The Informal Learning Processes of Young Engineers at the Workplace

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Abstract

In the following years, the demand for employees in the technical field in the Netherlands will grow. This is in contrast to the number of technical students and young graduates who could not find an internship or job in the technical field. This gap will increase even more because of the *new industrial reality*. This requires new skills of the future engineer: 21st century skills. These skills are hard to educate in a formal educational setting. Therefore, employers decide to train their employees on the job. This workplace learning could be formal or informal. The aim of the current study was to determine how young engineers learn at the workplace. Therefore, the research question is stated: *How do young technical employees learn at the workplace?*. This research aims to make a contribution to existing theories about workplace learning, along with providing insights about the 21st century- and technical skills that needed to be learned, how these skills are learned and the transfer of these skills. This study is an exploratory qualitative research. Twenty young male technicians, between age 20 and 30, with a technical vocational educational background from different technological organisations from the eastern of the Netherlands, are interviewed. This research found out that, in terms of 21st century skills, especially thinking-, interpersonal-, and intrapersonal skills are learned at the workplace by the young engineers. In terms of technical skills, the young engineers learned to install or place specialist products, keep up with new technology and quality standards, and learned how to do work preparation. The 21st century skills are learned by learning activities like gaining extra information, asking colleagues for help or recalling an earlier experience. Remarkable is the fact that technical skills are preferably learned by learning processes like formal training and course to learn about quality standards, new technologies and products and to learn about work preparation. Context factors, including communication and interaction, participation and cooperation are of greater importance than learning factors like feedback, evaluation, reflection, information and coaching. A notable distinction could be made between 21st century skills and technical skills based on the use of skills transfer and learning activities. The young technicians show particularly low road integration (Perkins and Salomon, 1992) when transferring interpersonal- and intrapersonal skills to another problem, while they use high-road integration during the transfer of thinking- and technical skills.

Key words: Workplace learning, young engineers, 21st century skills, learning activities, transfer of knowledge

1. Introduction

According to research of the Research Centre for Education and the Labour Market (ROA, 2015), in the following years, the demand for employees in the technical field in the Netherlands will grow, approximately with 3,8 percent per year. This is in contrast to the number of technical students and young graduates who could not find an internship or job in the technical field (Vos, Rademaker, Alons, van Riemsdijk & de Vries, 2014). One of the reasons for this gap is that the technical graduates do not have the required competences according to the employers. Professional and behavioural competences including social skills, creativity, entrepreneurship and costumer orientation are regarded as important by the employers of technical professions (Hiteq, 2007).

Moreover, these expectations will change even more the following years because of the *new industrial reality,* consisting of social developments like technologisation, internationalisation, individualisation and flexibilisation, which makes society more dynamic and expects higher requirements of adults (Onderwijsraad, 2014). The report of the Onderwijsraad (2014) gives a description of these key elements of the *new industrial reality*. In case of technologisation it is primarily about the emergence of IT and internet, and applications based on it. The amount of information available is growing exponentially and is more widely accessible. Technological developments have a catalysing effect on internationalisation. States and cultures get increasingly interwoven, also economical. These developments, in terms of technologisation and internationalisation, entail that employees should have more flexibility and learning capability. Furthermore, self-directed learning is aligned to the growing individualisation. There is freedom to create your own life and a focus to self-development and self-responsibility. In addition, the dynamic labour market requests flexible employees who are willing and competent to learn. Especially in production work in factories routine tasks disappear and more skills are required. Therefore, it is important for employees to keep learning and renew their knowledge and skills. To ensure their own employability the employees are expected to direct their own learning- and working career. Finally, the Onderwijsraad (2014) mentions it is important for the young engineers to have skills to apply knowledge into a new context. According to the Netherlands Scientific Council for Government Policy (WRR, 2013), this transfer of professional skills and knowledge is essential for innovation.

The study of Corporaal, Alons, and Vos (2015) mentions several skills that are required from future technicians, including management skills, functioning in changing teams, dealing with pressure and flexibility. These expected competences are hard to teach in the current educational system: making the technical courses more generic will be at the expense of the quality, because there will be less time for practicing specific technical skills, and a specialist training would not offer the time to train *new industrial reality* skills (also called 21st century skills). Therefore, a lot of technical companies do train their employees both 21st century skills as technical knowledge on the job (Vos, et al., 2014). This training on the job is an example of non-formal and informal learning.

