focuses on the levels of engagement as presented in table 4, because the levels of engagement are most important in comparing the formal and experiential curriculum, which is done at a later stage. A quality check for coding scheme 4 is done by calculating the inter-coder reliability score of twelve selected curriculum documents. A Krippendorff's alpha binary coefficient of .816 was reached. This score is considered good (Krippendorff, 2004). Furthermore, a Krippendorff's Cu-alpha of .784 was reached. This score is considered fair to good (Krippendorff, 2004). The alpha binary coefficient refers to the overall value for inter-coder agreement, while the Cu-alpha refers to the overall performance of the semantic domain (e.g., levels of engagement). In addition to Krippendorff's alpha, the weighted kappa coefficient is calculated. Weighted kappa is useful for ordinal data, which the levels of engagement are. A weighted kappa score of .905 was reached, which means there is near perfect agreement between the two raters (Ranganathan, Pramesh, & Aggarwal, 2017).

After coding the curriculum documents, a cross-case synthesis was performed as proposed by Yin (2014). This method involves creating a word table to display the data. The table is categorized according to the levels of engagement. After creating the word table, it was possible to detect cross-case patterns, revealing similarities or contrasts between programmes. Furthermore, a rubric was developed to analyse the professional socialisation elements in the formal STEM curriculum. This rubric was developed in collaboration with another student researcher, who used the rubric to create a heatmap for each study programme included in this study. The heatmaps indicate to which extent professional socialising experiences are embedded in the formal STEM curriculum. The rubric and heatmaps can be found in the fellow student researcher's thesis: *Stop the leaking pipeline!* (Jooss, 2021).

Table 3

Coding scheme for document and focus group analysis (curriculum components)

Code	Description
Curriculum: aims & objectives	Answers the question 'Towards which goals are they learning?'. All learning goals or competencies which are described or summed up.
Curriculum: assessment	Answers the question 'How is their learning assessed?'. Everything related to assessment, both formative and summative.
Curriculum: content	Answers the question 'What are they learning?'. Knowledge, skills, and attitudes related to the profession.
Curriculum: facilities & resources	Answers the question 'With what are they learning?'. Facilities and materials supporting education. For example: university library, field lab, books, articles, videos, software, or specific machines.
Curriculum: grouping	Answers the question 'With whom are they learning?'. Descriptions of group compositions. For example: students from different studies and nationalities working together in a multidisciplinary and international team.
Curriculum: location	Answers the question 'Where are they learning?'. The location where students learn. For example: classroom, field lab, company x, company y, abroad.
Curriculum: rationale	Answers the question 'Why are they learning?'. The rationale is often the higher goal of the study programme.
Curriculum: role of professional	Answers the question 'How are professionals facilitating their learning?'. A professional at the workplace contributing to the curriculum.
Curriculum: teacher role	Answers the question 'How is the teacher facilitating their learning?'. Ways how the teacher facilitates the learning process. For example by acting as a coach or a project client.
Curriculum: teaching & learning	Answers the question 'How are they learning?'. Activities through which students learn. For example: lecture, seminar, presentation, or (project) assignment.
Curriculum: time	Answers the question 'When are they learning?'. All indicators of time. For example: quartile, semester, x number of lectures/weeks/months/years.

Table 4

Coding scheme for document and focus group analysis (levels of engagement)

Code	Description
Level of engagement: knowledge acquisition	Activities where students acquire knowledge related to the future role or profession. This also includes working on a (simulation) project, where students are introduced to different roles.
Level of engagement: exposure	Activities where students are exposed to the workplace. This mostly concerns one-way interaction from the workplace. The student is in the role of student. For example: guest lecture, company presentation, company visit, or excursion.
Level of engagement: interaction	Activities where there is a significant chance of interaction. The student is in the role of professional. For example: interviewing a professional, fieldwork, or an internship.
Level of engagement: reflection	Activities where students reflect on their acting in professional practice or on their vision of the future role.

3.3 Focus group interviews – experiential curriculum

Respondents. Ideally, two focus group interviews would have been conducted for each participating study programme, consisting of six to eight students each. Of which one focus group consisted of pre-final year students (i.e., second-year students for the RU programmes and third-year students for the UAS programmes) and the other focus group of final-year students (i.e., third-year students for the RU programmes and fourth-year students for the UAS programmes). Unfortunately, this turned out to be too ambitious. The focus group interviews were administered at the start of the coronavirus pandemic, which made it more challenging to find participants and resulted in fewer and smaller focus groups. The circumstances have also caused the researcher to widen the scope of the participants, by allowing a second-year student for the technical bachelor programme at a Dutch UAS and two recent alumni for the technical bachelor programme at a Dutch RU.

A total of fifteen students participated in five different focus group interviews. For the technical bachelor programme at a Dutch RU, two focus group interviews were conducted. The first focus group consisted of three second-year students. The second focus group consisted of one second-year student and two recent alumni. For the intersection bachelor programme at a Dutch RU, one focus group interview was conducted. The focus group included three third-year students. For the technical bachelor programme at a Dutch UAS, two focus group interviews were conducted. The first focus group consisted of one second-year student and two third-year students. The second focus group

consisted of three fourth-year students. For the intersection bachelor programme at a Dutch UAS, zero focus group interviews were conducted. An overview of the focus group participants is provided in table 4.

Table 4
Overview of focus group participants

Study programme	Focus group	Number of participants	Year of study
Technical bachelor programme at a Dutch RU	1	3	2
	2	3	2 & recent alumni
Intersection bachelor programme at a Dutch RU	3	3	3
Technical bachelor programme at a Dutch UAS	4	3	2 & 3
	5	3	4

To select the participants for the focus group interviews, a homogeneous and snowball sample design was performed. Homogeneous sampling focuses on groups with similar characteristics (Cohen, Manion, Morrison, 2007). For this study, the sample predominantly consisted of (pre-)final year students of the four participating study programmes. The focus groups predominantly included students that are in their (pre-)final year because these students can best reflect upon the professional socialising experiences of the programme and are therefore most relevant for this study. Snowball sampling is a useful method when the participants are difficult to access (Cohen et al., 2007), which was the case in this study. The focus group interviews were conducted in Dutch, which means that non-Dutch speaking students were excluded from the sample. Excluding non-Dutch speaking students made the sample more homogeneous because two out of four participating programmes are offered in Dutch and therefore only teach Dutch-speaking students. Furthermore, it ensured that cultural differences were less likely to play a role. Conducting the focus group interviews in Dutch also ensured that participants were more likely to understand what the researcher was asking, and the participants will probably have felt more comfortable to speak. This fostered interaction and discussion, which is a prerequisite for a successful focus group interview and will have yielded additional and useful results.

Instrumentation. The focus group interviews were conducted to get an understanding of how the formal curriculum is perceived by students (i.e., experiential curriculum). The interview scheme was based on the guidelines from Krueger (2002). The interview scheme is attached to appendix B. The focus group interviews were semi-structured and used questions regarding the experiential

curriculum. The first two questions were general questions to get into the topic. These questions aimed to reveal why a participant chose his study and what profession he would like to pursue upon graduation. The following set of questions focused on the levels of engagement. For example, a question related to knowledge acquisition was: 'What do your teachers and teaching materials say about the work field?'. The last set of questions focused on three curriculum elements as presented by Thijs and Van den Akker (2009), being: teacher role, grouping, and assessment. For example, a question related to teacher role was: 'Do you have teachers who work or who have worked in the professional field and who tell a lot from their experience as a professional in the work field?'. The interview scheme was tested during a pilot focus group interview. Based on the pilot, no questions were adjusted. However, after conducting four focus group interviews, the question regarding knowledge acquisition was adjusted, resulting in two different versions of the interview scheme.

Procedure. After the document analysis, potential participants were contacted either directly or indirectly via the respective study department, the respective study association, student association, student sports association, email, Facebook, LinkedIn, or fellow student. The invitation is attached to appendix C. After finding sufficient participants for a specific focus group, an appointment was made by using a date picker. Due to the coronavirus pandemic, the focus group interviews were conducted online via Google Meet. Before the focus group interview started, the participants were informed that participation is voluntary, and that all data is being processed anonymously. Furthermore, since all interviews were audio-recorded, permission of the participants was asked, and an online consent form was signed via Qualtrics software. The duration of the focus group interviews was around 50 to 70 minutes. After conducting a focus group interview, a verbatim transcript was written with the use of Amberscript software. A copy of the transcript was emailed to the participants to get their approval. The transcripts were analysed by using a deductive coding scheme and Atlas.ti software.

Data analysis. The focus group transcripts were analysed based on a content analysis approach by using a deductive coding scheme and Atlas.ti software. The coding scheme is visualized in Table 4 and includes the levels of engagement based on van Hattum-Janssen and Endedijk (2019): knowledge acquisition, exposure, interaction, and reflection. The analysis of the experiential curriculum focuses on the levels of engagement in table 4 because the levels of engagement are most important in comparing the formal and experiential curriculum. After coding the focus group transcripts, a cross-case synthesis was performed as proposed by Yin (2014). This method involves creating a word table to display the data. The table is categorized according to the levels of engagement. After creating the word table, it was possible to detect cross-case patterns, revealing similarities or contrasts between programmes.

3.4 Comparing the formal and experiential curriculum

To compare the formal and experiential curricula, cross-case syntheses are performed as proposed by Yin (2014). First, word tables are created to display the data from the individual bachelor programmes, for both the formal and experiential curriculum. The tables are categorized according to the levels of engagement. After creating the word tables, it was possible to detect cross-case patterns, revealing similarities or contrasts between cases.

4. Results

This chapter consists of five parts. Firstly, the within-case analysis and cross-case analysis of the formal curriculum are presented. These analyses provide an answer to research question 1 (i.e., How is professional socialisation embedded in the formal engineering curriculum?). Second, the within-case analysis and cross-case analysis of the experiential curriculum are presented. These analyses provide an answer to research question 2 (i.e., How is professional socialisation embedded in the experiential engineering curriculum?). Lastly, the professional socialising experiences of the formal curriculum are compared with the professional socialising experiences of the experiential curriculum. This comparison provides an answer to research question 3 (i.e., How do the professional socialisation elements of the formal engineering curriculum compare to the experiential engineering curriculum?).

4.1 Within-case analysis of the formal curriculum

This section contributes to answering research question 1 (i.e., How is professional socialisation embedded in the formal engineering curriculum?). The aim of the within-case analysis of the formal curriculum was to get an in-depth understanding of the professional socialising experiences of four engineering bachelor programmes. The formal curriculum is the first curriculum domain as proposed by Goodlad et al. (1979) so when researching a curriculum, studying the formal curriculum is a good starting point.

4.1.1 Technical bachelor programme at research university

This programme is strongly project-oriented, providing students with opportunities to work in multidisciplinary teams in a business context and involving companies in the programme delivery.

4.1.2 Intersection bachelor programme at research university

Within this programme, there is a focus on working in interdisciplinary teams in which the management role alternates. The business context is involved in programme delivery through guest lectures and workshops and through project presentations.

4.1.3 Technical bachelor programme at university of applied sciences

Key of this programme is the internship and subsequent graduation project, for which smaller realistic projects in the first study years prepare. The business context is involved through company visits and involvement in the assessment.

4.1.4 Intersection bachelor programme at university of applied sciences

Students in this programme do two internships as well as a graduation project within a professional context. The programme includes various project assignments in a realistic context and (international) interdisciplinary teams.

4.1.5 Overview of the professional socialising experiences in the formal curriculum

Table 5 provides an overview of the relevant professional socialisation elements in the formal curriculum of the four engineering programmes that are part of this study. The overview indicates that all four study programmes offer professional socialising experiences on all four levels of engagement (i.e., knowledge acquisition, exposure, interaction, reflection).

Table 5

Overview of the professional socialisation elements in the formal curriculum

	Technical bachelor programme at RU	Intersection bachelor programme at RU	Technical bachelor programme at UAS	Intersection bachelor programme at UAS
Knowledge acquisition	<ul style="list-style-type: none"> - year 1: students take the role of a project team in a company - year 2: assignment with a realistic business context - year 2: working in interdisciplinary teams 	<ul style="list-style-type: none"> - year 2: the context for the assignment is provided by real data (e.g., annual reports of several companies) - year 2: assignment with a realistic business context - year 2: working in interdisciplinary teams - year 2: the project management role alternates among the team members 	<ul style="list-style-type: none"> - working with software commonly used in the work field - all staff members act as role models - in projects, teachers act as coach and teacher. In the first projects, the teacher role is greater and in the last projects the coach role takes the upper hand - year 1: orientation to professional practice - year 1: demonstrating awareness of the specific engineering competencies - year 2, 3 & 4: the assignments are of a more multidisciplinary nature and are placed and/or carried out in an authentic context - year 2: assignment with a realistic business context - year 2: international project week: working in international and interdisciplinary teams 	<ul style="list-style-type: none"> - optional participation in the international project week, where students work in international and interdisciplinary groups - year 1: orientation on the future profession - year 1: gaining knowledge of the structure of an organization - year 1: researching the internal and external environment of a company - year 1, 2 & 3: project with a realistic business context - year 2: opportunity to work with international students from other universities - year 2: students work in international groups. - year 2 & 3: students work on realistic cases

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			<ul style="list-style-type: none"> - year 3: Interdisciplinary project semester: working in interdisciplinary teams - year 3: writing the internship plan - year 4: preparation assignment 	<ul style="list-style-type: none"> - year 3: students take on a role within a management team
Exposure	<ul style="list-style-type: none"> - year 1: excursion to a manufacturing facility - year 1: presenting a structured scientific poster to a technical public - year 1: presenting to the employer with technical knowledge and a technically skilled public - year 2: the client (company) introduces the problem via a guest lecture 	<ul style="list-style-type: none"> - year 2: the client (company) introduces the problem via a guest lecture - year 2: workshops provided by guest lecturers - year 2: several guest lectures 	<ul style="list-style-type: none"> - year 1: 3 company visits - year 1: 5 company presentations - year 2: company visit - year 2: company visit 	<ul style="list-style-type: none"> - year 1: company presentation - year 1 & 3: company visit
Interaction	<ul style="list-style-type: none"> - year 2: the client (company) provides feedback - year 2: if possible, the company will be involved during the project 	<ul style="list-style-type: none"> - year 1: students interview an alumnus - year 2: formal meeting with the client (company), during which each project group presents the results up until then - year 2: the client (company) provides feedback 	<ul style="list-style-type: none"> - visiting career fairs - internship - year 3: interdisciplinary project semester (project in assignment of a company or research group) - year 4: graduation project in the professional context 	<ul style="list-style-type: none"> - year 1: visiting an intern at his/her internship company - year 2 & 4: internship - year 3: opportunity to participate in the interdisciplinary project semester (project in assignment of a company or research group)

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- year 2: during the project fair, students present the final results to the client as well as to other interested parties
- year 4: a professional from the company is involved in the assessment
- year 4: an external expert is involved in the assessment
- year 3: interviewing a manager from the field
- year 3: a project in assignment of a company
- year 3: students present to and receive feedback from professionals from the field
- year 4: graduation project in the professional context

Reflection	<ul style="list-style-type: none"> - year 1: students have to reflect on their own work in the last year and look forward to the future as a student (and professional) - year 2: reflect on the consequences of interdisciplinarity on the team cooperation and performance - year 2: students reflect on their own discipline and their unique contribution - year 2: students reflect based on their own strong and weak points in the role of an engineering student as well as future professional and translates the reflection into clear action points - year 2: writing an essay about professional strengths and 	<ul style="list-style-type: none"> - year 1: reflection based on interviewing an alumnus - year 2: students reflect on their own discipline and their unique contribution 	<ul style="list-style-type: none"> - year 1: reflection assignment based on career fair visit(s) - year 1: person profile test with reflection - year 1: reflecting on own actions and on those of others - year 3: reflection assignment based on the internship (plan) - year 4: writing a learning report upon completing the graduation project 	<ul style="list-style-type: none"> - reflecting on own actions, thinking, and results - reflection on functioning within projects, internship, and graduation - year 2, 3 & 4: the emphasis is on reflecting on inner drives, career exploration, and career management - year 3: students keep a logbook during the project and base reflections on that - year 4: graduation circles in which students provide each other with peer feedback
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improvement points related to
the master profiles

4.2 Cross-case analysis of the formal curriculum

This section presents the main similarities and differences between the four engineering programmes included in the formal curriculum analysis of this study. In doing so, this section contributes to answering research question 1 (i.e., How is professional socialisation embedded in the formal engineering curriculum?).

Knowledge acquisition. According to the formal curriculum documents, the UAS programmes offer more professional socialising experiences on the level of knowledge acquisition than the RU programmes. A similarity that stands out from the data is that all four study programmes offer simulated learning environments.

Exposure. All four study programmes offer a mix of different socialising experiences on the level of exposure (i.e., guest lecture/workshop, company presentation, company visit/excursion). Of the four programmes, the technical degree programme at the UAS offers the most professional socialising experiences on the level of exposure.

Interaction. On the level of interaction, the UAS programmes offer a mandatory internship, while the RU programmes do not. The technical degree programme at the UAS offers one mandatory internship, while the intersection degree programme at the UAS offers two mandatory internships.

Reflection. On the level of reflection, the RU students mainly reflect on professional socialising experiences on the level of knowledge acquisition and exposure, while UAS students also reflect on professional socialising experiences on the level of interaction. The UAS students reflect on their internship(s), while students of the RU programmes do not because they do not have a mandatory internship in their curriculum. Furthermore, students of the UAS programmes reflect on their graduation project experience, while students of the RU programmes do not.

4.3 Within-case analysis of the experiential curriculum

This section contributes to answering research question 2 (i.e., How is professional socialisation embedded in the experiential engineering curriculum?). The focus group interviews aimed to get an in-depth understanding of the experiential curriculum. The experiential curriculum is the final curriculum domain as proposed by Goodlad et al. (1979). Goodlad et al. (1979) recognized that there are discrepancies between curriculum domains, indicating that the experiential curriculum might differ from the other curriculum domains. Therefore, it is valuable to not only study the formal curriculum and perceived curriculum, but also the experiential curriculum. Studying the experiential curriculum provides a new dimension to curriculum research. Especially, since the experiential curriculum has not often been studied yet in relation to the formal curriculum in terms of professional socialisation.

The results will be presented for all three participating degree programmes. Since not all eleven curriculum components are present in the experiential curriculum, not all eleven curriculum components were discussed during the focus group interviews. The focus group interviews mainly focused on teaching and learning, teacher role, grouping, assessment, and the role of the professional. The student researcher asked the participants about their experiences, after which the student researcher structured the participants' input based on the levels of engagement (i.e., knowledge acquisition, exposure, interaction, and reflection).

4.3.1 Technical bachelor programme at research university

Knowledge acquisition. On the level of knowledge acquisition, students of both focus groups mentioned that they have worked on several different projects where a simulation-like environment is created: *"[...] each project has a different theme. Therefore, each project sheds a light on a different specialisation within our field. So, the projects are a good indicator of what possible directions you could choose for the future."* Students of focus group 2 stated that they often had to pretend that a project is assigned by a company. However, a student commented: *"I think it is mentioned once and after that it is not important, so to speak."*

Some teachers gave insight into the future professional role by speaking from their own experience in the field. In these cases, the role of the teacher can be grouped as knowledge acquisition. Students of focus group 1 mentioned that they had one teacher that worked in the field previously and told about his experiences in the field. However, a student commented: *"You have not missed anything. [...] the teacher told an anecdote now and then instead of giving really useful information from the working field."* In the second focus group, a student mentioned one specific teacher that has working experience at a company and was able to establish *"a nice link"* between the discipline and his previous working field. Another student noted that *"some professors do research for companies and occasionally hint at that within the lectures"*. Students from both focus groups explained that their teachers do not usually have any work experience in the field though. Teachers are either PhD students that have not previously worked in the field, or professors that have worked in academia their entire life: *"[...] just people who have done nothing but study all their lives."* One student thinks that is a pity. However, another student commented: *"Yes, but despite that, I do not necessarily feel like I miss a lot. Because the study association creates many opportunities to get in contact with companies. So, if you want to get in contact with companies, you can."* Students of focus group 1 do not see their teachers as role models. Students of focus group 2 see some teachers as role models, especially the ones that teach enthusiastically.

Students often work in (diverse) groups, which can be classified as knowledge acquisition because in the work field employees often work in (diverse) groups as well. Furthermore, by working with other disciplines and/or nationalities, one becomes more aware of its own discipline, culture, and unique contribution. One student noted that working in project groups simulates how it goes on in a real-life company situation: “[...] you often cannot choose your colleagues. I think that resembles working life at a company. [...]” Students of focus group 1 mentioned that they are encouraged to fulfil different roles within group projects. However, the students of focus group 2 stated that they were not encouraged to take on different roles due to the size of the project groups: “I also found it a bit annoying sometimes that you had those big projects. That you are thrown into a group with twelve students from your study programme. Then you always have the same people who take on the same role.” Another student agrees and adds: “often everyone is really in their own role.” During module 6, students worked in a group of students from three different study programmes. One student noted: “[...] if you work in a multidisciplinary group, the relationships are very different for different types of people [...]. Yes, that just gives a completely different dynamic within the group. And I also think it is more representative for later work life.” In focus group 2 it was noted that the male-female ratio is not representative for the work field: “Of course, you work much more with women in business than in the study programme, I think.” Students did however recognize that a representative male-female ratio is difficult to accomplish when there are just a few women enrolled in the programme. In terms of multiculturalism, students stated they usually work in a group with a few international students. It was noted that the number of international students is increasing, and that the university is actively mixing the groups so “[...] in terms of how it reflects the world labour market, it is doing pretty well and getting better”.

Exposure. On the level of exposure, several learning activities were mentioned: a company visit in module 1, an excursion (which was cancelled due to the coronavirus pandemic) in year 2, several guest lectures, and the module 6 project. In module 6, students worked on a project in assignment of a company. During this project, students received guest lectures and students gave a presentation to the company at the end of the project. The module 6 project was mentioned multiple times and is considered “the project that is linked to a company.” Although the project was in assignment of a company, there was little direct interaction. Therefore, the project is classified on the level of exposure instead of interaction. Students explained that a contact person from the university would pass on all the students’ questions to the company. And the answers from the company were again passed on through the contact person. Even though there was very little direct interaction with the company, one student did feel a connection.

The study association plays a significant role in providing co-curricular activities on the level of exposure. Normally, the study association organises a weekly lunch lecture and several company visits. A student explains about the lunch lectures: *“Yes, you lure students in with food, but in the meantime, they learn what a company can do for them.”* Students from focus group 2 agreed that it is more useful when a technical employee gives a presentation instead of someone from HR: *“[...] I think it is much more interesting to speak to someone from the technical staff. Yes, we often like the HR talk, but we cannot do much with it. [...]”* It was also highlighted that the study association is funded by the study programme and that they *“work together quite closely”*. One student feels that the study association is a real asset: *“I think it is much better if these activities are organised by the study association instead of a teacher who is more distant from the working field. So yes, I think the study association has something to offer.”* Another student agrees but also regrets it, because it feels as if the study programme shifted the responsibility to the study association and, as a consequence, there is little connection with the working field in the courses.

Interaction. On the level of interaction, students of focus group 2 stated that it is possible to do an internship or a graduation project in the professional context. However, most students choose to do a minor (instead of an internship) and work on a graduation project offered by the university. Students explained that this is because the university does not facilitate any internship placements or graduation projects at companies: *“The funny thing is, they say it is possible, but they are not going to help you with it. You have to do almost everything yourself. It feels very demotivating.”*

Students named one example where a professional from the field was involved in the assessment. This example can be classified on the level of interaction. Upon completing the project in module 6, students gave a presentation to both the university and the company that provided the assignment. Both the university and the assigning company had the opportunity to ask questions and provide feedback. This resulted in interaction between the students and a professional from the field. However, a student stated that only the grade from the university was valid; the grade from the company was *“a nice bonus”* but was not included in the final grade. Despite that, one student really valued the feedback from the company.

Reflection. Focus group 1 mentioned that reflection is not an essential part of the study programme. Although students could mention a few reflection activities. Most of them are related to the course Academic Skills. In module 1, students had to write a motivation letter for a vacancy they received: *“Actually we had to write about the reason why we started in this study programme.”* However, it was noted that reflection was not the main reason for the assignment: *“But the main goal was to test our English level.”* In module 2, students had to write about their own strengths and weaknesses related to group work. And after completing their project assignment for module 3, they

had to sit around a table with their project group and teacher and discuss each other's strengths and weaknesses. *"But that was once and that was it."* Lastly, students had to write an essay about which specialisation they wanted to choose for their master programme. Focus group 2 also acknowledged the role of the course Academic Skills in providing reflective assignments. However, one student commented: *"then you always had to [...] give feedback at the end on what your role in the project had been. But I have the feeling that no one took that very seriously."* Another student agrees and added that Academic Skills is a course *"that people just do to get rid of it and get a checkmark"*.

General remarks. Two students of focus group 2 are recent alumni, who are now enrolled in a technical master programme. They explained that during the master there is a better connection with the work field. *"[...] I think that is a shame because it is done in the master, while in the first two years you try to orient yourself and determine why you are studying this programme. [...]"* Furthermore, the student feels *"that as a student you live in an abstract world for almost three years"*. Another student also stated that she missed the connection with the working field during her bachelor: *"[...] it was all focused on pass your courses, pass your studies, just continue quickly and all. And yes, that is why I now have reached the point where I am like oh damn I have to know what I want later. It would have been nice if more attention had been focused on it earlier on."*

Students of focus group 2 stated they perceived talking to alumni as very valuable. Thus, they see potential in the use of alumni, which currently is not used to the fullest according to the students. *"Yes, [...] I sometimes just meet alumni here at the university who are just here for a day. Who can really talk about how things work at a company and what is fun about it. I think that is always very valuable."*

4.3.2 Intersection bachelor programme at research university

Knowledge acquisition. Students agreed that knowledge acquisition is not addressed in the courses. However, students stated that they acquired some knowledge of the future role through the module projects: *"I think it is mainly about running companies and consultancy. Considering the projects."* One student noted however that the knowledge they gain about the future role is not very concrete: *"But it is not so much that we really get an idea of a particular position within a company. That you really know what positions there are and what these positions entail."* Another student said that the study programme provides an introduction to what sectors and positions are available in the field, but it is *"not very focused on what a position entails"*. One student thinks this might be because the study programme is *"quite broad"*. Furthermore, many of the module projects include an assignment from a fictional company. For instance, module 8 *"[...] Is about a kind of demo company. I mean, you are talking to the teacher, but the teacher is pretending to be the contact person of a company."* Another

student said he prefers an assignment from a real company: *“Well, I would like it if more assignments come from the working field instead of being busy with some random numbers or some other fabrications.”*

One student named two examples of teachers that gave insight into the future professional role by speaking from their own experience in the field. In these cases, the role of the teacher can be grouped as knowledge acquisition. However, students think that most of their teachers are PhD-students and researchers: *“So, then you do not hear anything about the working field or that sort of thing.”* Furthermore, one of the students felt that their teachers could be seen as role models in their area of expertise because they often do research in cooperation with a company in the field; they work with real-life problems of the industry and *“[...] sometimes they tell something about their research [...]”*.

Students often work in (diverse) groups, which can be classified as knowledge acquisition because in the work field employees often work in (diverse) groups as well. Furthermore, by working with other disciplines and/or nationalities, one becomes more aware of its own discipline, culture, and unique contribution. Students have worked together with students from four different study programmes throughout modules 6, 7, and 8. The amount that students worked together with international students differs. One student has never worked together with an international student, another student once, and yet another student multiple times. It was explained that no real attention is paid to it when creating the groups and that they have not often worked in international groups because there are not many international students enrolled in the programme.

Exposure. On the level of exposure, students noted that they often have a guest lecture at the start of a project. For instance, in modules 2 and 6, where they worked on a project in assignment of a company. However, *“they do not make the best impression [...] because we have to dig deep.”* The two other students added that these guest lectures are really about the project, and not so much about the respective company and future roles for graduates. In module 7 however, students received multiple short guest lectures which were more focused on the working field. Furthermore, in module 2, students went on an excursion to a company. One student feels *“[...] that it is useful to have more excursions [...]”*. Another student explained that in the past, not many students showed up for an excursion, after which the study programme decided not to organize excursions anymore. Lastly, it was noted that the study association offers many *“opportunities”* to get in contact with the working field. The study association offers many guest lectures, excursions, and a yearly conference with multiple companies present. A student noted: *“Perhaps that is why the study programme thinks it does not need to initiate a lot of contact with companies because the study association is already doing that.”*

Interaction. On the level of interaction, students had to interview someone from the working field. One student *“really liked”* doing the interview. Students also explained that they are supposed to do their graduation project in a professional context. One student noted: *“Yes, that is the most teachable I think. That you work within a company and you apply your skills to it.”*

There are a few examples where a professional from the field was involved in the assessment. These examples can be classified on the level of interaction. Students presented their work to and received feedback from a professional from the field in modules 3, 6, and 7. This resulted in interaction between the students and a professional from the field. In module 3, one student thought this was *“pretty cool”*. However, students are not sure whether the assessment of the professional was integrated into the final grade in module 3. For modules 6 and 7, the assessment of the professionals was not integrated into the final grade. Lastly, students noted they receive feedback from the company where they work on their graduation project.

Reflection. On the level of reflection, one student noted: *“We have to reflect a lot, but not so much really on the work field, I think. More about if you grow as a person and stuff, and [...] self-driven learning and stuff.”* This also applies to the reflection assignment linked to the graduation project. Mark: *“Well, not really a reflection on, say, professional functioning. Yes, sort of about professional functioning, but not so much very professionally oriented or something. It is more about how you as a person have gotten better at certain skills. Not more than that.”* Only for module 2 students had to reflect on their future role. For this assignment, they had to interview someone from the working field, after which they had to write a reflection.

General remarks. One student said that the study programme and the working field are quite separate from each other. Another student commented: *“No exactly. Yes. But I think that is also what university education is all about. That you do not teach professionally oriented.”*

4.3.3 Technical bachelor programme at university of applied sciences

Knowledge acquisition. One student of focus group 4 said that the curriculum itself does not really provide insight into work life. Another student added that they do not specifically learn which roles they can fulfil upon graduation. Yet another student commented: *“Yes, our study programme focuses mainly on theory.”* In the fifth focus group, one example of knowledge acquisition was mentioned: The interdisciplinary project semester in year three ends with a fair where students can walk around and see which companies were involved in other groups’ projects and take a look at the project results. Thus, at the fair, students get insight into what type of projects they could work on and for what type of companies.

Students of focus group 4 said the role of the teacher differs. Some teachers predominantly teach while some others work at the university but mainly in a non-teaching role and do teaching on the side. A few teachers have previous work experience in the field, but others have been a teacher all their lives. Because some teachers work or have worked in the field, they can give practical examples and share their experiences, in which case the role of the teacher can be grouped as knowledge acquisition. One teacher for instance discussed work attitude and work pace from a real-life perspective. In focus group 5, students said they have some teachers that have worked in the field, but they cannot recall that they really talked about their experiences. Students of focus group 4 stated that they do not see their teachers as role models: *"You get some inspiration from them every now and then",* but *"that is about it"*. In focus group 5, students see some of the teachers as role models. Mostly the specialists that teach enthusiastically. Student: *"If you like thermodynamics then you can talk to the thermodynamics teacher and see, oh this is what you can become, this is what you can do with it. That is the way it is if you know much about this."*

Students often work in (diverse) groups, which can be classified as knowledge acquisition because in the work field employees often work in (diverse) groups as well. Furthermore, by working with other disciplines and/or nationalities, one becomes more aware of its own discipline, culture, and unique contribution. Students mostly work with classmates, thus, with students from the same study programme. The international student week, however, is an interdisciplinary project: *"I believe that the project focuses more on collaborating with other disciplines than your professional knowledge."* Furthermore, the international student week is, as the name suggests, supposed to be international. Thus, students are supposed to be grouped with some international students. However, one student explained that there are not enough international students so by no means all groups are actually international. And if a group consists of a few international students, collaboration is hampered by the language barrier: *"[...] it is just such a language difference that it never really works well for us. [...] you start in English, but after half an hour you speak Dutch again. Yes, then you exclude the international students a bit from the group."* Two students noted that they found the international student week a *"useful experience"* in year 3 when they acted as the project leader. In years 1 and 2, they acted as a general group member and were less motivated. Furthermore, for the interdisciplinary project semester, one student said they were *"paired with two or three other studies"*. However, this was not the case for all students. One student was grouped with three students from his study programme and one student from another programme while another student was grouped with seven students from his study programme and one student from another programme. It was noted that the interdisciplinary project semester coordinators became aware of this problem and have made sure that the groups are now more interdisciplinary.

Exposure. On the level of exposure, a student mentioned that he interviewed three interns at their internship company during the first year of his studies. In the second year, students went on an excursion. The content of this excursion differs each year because the second-year student of focus group 4 had a different excursion for a different course than the third-year students. Apart from the activities mentioned above, it is mostly the study association that exposes students to the working field. The study association organises excursions and guest lectures regularly. Therefore, if students want, it is possible to come into contact with companies. For one student the excursions from the study association confirmed that he chose the right study programme.

Interaction. The students of focus group 5 said they went to a national career fair that focused on the manufacturing industry. The level of engagement at the fair differed per student. One student said *“not a single company wanted to talk to us because we were just students”*, while student number 2 received free drinks and several job offers. Student number 3 explained that he left the fair early to join fellow students at a bar, while student number 2 stayed longer and really enjoyed seeing what happens in the work field. Thus, for some students, the fair was an experience on the level of exposure, and for some, it was on the level of interaction. In addition, students of focus group 5 noted that the study programme organised a career fair in cooperation with the study association. Apart from the career fairs mentioned above, interacting with the working field mostly occurs in years 3 and 4 of the programme. In these years, students work on a project in assignment of a company or research group (interdisciplinary project semester), do an internship, and work on a graduation project for a company or research group. Furthermore, the programme offers an international project week, for which students work on an assignment that is provided by a company. Students participate in this yearly project week during years 1, 2, and 3 of their studies. It is noted, however, that throughout the project, students only really interact with the company in year 3. Being a more senior student in year 3, students usually take on the role of project leader and hence, act as the contact person. First and second-year students only interact with the company indirectly, through the project leader.

There are a few examples where a professional from the field was involved in the assessment. These examples can be classified on the level of interaction. Students explained that in case they worked on a project in assignment of a company, a representative of the assigning company was present during the final presentation and provided feedback. For example the report of the international student week was presented to the company that provided the assignment, after which students received questions and feedback from the company. This resulted in interaction between the students and a professional from the field. Two students of focus group 5 think the input from the company is taken into account for the final grade, but the teacher probably has the final say. Furthermore, the students of focus group 5 said a specialist from a company came to provide feedback

on their assignment for the second-year course Energy Systems. One student said *“he was critical”* and thought it was useful to receive feedback from a specialist from the field. In case of the internship, students noted that their performance is graded by the company (while the final report and presentation are graded by the university). Lastly, for the presentation of the graduation project, an expert from the field is present to provide feedback.

Reflection. On the level of reflection, a student from focus group 4 noted that there was a reflection assignment for the course Orientation to Study and Profession: *“But that teacher was very vague so it was not clear.”* Another student added: *“That course is a bit annoying”*. The students of focus group 5 talked about the course Personal Professional Development (which might be the predecessor of the course Orientation to Study and Profession). For this course, they interviewed three fellow students who interned at a company, after which they had to write a reflection. A student commented: *“I do not think anyone was really excited about it. It was more like it is a must and it is good for you, but it does not go wholeheartedly.”* Another student added that the teacher for this course is taking on the role of study career counsellor, which is not suitable for every engineering teacher. A *“blunt engineer”* as he called it, might not be interested in subject matters related to study career counselling. Thus, for some students, it was more about meeting attendance than about reflecting on what they want to do in the future. During the interdisciplinary project semester, one student completed the Belbin Test, which is a peer review assignment to see who took what role within the group: *“[...] the reflection in the interdisciplinary project semester project helped me a lot”*. Students of both focus groups noted that they had to write a reflection on their internship. However, students have interpreted the assignment in various ways. One student thoroughly reflected on his role, while two other students only reflected on their tasks and not so much on themselves. For the graduation project, the reflection assignment was more specific. A student of focus group 5 said he needed to reflect on what he wants to improve about himself in the next two years. All in all, there are several reflective assignments throughout the study, but one student feels that the programme does not *“[...] very specifically ask about reflection on later work area [...]”*.

4.3.4 Overview of the professional socialisation elements in the experiential curriculum

Table 6 provides an overview of the professional socialisation elements in the experiential curriculum.

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Table 6

Overview of the professional socialisation elements in the experiential curriculum

	Technical bachelor programme at RU	Intersection bachelor programme at RU	Technical bachelor programme at UAS
Knowledge acquisition	<ul style="list-style-type: none"> - several projects with a realistic business context - some teachers have worked in the field - some students see their teachers as role models (if they do, then just a few who teach enthusiastically) - several international project groups - interdisciplinary groups in module 6 	<ul style="list-style-type: none"> - several projects with a realistic business context - some teachers have worked in the field - teachers are seen as role models in their area of expertise - students work in interdisciplinary groups in modules 6, 7, and 8 - students occasionally work in international groups 	<ul style="list-style-type: none"> - interdisciplinary project semester fair - some teachers work or have worked in the field - some students see their teachers as role models (if they do, then just a few who teach enthusiastically) - students work in interdisciplinary and sometimes international groups during the international student week in years 1, 2, and 3 - interdisciplinary groups in the interdisciplinary project semester
Exposure	<ul style="list-style-type: none"> - company visit in module 1 - excursion in year 2 - several guest lectures - project in assignment of a company in module 6 - weekly lunch lecture and several company visits organised by the study association 	<ul style="list-style-type: none"> - several guest lectures at the start of a project - excursion in module 2 - several guest lectures in module 7 - many guest lectures, excursions, and a yearly conference organised by the study association 	<ul style="list-style-type: none"> - interviewing interns at their internship company in year 1 - excursion for a varying course in year 2 - regular guest lectures and excursions organised by the study association
Interaction	<ul style="list-style-type: none"> - optional internship in year 3 - optional graduation project in the professional context in year 3 - module 6 project is assessed by the company that provided the assignment 	<ul style="list-style-type: none"> - interviewing a professional from the field in module 2 - intended graduation project in the professional context - In modules 3, 6, and 7 students receive feedback from the company that provided the assignment 	<ul style="list-style-type: none"> - national career fair - career fair organised by the study programme and study association - compulsory interdisciplinary project semester (project in assignment of a company) in year 3 - compulsory internship in year 4

- student performance is assessed by the company where students work on their graduation project
- compulsory graduation project in the professional context in year 4
- international project week in year 3 (only when the student takes on the role of project leader)
- in case students worked on a project in assignment of a company, the assignment is presented to and assessed by the company (for instance the international student week project)
- for the second-year course Energy Systems, students received feedback from a specialist from the field
- internship performance is graded by the internship company
- an expert from the field provides feedback on the final presentation of the graduation project

Reflection	<ul style="list-style-type: none"> - writing a motivation letter for a vacancy in module 1 - writing about own strengths and weaknesses related to group work in module 2 - discussing each other's strengths and weaknesses in group work in module 3 - writing an essay related to the master specialization in module 8 	<ul style="list-style-type: none"> - reflection assignment in module 2 	<ul style="list-style-type: none"> - one reflection assignment for the course Orientation to Study and Profession / Personal Professional Development - Belbin test during the interdisciplinary project semester - internship reflection (was interpreted in various ways) - graduation project reflection
General remarks	<ul style="list-style-type: none"> - according to students the master programme offers a better connection with the working field compared to the bachelor programme 	<ul style="list-style-type: none"> - according to students the study programme and the working field are quite separate from each other 	

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- students see great potential in the use of alumni
-

4.4 Cross-case analysis of the experiential curriculum

This section presents the main similarities and differences between the three engineering programmes included in the analysis of the experiential curriculum. In doing so, this section contributes to answering research question 2 (i.e., How is professional socialisation embedded in the experiential engineering curriculum?).

Knowledge acquisition. Students of all three programmes acquired some knowledge of the future role through projects. Both through simulation projects as well as projects assigned by a real company. However, despite the projects, students of the intersection degree programme feel the knowledge they gain about the future role is not very concrete. Furthermore, students of the technical degree programme at the UAS feel their programme is mostly focused on theory.

Students of all three study programmes experience that some teachers have working experience in the field and are therefore able to give insight into the future professional role by speaking from their own experience. However, according to the RU students there are only a few teachers with working experience in the field since most of the teachers are PhD-students and researchers who have been in academia their entire working life. Even if a teacher has working experience in the field and shared his experiences, not all students from the technical degree programme found this useful. Students from the intersection degree programme noted that their teachers often do research in cooperation with a company in the field and elaborate on their research in class. Therefore, even if the teachers do not have working experience in the field, they have worked with real-life problems of the industry and share these with their students, which is valued by students. Students of the technical degree programme at the UAS said they have some teachers that have worked or currently work in the field but not all students can recall that these teachers really talked about their experiences. In all three programmes, some students see their teachers as role models, but others do not.

Students of all three programmes often work in groups. The diversity of the group composition differs per project and per programme. Students of all three programmes work in an interdisciplinary group for at least one project. Of all three programmes, students of the technical degree programme at the RU work in interdisciplinary groups the least. Furthermore, students of all three programmes work in an international group for at least one project. Of all three programmes, students of the technical degree programme at the UAS work in international groups the least.

Exposure. Students of all three programmes mentioned several learning activities in which they are exposed to the workplace. In addition to the learning activities offered by the education institution, all three study programmes have a study association that organises activities that foster professional socialisation on the level of exposure. The study associations of the RU programmes are

more active in this regard compared to the study association of the technical degree programme at the UAS. The activities organised by the study association are related to and complement the study programme but are not part of the formal curriculum and therefore not mandatory. Thus, these activities are co-curricular.

Interaction. Students of the UAS programme experience more professional socialising experiences than students of the RU programmes. The most striking difference is a compulsory internship at the UAS compared to an optional or no internship at the RU.

Reflection. Students from all three study programmes experience some activities on the level of reflection. Although some students more than others. Students of the intersection degree programme at the RU only experienced one reflection assignment while students of the other two programmes experienced several. Most of the reflection assignments are focused on professional socialising experiences on the level of knowledge acquisition (e.g., group work). Only the technical degree programme at the UAS has two reflection assignments that are focused on professional socialising experiences on the level of interaction (i.e., internship reflection and graduation project reflection). Furthermore, all three study programmes have a course that is aimed at professional development and providing reflection assignments.

4.5 Comparison between the formal and experiential curriculum

This section presents the main similarities and differences between the formal curriculum and experiential curriculum. Each programme is analysed individually. In doing so, this section aims to answer research question 3 (i.e., How do the professional socialisation elements of the formal engineering curriculum compare to the experiential engineering curriculum?).

4.5.1 Technical bachelor programme at research university

An overview of the professional socialisation elements in both the formal and experiential curriculum is presented in table 7 in appendix D.

Knowledge acquisition. On the level of knowledge acquisition, the intended professional socialisation in the formal curriculum is also included in the experiential curriculum. In addition, there are some aspects of the experiential curriculum that are not included in the formal curriculum. These aspects relate to the teacher role and occasionally working in international project groups.

Exposure. Most of the intended professional socialisation in the formal curriculum is experienced by students. One difference that stands out from the data is that students highlighted the activities organised by the study association, while these activities are not included in the formal curriculum.

Interaction. On the level of interaction, there are some discrepancies between the formal and experiential curriculum. Students indicated that they can do an internship and graduation project in a professional context. However, this is not reflected in the formal curriculum.

Reflection. There are several discrepancies between the formal and experiential curriculum since only one professional socialisation element is included in both the formal and the experiential curriculum.

4.5.2 Intersection bachelor programme at research university

An overview of the professional socialisation elements in both the formal and experiential curriculum is presented in table 8 in appendix E.

Knowledge acquisition. The professional socialisation elements in the formal curriculum are also included in the experiential curriculum. In addition, there are some aspects of the experiential curriculum that are not included in the formal curriculum. These aspects relate to the teacher role and occasionally working in international project groups.

Exposure. Both the formal and experiential curriculum indicate that there are several guest lectures. A difference that can be detected is that the experiential curriculum includes an excursion, which is not included in the formal curriculum.

Interaction. Most of the intended professional socialisation in the formal curriculum is experienced by students. One discrepancy that stands out is that students indicated that they are supposed to do a graduation project in the professional context while this is not reflected in the formal curriculum.

Reflection. There are few professional socialisation elements on the level of reflection. The formal curriculum includes two elements, while the experiential curriculum only includes one.

4.5.3 Technical bachelor programme at university of applied sciences

An overview of the professional socialisation elements in both the formal and experiential curriculum is presented in table 9 in appendix F.

Knowledge acquisition. The formal curriculum contains many professional socialisation elements that are not included in the experiential curriculum. Elements that overlap are related to teachers acting as role models and working in interdisciplinary/international groups. Elements that are only included in the formal curriculum are for instance related to the software used and preparation of the internship and graduation project.

Exposure. The company presentations and one company visit in the formal curriculum are not reflected in the experiential curriculum. In addition, the guest lectures and excursions organised by the study association are included in the experiential curriculum but not in the formal curriculum.

Interaction. On the level of interaction, students recognized more professional socialising experiences than are embedded in the formal curriculum. Students often interacted with a professional in the field during the international project week in year 3, and there were several occasions where students presented their work to a professional and received feedback.

Reflection. Most of the professional socialisation elements are included in both the formal and experiential curriculum. The discrepancies relate to two reflection assignments in year 1 (which are included in the formal curriculum but not in the experiential curriculum) and the interdisciplinary project semester (which is included in the experiential curriculum but not in the formal curriculum).

5. Discussion and Conclusion

This research aimed to map the professional socialising experiences of the formal curriculum and the experiential curriculum. This chapter first elaborates on the formal curriculum, after which the results of the experiential curriculum are discussed. Next, this chapter elaborates on the similarities and differences between the formal and experiential curriculum. Furthermore, the implications, limitations, and recommendations for further research are presented.

5.1 Formal curriculum

The document analysis of the formal curriculum indicates that all four study programmes offer professional socialising experiences on all four levels of engagement (i.e., knowledge acquisition, exposure, interaction, reflection). This section focuses on explaining the main similarities and differences between programmes.

Knowledge acquisition. Although knowledge acquisition is an important first step in professional socialisation, the RU programmes included in this study offer fewer professional socialising experiences than the UAS programmes. This corresponds with the knowledge we have about the distinction between UAS and RU institutions; UAS programmes are more practical oriented and train students for a profession while research universities are more theoretical and have a stronger focus on research (Decanenvereniging VvSL, 2020). Although RU programmes have a different profile, students could benefit from gaining knowledge about the future profession because it is an important first step in professional socialisation. By acquiring knowledge of the future profession, students start to identify themselves with it (Weidman et al., 2001).

All four study programmes offer simulated learning environments on the level of knowledge acquisition, which indicates that knowledge acquisition does not always have to be traditional face-to-face education. The use of simulated learning environments corresponds with literature; According to Juan, Loch, Daradouis, and Ventura (2017), the use of simulation software and serious games in higher education is increasing and can significantly enrich the learning experience, particularly in STEM education.

Exposure. Despite the profile differences between UASs and RUs, there are little differences concerning the offering of socialising experiences on the level of exposure. On paper, the RU programmes probably offer just as much professional socialising experiences on the level of exposure as the UAS programmes, because RUs are increasingly conscious that they have a social and regional responsibility. Therefore, RUs are seeking collaboration with institutions and companies in the region to ensure their relevance. Providing professional socialising experiences on the level of exposure is in line with literature since literature states that exposure to the profession is an important aspect of

professional socialisation. At this level, students are exposed to the profession without having to play an active role yet. This makes it a relatively low-key and safe encounter with the profession. By observing, students become familiar with normative role expectations (van Hattum-Janssen & Endedijk, 2019).

Interaction. The formal curriculum indicates that the UAS programmes offer one or two mandatory internship(s), while the RU programmes do not. This corresponds with the knowledge we have about the distinction between UASs and RUs; UAS programmes are more practical oriented and train students for a profession while research universities are more theoretical and have a stronger focus on research (Decanenvereniging VvSL, 2020). Keeping these distinctions in mind, it is expected that the UAS programmes offer more internships. And in doing so, the UAS programmes offer more professional socialising experiences on the level of interaction. An internship is an important aspect of professional socialisation development because, during an internship, a student has extensive interaction with the professional context. During an internship, students determine which competencies are important for their future career. Furthermore, an internship enables students to observe and model skills and behaviours that professionals embodied on the job (Polmear et al., 2020).

Reflection. On paper, the RU students mainly reflect on professional socialising elements on the level of knowledge acquisition and exposure, while UAS students also reflect on professional socialising experiences on the level of interaction (i.e., internship(s), graduation project in the professional context). This distinction can partly be explained because the RU programmes have fewer professional socialising experiences on the level of interaction. However, we have also seen that not all professional socialising experiences on the level of interaction are reflected upon. Especially for the intersection degree programme at the RU there is a missed opportunity. Students of this programme ought to do their graduation project in the professional context, but the formal curriculum does not indicate that students reflect on this experience. Reflecting on a professional socialising experience is an important step in professional identity formation because it is a mediator between experience and identity (de Weerd et al., 2006).

5.2 Experiential curriculum

The focus group analysis of the experiential curriculum indicates that all four study programmes offer professional socialising experiences on all four levels of engagement (i.e., knowledge acquisition, exposure, interaction, reflection). This section focuses on explaining the main similarities and differences between programmes.

Knowledge acquisition. Overall, we have seen that knowledge acquisition on future roles takes place through projects, but remains too implicit and is therefore not always recognized. Using situated

inquiry, this could be improved. Situated inquiry (Krajcik & Blumenfeld, 2005) involves projects addressing a real-life problem that needs to be solved by using authentic methods that professionals from the field could also use when solving a similar problem.

Because RUs are more research-oriented, it is expected that the UAS teachers have more working experience in the field compared to RU teachers. Therefore, it was expected that the UAS students included in this study, would come into contact more often with teachers who give insight into the future professional role by speaking from their own working experience in the field. However, this is not mentioned by students and can be seen as a missed opportunity for professional socialisation on the level of knowledge acquisition.

Students of all three study programmes see some of their teachers as role models, especially the ones that have a lot of subject matter knowledge and teach enthusiastically. This is a positive observation, because literature indicates that role models are important for professional identity development (Bragg, 1976; Cornelissen & van Wyk, 2007; Ibarra, 1999; Wong & Trollope-Kumar, 2014). During the focus group interviews, students highlighted that alumni could also serve as role models. This is backed-up by literature, which states that alumni serving as effective role models and role incumbents could foster students' professional identity development (Jackson, 2016; Stark, Lowther, Hagerty, & Orczyk, 1986).

All interviewed students occasionally work in interdisciplinary and international groups. Of all three programmes, students of the technical degree programme at the UAS work in international groups the least. This is in line with what is expected, because this programme is offered in Dutch while the RU programmes are offered in English and are therefore more likely to host international students. Working in an interdisciplinary and/or international group contributes to professional identity development because by working with other disciplines and/or nationalities, one becomes more aware of one's own discipline, culture, and unique contribution.

Exposure. Students of all three programmes mentioned several learning activities in which they are exposed to the workplace. In addition to the learning activities offered by the education institution, all three study programmes have a study association that organises activities that foster professional socialisation on the level of exposure. A study association constitutes a learning network (Ansala, Uusiautti, & Määttä, 2016) and can be considered a stepping stone to a community of practice. The importance of a community of practice is highlighted by previous research (Du, 2006; Hunter, Laursen, & Seymour, 2006). The study associations of the RU programmes are more active than the study association of the technical degree programme at the UAS. This means that the UAS programmes bear the task of providing professional socialising experiences more unilaterally, whereas the RU programmes share this task with the study associations. It should be noted that participation

in the activities organised by the study association is not mandatory. Thus, especially at a RU, the number of professional socialising experiences can differ per student, depending on whether a student takes part in the activities organised by the study association. It should also be noted that the activities organised by the study associations are mostly on the level of exposure so the study associations do not provide a balanced pallet of professional socialising experiences. This results in a higher urgency for study programmes to provide professional socialising experiences on the level of knowledge acquisition, interaction, and reflection to balance out the professional socialising experiences organised by the study association.

Interaction. Especially on the level of interaction, students of the UAS programme experience more professional socialising experiences than students of the RU programmes. A possible explanation can be found in the fact that the vast majority of UAS bachelor students start their professional career upon graduation, while 80% of RU bachelor students enrol in a master programme after obtaining their bachelor degree (Inspectorate of Education, 2018). Therefore, it is important to provide professional socialising experiences at the UAS bachelor programme. Only a few RU master students continue their academic career as a PhD student (VSNU, n.d. a; VSNU, n.d. b). Thus, for RU students it is important to provide professional socialising experiences in the master programme at the latest. The recent alumni included in this study were enrolled in the master programme and indicated that the master programme offers more professional socialising experiences than the bachelor programme. This corresponds with the aforementioned explanation.

Reflection. According to the results, students from all three study programmes experience some activities on the level of reflection. Although some students more than others, which may indicate that there is still something to be gained in the field of reflection. Previous research acknowledges the importance of reflection. Marcia (1966) acknowledged that reflection on exploration activities is a key aspect of identity development. In line with this, Moorhead, Bell, Jones-Mutton, Boetto, and Bailey (2019) stated that students should be exposed to a range of learning activities followed by guided and deep reflection to be socialised into the profession. Thus, insufficient reflection will hinder the development of a professional identity.

The experiential curriculum reveals that all three study programmes have a course that is aimed at professional development and providing reflection assignments. Students from the technical degree programme at the UAS hinted that they were not satisfied with how the course was taught, which might have negatively affected the quality of their reflections. Research indicates that students need to be provided with appropriate training to be able to engage in meaningful reflection (Oakley, Pegrum, & Johnston, 2014; O'Connell & Dymont, 2005; Levett-Jones, 2007). So, in these courses, adequate attention needs to be paid to reflection skills. Furthermore, students of both technical

degree programmes stated that they complete the reflection assignments just to pass the course, but they were not enthusiastic about them and did not always take the assignments seriously. Research indicates that students need to view reflection as beneficial or relevant to their learning experience, otherwise they are more likely to treat it as a routine activity. Thus, the benefits and relevance of reflection need to be highlighted for students to engage in and benefit from reflection (Chan & Lee, 2021).

5.3 Comparison between the formal and experiential curriculum

This section focuses on explaining the main differences between the formal curriculum and experiential curriculum.

Knowledge acquisition. At the UAS programme, many professional socialising experiences in the formal curriculum are not experienced by students. A factor that could play a role in this discrepancy, is that the concept of knowledge acquisition is difficult to grasp. It is possible that students do not recognize the knowledge acquisition activities as such, and therefore did not mention them during the focus group interviews.

Another difference between the formal and experiential curriculum is that students of all three programmes acknowledge that some teachers have working experience and that some teachers can be seen as role models, while the curriculum documents do not say anything (i.e., RU programmes) or very little (i.e., technical degree programme at the UAS) about the teacher role. Thus, even though the teacher role is not or scarcely formalised in the formal curriculum, students do experience the role of the teacher. This may mean that the curriculum is influenced by the teachers' background. According to Goodlad et al. (1979), this is a discrepancy that occurs between the formal and perceived curriculum since teachers adapt the formal curriculum based on their own values, beliefs, and competencies. The perceived curriculum is in between the formal curriculum and experiential curriculum (see Figure 1 on page 12). Therefore, a discrepancy between the formal and perceived curriculum, can also be considered a discrepancy between the formal and experiential curriculum.

Exposure. Students highlighted the activities organised by the study association, while these activities are not included in the formal curriculum. This corresponds with what is expected, since the activities organised by the study association are part of the co-curriculum instead of the formal curriculum. Students and study programmes can however benefit from co-curricular activities. Research indicates that involvement in co-curricular activities has a positive influence on students' academic performance (Drayton, Weeda, Avery, Penland, & Knight, 2019; Fox & Sease, 2019; Garavalia, Chan, Ortiz, Muniz-Delgado, Martinez, 2017). If the activities provide professional socialising experiences, the activities can be beneficial for the development of a professional identity.

Interaction. On the level of interaction, the most prominent differences between the formal and experiential curriculum concern the internship and graduation project at the RU programmes. For students of the technical degree programme at the RU, the opportunity to do an internship and a graduation project in the professional context is not reflected in the formal curriculum. Furthermore, for students of the intersection degree programme at the RU, the graduation project in the professional context is not reflected in the formal curriculum. In these cases, the curriculum lacks a comprehensive formal curriculum (e.g., syllabus). Even if an internship is only optional, the option can be enshrined in the formal curriculum. According to literature, both teachers and students benefit from having a comprehensive syllabus. First and foremost because the syllabus serves as a contract between teacher and students (Doolittle & Lusk, 2007; Grunert, 1997; McKeachie, 1999; Parkes & Harris, 2002). A syllabus is an important means of communication (Garavalia, Hummel, Wiley, & Huitt, 1999) and sets the expectations of a course (Danielson, 1995; Eberly, Newton, & Wiggins, 2001; McKeachie, 1978; 1999). Thus, it is advised to have a comprehensive syllabus for every course unit. Another reason why it is valuable to have a syllabus for each course unit is that the design of the curriculum is assessed during a programme's accreditation process (NVAO, 2018). If a comprehensive formal curriculum is in place, it can be assessed properly.

Reflection. On the level of reflection, the data indicates that there are multiple discrepancies between the formal and experiential curriculum. If professional socialising experiences are included in the formal curriculum but not experienced by students, it is possible that the assignments were administered but did not make a lasting impression on students, explaining why students did not mention them. If professional socialising experiences are not included in the formal curriculum but experienced by students, it is possible that teachers deviated from the formal curriculum. According to Goodlad et al. (1979), this is a discrepancy that occurs between the formal and perceived curriculum since teachers adapt the formal curriculum based on their own values, beliefs, and competencies. The perceived curriculum is in between the formal curriculum and experiential curriculum (see Figure 1 on page 12). Therefore, a discrepancy between the formal and perceived curriculum, can also be considered a discrepancy between the formal and experiential curriculum.

5.5 Implications

The findings of this study contribute to the body of literature. Existing literature on professional identity development mainly focuses on the medical and educational field. This study focused on the engineering field and therefore provides new insights. This study is the first that studied the formal curriculum and the experiential curriculum. In doing so, this study provides a broader and richer view of professional identity development in engineering curricula.

Findings from this study can be useful for engineering programmes at higher education institutions. With these findings, educational institutions get more insight into how to design a curriculum that includes meaningful professional socialising experiences. Next to assessing the formal curriculum, this study shows that it is useful to also study other curriculum domains such as the experiential curriculum. This ensures a broader and richer view of the curriculum, which is important due to the discrepancies between curriculum domains.

This study indicates that it is important for higher education institutions to provide professional socialising experiences on all levels of engagement. The first step in facilitating professional socialising experiences on all levels of engagement, is having a comprehensive formal curriculum. Meaning that professional socialising experiences on all levels of engagement should be included in the formal curriculum documents.

Subsequently, it is important to make teachers aware of their role in providing professional socialising experiences. This study implicates that teachers play an important role in carrying out the formal curriculum. As such, discrepancies between curriculum domains can occur. Once teachers are aware of this, they can actively try to prevent negative discrepancies from occurring and contribute to the occurrence of positive discrepancies.

This study indicates that study associations and alumni can play a role in providing professional socialising experiences. Therefore, higher education institutions may consider collaborating with study associations and alumni. It could be an option to link a (limited) number of credits to participation in activities of a study association. Furthermore, higher education institutions may consider formalising the role of alumni in providing professional socialising experiences.

5.6 Limitations

Some limitations need to be considered. There are several limitations related to the document analysis. Firstly, only four study programmes at two different institutions were included in the document analysis of this study. Second, the document analysis of this study is limited to the curriculum of the academic year of 2019-2020. The aforementioned limitations affect the generalizability of the results. Third, the formal curriculum documents for the intersection degree programme at a RU were more elaborate than the documents for the technical degree programme of a RU. The documents for the intersection degree programme were manuals, while the documents for the technical degree programme were course descriptions. This could have resulted in a narrower view on the professional socialising elements of the technical degree programme. Lastly, some formal curriculum documents were missing. For instance, no detailed internship documents were available for the UAS programmes. This is not in line with the expectation because for these programmes

students are obliged to complete an internship. The fact that there were no detailed internship documents could have led to a narrower view of the programmes in question.

There are several limitations related to the analysis of the experiential curriculum. Firstly, only three study programmes at two different institutions were included in the experiential curriculum analysis of this study. Second, the experiential curriculum analysis of this study focuses on current students of cohorts 2016-2017, 2017-2018, and 2018-2019. The aforementioned limitations affect the generalizability of the results. Third, no focus groups were conducted for the intersection degree programme offered at a Dutch UAS that is included in the document analysis. Therefore, the experiential curriculum of this programme could not be studied and compared with the formal curriculum. Fourth, the focus groups that were conducted were significantly smaller than anticipated. Instead of six to eight students per focus group, each focus group consisted of three students. This might have resulted in a narrower view of the experiential curriculum. Lastly, three out of fifteen participants did not fall within the original sample, which could have resulted in narrower and/or different data. Focus group 2 consisted of one second-year student and two recent alumni instead of three third-year students and focus group 4 consisted of one second-year student and two third-year students instead of three third-year students. Possibly all three aforementioned limitations are caused by the coronavirus pandemic that hit the Netherlands at the start of this research. Many adjustments had to be made in higher education, which could have led to a lower willingness to participate in extracurricular activities such as this study.

5.7 Further research

Some suggestions for further research can be done. Firstly, more and larger focus groups can be conducted for the programmes included in this study. This will provide a richer view of the experiential curriculum of the study programmes in question and enhance the validity. This especially applies to the intersection degree programme at the UAS, since there were no focus groups conducted for this study programme yet.

Second, this study only focused on bachelor programmes. In further research, subsequent master programmes could be studied as well. This is especially valuable for the RU programmes because the vast majority of the RU students enter the work field upon completing their master degree (Inspectorate of Education, 2018; VSNU, 2020). To get a complete picture of the professional socialising experiences in higher education, it is therefore important to research both the bachelor programme and the subsequent master programme at research universities.

A third suggestion for further research is to include alumni that are currently working in the field. In further research, a distinction can be made between alumni that entered the work field upon

completing their bachelor degree and alumni that entered the work field upon completing their master degree. Both groups of alumni can reflect on whether their professional identity has sufficiently been developed during their university programme(s) and what role their curriculum has/curricula have played.

Fourth, in future research, it is advised to adjust the interview scheme. For instance regarding the question about reflection assignments. The interview scheme used for this study asked to what extent students have reflected during their studies. A future interview scheme might ask explicitly to what extent students have reflected on professional socialising experiences that they previously mentioned during the interview.

Fifth, this study indicated that there is an interaction between the formal curriculum and co-curricular activities. Further research could focus on researching this interaction more extensively. In doing so, it would be especially interesting to determine who bears which degree of responsibility.

Sixth, this study focused on two technical engineering programmes and two intersection engineering programmes. In addition, other engineering programmes could be studied. By doing so, the generalizability will be improved. If these engineering programmes are being taught at other universities, this will benefit the generalizability even more. Furthermore, as mentioned just above, this study focused on four engineering programmes. Future research could focus on other STEM disciplines to discover whether the results of this study are generalizable to other STEM disciplines and vice versa.

Seventh, this study contributed to the development of a rubric that can be used to map professional socialising experiences in the formal engineering curriculum. Further research is needed to improve this rubric. The rubric could be validated by asking multiple researchers to use the rubric to analyse a specific study programme. Afterwards, the inter-rater reliability can be determined and the results can be used for improving the validity. Furthermore, the rubric could be refined by researching if some elements of professional socialisation make more impact on students than others.

Lastly, this study possibly concluded that not all professional socialising experiences on the same level of engagement have an equal impact on students. It is important to provide students with impactful professional socialising experiences. Therefore it is valuable to study the level of impact of different professional socialising experiences, especially within the same level of engagement.

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Appendices

Appendix A | Overview of the professional socialising experiences in the perceived curriculum

Table 1

Overview of the professional socialising experiences in the perceived curriculum

	Technical degree programme at RU	Intersection degree programme at RU	Technical degree programme at UAS	Intersection degree programme at UAS
Knowledge acquisition	<ul style="list-style-type: none"> - M6: interdisciplinary project group - students take on different roles while working in mono-disciplinary groups (in the first-year students obtain a different role each week) - some teachers have working experience in the field but most teachers do not - teachers are sometimes seen as role models - the software used in the programme is representative of the field 	<ul style="list-style-type: none"> - students work on simulation projects (serious games) - M4: Students take on different roles each (CEO, CFO, etc.) - M6: interdisciplinary project group - an estimate of 10% of the teachers has working experience in the field - teachers are a source of inspiration rather than a role model - teachers tell anecdotes about their experience with the work field - the software used in the programme is representative for the field 	<ul style="list-style-type: none"> - year 1: each student gives a presentation about the 3 companies he/she visited - students work in an interdisciplinary group during the yearly international project week - year 3: students work in an interdisciplinary group during the interdisciplinary project semester - an estimate of 50% of the teachers has working experience in the field - students see this as a benefit - teachers try to serve as role models - the software used in the programme is representative for the field 	<ul style="list-style-type: none"> - students work on a simulation project (serious game) - year 1: during the first project, students switch roles every week. These roles are representative of the working field. - year 3: students work in an interdisciplinary team during the optional interdisciplinary project semester - teachers often have connections with companies, partly because they have working experience in the professional field. - teachers are aware that they serve as role models - software that is representative of the field is

				shown to students. Students actually start working with it during their internship(s).
Exposure	<ul style="list-style-type: none"> - M6: a project in assignment of a company - guest lectures - company visit in M1, M3, M4, M6, and M8. Though, these company visits are not so much focused on professional orientation. - M8: guest lectures in relation to master specializations - weekly lunch lecture organised by the study association - excursions organised by the study association 	<ul style="list-style-type: none"> - M6: a project in assignment of a company - guest lectures - company visit in year 1 - M8: guest lectures - excursions organised by the study association 	<ul style="list-style-type: none"> - year 1: 3 company visits - 4 to 5 guest lectures - several excursions (in relation to project assignments) 	<ul style="list-style-type: none"> - guest lectures - career fairs - excursions - year 3: excursion to Volkswagen - company visits for female students
Interaction	<ul style="list-style-type: none"> - M6: the assigning company plays an informal role in assessment by choosing the best design - year 3: no internship, except when students do not want to pursue a masters. - M12: opportunity to collect data in 	<ul style="list-style-type: none"> - year 1: interviewing an alumnus - M6: the assigning company plays an informal role in assessment by choosing the best design - year 3: graduation project in the professional context 	<ul style="list-style-type: none"> - year 1: interviewing a professional from the field - year 1 & 2: students visit various career fairs - yearly International project week where students work on a project in assignment of a company 	<ul style="list-style-type: none"> - students work on projects in assignment of a company (this leads to interaction, especially in the later phase of the study) - year 3: optional participation in the interdisciplinary project semester where an assignment is

	<p>the professional context for the graduation project</p>	<ul style="list-style-type: none"> - year 3: graduation project is assessed by a professional from the assigning company 	<ul style="list-style-type: none"> - project courses are often carried out for companies - in case a project is carried out for a company, the company is present during the final presentation and has an advising role in the assessment - year 3: the interdisciplinary project semester is carried out for a company - year 4: internship - year 4: graduation project in the professional context - year 4: the internship is assessed by a professional from the company - year 4: graduation project is assessed by a professional from the assigning company 	<p>carried out for a company</p> <ul style="list-style-type: none"> - year 2: internship - year 4: internship - year 4: graduation project in the professional context - year 4: an external advisor is involved in the assessment of the graduation project
Reflection	<ul style="list-style-type: none"> - year 1: students need to write a motivation letter for a vacancy - M8: reflection on the guest lectures and master specializations 	<ul style="list-style-type: none"> - reflection assignments in every module for Academic Skills 	<ul style="list-style-type: none"> - year 1 & 2: reflecting on the various career fair visits - year 4: students have to write a reflection on their graduation project 	<ul style="list-style-type: none"> - reflection assignment after each excursion - students reflect on their experiences by interacting with their study

- year 4: students have to fill out a 360 degrees feedback form at the end of their graduation project

General remarks - the study association is supported by the study programme

Appendix B | Interview scheme (translated to English)

Action			Time
Introduction			5 min.
Discuss ground rules			
Questions?			
Variable	Indicator	Question	Time
Introduction question	General	Why did you choose this study?	5 min.
		Possible follow-up question: <ul style="list-style-type: none"> • What profession would you like to pursue after your studies? 	
Professional socialising experience	Knowledge acquisition	Version 1: To what extent have you gained knowledge of the future profession within the school walls? I am specifically looking for activities in which you are not yet exposed to the work field.	5 min.
		Version 2: What do your teachers and teaching materials say about the work field?	
		Possible follow-up question: <ul style="list-style-type: none"> • Do you know for example which professions you can perform after your studies? 	
		Concluding question version 1: <ul style="list-style-type: none"> • Are there any other activities within the school walls where you have gained knowledge of the future profession? Concluding question version 2: <ul style="list-style-type: none"> • What else do your teachers and teaching materials say about the work field? 	
	Exposure	To what extent were you exposed to the work field during your studies? Consider, for example, a guest lecture, company visit, or excursion.	5 min.
		Concluding question:	

		<ul style="list-style-type: none"> • Are there any other activities where you have been exposed to the work field? 	
	Interaction	<p>To what extent does the study pay attention to interaction with the professional field? Consider, for example, the implementation of a project on behalf of a company, where there is interaction between you and the company.</p> <p>Concluding question:</p> <ul style="list-style-type: none"> • Are there any other activities in which you have interacted with the work field? 	5 min.
	Reflection	<p>To what extent did you have to reflect on your future role as a professional during your studies? Think, for example, of a reflection on your role during a project, your graduation (only final year students) or your internship report (only at UAS).</p> <p>Concluding question:</p> <ul style="list-style-type: none"> • Are there any other activities in which you reflected on your future role as a professional? 	5 min.
Curriculum component	Teacher role	<p>Do you have teachers who work or who have worked in the professional field and who tell a lot from their experience as a professional in the work field?</p> <p>Possible follow-up question:</p> <ul style="list-style-type: none"> • To what extent do you see the teachers as role models? 	5 min.
	Grouping	<p>To what extent do you work in groups that are representative of the work field? Consider, for example, multidisciplinary or international groups.</p> <p>Possible follow-up question:</p> <ul style="list-style-type: none"> • When you work in a team for an assignment, to what extent does the team resemble a team that could also occur in the field? 	5 min.
	Assessment	<p>To what extent does the work field play a role in assessment?</p>	5 min.

		Possible follow-up question: <ul style="list-style-type: none">• What role do professionals from the work field play in for example assessment?	
Action			Time
Summary			5 min.
Closing			

Appendix C | Invitation (translated to English)

Dear student,

I might be looking for you for my graduation research!

At the moment, many students are studying at home because of the coronavirus, so you probably have less travel time. I hope you want to invest a small portion of this time in my graduation research. My research is part of the research project "Bridge the Gap!" and is about improving the transition of technical students to the labour market. My research focuses on the formation of a professional identity ("Who am I as a professional?") during the study. I am particularly interested in how you experience this as a student.

Target audience

For my research I am looking for:

- 2nd and 3rd-year students BSc Mechanical Engineering (Dutch research university)
- 3rd and 4th-year students BSc Mechanical Engineering (Dutch university of applied sciences)
- 2nd and 3rd-year students BSc Industrial Engineering & Management (Dutch research university)
- 3rd and 4th-year students BSc Industrial Engineering & Management (Dutch university of applied sciences)

What is expected of you?

If you fall within this target group, I would like to ask you to participate in a focus group. During this focus group, you will be asked for your opinion and you will talk to fellow students. Given the current circumstances regarding the coronavirus, the focus group will take place digitally. The focus groups are ideally held in June. Participation takes 45 minutes to an hour of your time and is completely anonymous.

What do you get in return?

Of course, I will be very grateful, because you help me to graduate! You will also gain more insight into how your curriculum contributes to the transition of technical students to the labour market.

Enthusiastic? Questions?

Are you available (the date and time are determined in consultation) and are you willing to participate in my research? Or do you have questions? Please contact e.a.oprins@student.utwente.nl.

Sincerely,
Erlijn Oprins

Appendix D | Overview of the professional socialisation elements in the formal and experiential curriculum of the technical bachelor programme at research university

Table 7

Overview of the professional socialisation elements in the formal and experiential curriculum of the technical bachelor programme at research university

	Formal curriculum	Experiential curriculum
Knowledge acquisition	<ul style="list-style-type: none"> - year 1: students take the role of a project team in a company - year 2: assignment with a realistic business context - year 2: working in interdisciplinary teams 	<ul style="list-style-type: none"> - several projects with a realistic business context - some teachers have worked in the field - some students see their teachers as role models (if they do, then just a few who teach enthusiastically) - several international project groups - interdisciplinary groups in module 6
Exposure	<ul style="list-style-type: none"> - year 1: excursion to a manufacturing facility - year 1: presenting a structured scientific poster to a technical public - year 1: presenting to the employer with technical knowledge and a technically skilled public - year 2: the client (company) introduces the problem via a guest lecture 	<ul style="list-style-type: none"> - company visit in module 1 - excursion in year 2 - several guest lectures - project in assignment of a company in module 6 - weekly lunch lecture and several company visits organised by the study association
Interaction	<ul style="list-style-type: none"> - year 2: the client (company) provides feedback - year 2: if possible, the company will be involved during the project 	<ul style="list-style-type: none"> - optional internship in year 3 - optional graduation project in the professional context in year 3 - module 6 project is assessed by the company that provided the assignment
Reflection	<ul style="list-style-type: none"> - year 1: students have to reflect on their own work in the last year and look forward to the future as a student (and professional) - year 2: reflect on the consequences of interdisciplinarity on the team cooperation and performance - year 2: students reflect on their own discipline and their unique contribution 	<ul style="list-style-type: none"> - writing a motivation letter for a vacancy in module 1 - writing about own strengths and weaknesses related to group work in module 2 - discussing each other's strengths and weaknesses in group work in module 3 - writing an essay related to the master specialization in module 8

PROFESSIONAL SOCIALISATION IN THE ENGINEERING CURRICULUM

- year 2: students reflect based on their own strong and weak points in the role of an engineering student as well as future professional and translates the reflection into clear action points
 - year 2: writing an essay about professional strengths and improvement points related to the master profiles
-

Appendix E | Overview of the professional socialisation elements in the formal and experiential curriculum of the intersection bachelor programme at research university

Table 8

Overview of the professional socialisation elements in the formal and experiential curriculum of the intersection bachelor programme at research university

	Formal curriculum	Experiential curriculum
Knowledge acquisition	<ul style="list-style-type: none"> - year 2: the context for the assignment is provided by real data (e.g., annual reports of several companies) - year 2: assignment with a realistic business context - year 2: working in interdisciplinary teams - year 2: the project management role alternates among the team members 	<ul style="list-style-type: none"> - several projects with a realistic business context - some teachers have worked in the field - teachers are seen as role models in their area of expertise - students work in interdisciplinary groups in modules 6, 7, and 8 - students occasionally work in international groups
Exposure	<ul style="list-style-type: none"> - year 2: the client (company) introduces the problem via a guest lecture - year 2: workshops provided by guest lecturers - year 2: several guest lectures 	<ul style="list-style-type: none"> - several guest lectures at the start of a project - excursion in module 2 - several guest lectures in module 7 - many guest lectures, excursions, and a yearly conference organised by the study association
Interaction	<ul style="list-style-type: none"> - year 1: students interview an alumnus - year 2: formal meeting with the client (company), during which each project group presents the results up until then - year 2: the client (company) provides feedback - year 2: during the project fair, students present the final results to the client as well as to other interested parties 	<ul style="list-style-type: none"> - interviewing a professional from the field in module 2 - intended graduation project in the professional context - In modules 3, 6, and 7 students receive feedback from the company that provided the assignment - student performance is assessed by the company where students work on their graduation project
Reflection	<ul style="list-style-type: none"> - year 1: reflection based on interviewing an alumnus - year 2: students reflect on their own discipline and their unique contribution 	<ul style="list-style-type: none"> - reflection assignment in module 2

Appendix F | Overview of the professional socialisation elements in the formal and experiential curriculum of the technical bachelor programme at UAS

Table 9

Overview of the professional socialisation elements in the formal and experiential curriculum of the technical bachelor programme at UAS

	Formal curriculum	Experiential curriculum
Knowledge acquisition	<ul style="list-style-type: none"> - working with software commonly used in the work field - staff members act as role models - In projects, teachers act as coaches and teacher. In the first projects, the teacher role is greater and in the last projects the coach role takes the upper hand - year 1: orientation to professional practice - year 1: demonstrating awareness of the specific engineering competencies - year 2, 3 & 4: the assignments are of a more multidisciplinary nature and are placed and/or carried out in an authentic context - year 2: assignment with a realistic business context - year 2: international project week: working in international and interdisciplinary teams - year 3: Interdisciplinary project semester: working in interdisciplinary teams - year 3: writing the internship plan - year 4: preparation assignment graduation project: students give a description of the desired company and what they want to do exactly 	<ul style="list-style-type: none"> - interdisciplinary project semester fair - some teachers work or have worked in the field - some students see their teachers as role models (if they do, then just a few who teach enthusiastically) - students work in interdisciplinary and sometimes international groups during the international student week in years 1, 2, and 3 - interdisciplinary groups in the interdisciplinary project semester
Exposure	<ul style="list-style-type: none"> - year 1: 3 company visits - year 1: 5 company presentations 	<ul style="list-style-type: none"> - interviewing interns at their internship company in year 1 - excursion for a varying course in year 2

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	<ul style="list-style-type: none"> - year 2: company visit - year 2: company visit 	<ul style="list-style-type: none"> - regular guest lectures and excursions organised by the study association
Interaction	<ul style="list-style-type: none"> - visiting career fairs - internship - year 3: interdisciplinary project semester (project in assignment of a company or research group) - year 4: graduation project in the professional context - year 4: a professional from the company is involved in the assessment - year 4: an external expert is involved in the assessment 	<ul style="list-style-type: none"> - national career fair - career fair organised by the study programme and study association - compulsory interdisciplinary project semester (project in assignment of a company) in year 3 - compulsory internship in year 4 - compulsory graduation project in the professional context in year 4 - international project week in year 3 (only when the student takes on the role of project leader) - in case students worked on a project in assignment of a company, the assignment is presented to and assessed by the company (for instance the international student week project) - for the second-year course Energy Systems, students received feedback from a specialist from the field - internship performance is graded by the internship company - an expert from the field provides feedback on the final presentation of the graduation project
Reflection	<ul style="list-style-type: none"> - year 1: reflection assignment based on career fair visit(s) - year 1: person profile test with reflection - year 1: reflecting on own actions and on those of others - year 3: reflection assignment based on the internship (plan) - year 4: writing a learning report upon completing the graduation project 	<ul style="list-style-type: none"> - one reflection assignment for the course Orientation to Study and Profession / Personal Professional Development - Belbin test during the interdisciplinary project semester - internship reflection (was interpreted in various ways) - graduation project reflection