This study focuses on informal learning because, according to van de Wiel, van den Bossche, and Koopmans (2011), professional expertise is based on a large and well-organised knowledge base that is developed in great part by learning from experience. Moreover, Garrick (1998) and Boud (1999) suggest that informal interactions with peers are predominant ways of learning and that the impact of formal training on practice can be quite marginal. Eraut (2000) has stressed the importance of informal interactions, non-formal learning, during work in his research; most human learning does not occur in formal contexts such as schools, courses and training, but in everyday contexts.

However, earlier research showed that employees with a vocational educational background are less prepared to take advantage of informal learning resources, in particular 'networking within the organisation', 'networking outside the organisation', and 'proactivity', than employees with another educational background (Kirschner, Caniëls, & Bijker, 2012). Moreover, the research of Kirschner et al. (2012) stated that the very limited attending of post-initial education by employees with a vocational educational background leads to a significant threat for their employability.

Insight into how young technicians learn 21st century- and technical skills is needed because society and the jobs will continue to change over time. Therefore, the purpose of this study is to contribute to the existing theories about workplace learning by doing exploratory qualitative research. Furthermore, the practical purpose of this study is to contribute to a better understanding of the informal learning of required competences within a technical organization because of three reasons. First, it is important to understand which 21st century- and technical skills are being learned to map the skills that are needed in workplace but still must be acquired by the young technician. This knowledge could be used to understand the 'gap' between the employer's preferences and the abilities of the young technician, but also to redesign the formal technical education. Second, it is important to understand how the 21st century- and technical skills are learned by non-formal and informal learning so the employer can contribute to the workplace learning. Finally, it is important to research the transfer of the acquired knowledge and skills to future new problems. If an employee could transfer his knowledge to another problem or context, he or she will be widely employable and that will be important in a constantly changing work environment.

To conclude, there is an increasing demand for employees in the technical field in the Netherlands. However, the young graduated technicians did not learn the required competences at school and are therefore not prepared enough for their work, according to the employers. The young graduates lack the required competences because the new industrial reality asks for different demands and expectations than formal education taught them. Moreover, these new required skills are hard to learn at school. They should be learned during work, therefore informal learning is of great importance. However, especially employees with a vocational degree do not take advantage of informal learning. As yet, not much research has been done into the workplace learning of young technicians with a vocational degree. Therefore, the research question is stated: *How do young technical employees learn at the workplace?*.

2. Theoretical framework

2.1 Theories of workplace learning

During the past 20 years there has been an explosion of interest in the learning that can take place at, or in direct association with, a workplace (Illeris, 2007). This is partially caused by the general problems for learning in the institutionalised education programmes. For example in engineering, where more generic courses will be at the expense of the quality, and a specialist training would not offer the time to train 21st century skills. However, Illeris (2007) also mentions the constantly change of work functions and the reluctance of adults to go back to school as other conditions for the increasing interest in workplace learning.

Pieters and Verschaffel (2009) define workplace learning as a process of knowledge- and skill development, focused on the actual performance of tasks, taking place at the workplace. Eraut (1994) states that workplace learning is more efficient than formal training when it comes to learning job-related skills and obtaining knowledge, because these specific skills and knowledge are less appreciated in formal education and the learners frequently lack the necessary insight to put theory into practice.

A huge amount of learning takes place in direct connection with the performance of the work, and the employees typically experience that this learning is of greater importance for them than learning in institutionalised education (CEDEFOP, 2003). Illeris (2007) mentions: 'Viewed from the outside, it must, however, be maintained that fundamentally this learning is accidental in nature' (p. 226). This 'accidental learning' is explained in the next section.

2.1.1. Informal learning at the workplace. In describing the different types of learning, the level of intention to learn can be seen as the most important distinction between formal, non-formal, and informal learning (Eraut, 2000). When learning is planned, and time is specifically set aside, the learning is deliberate and formal. On the other hand, if there is no intention to learn and no awareness of the learning process, there is implicit and informal learning. A category between these two types of learning has been described as reactive and non-formal. This learning takes place in response to specific situations and events that draw attention. This near spontaneous and unplanned learning can vary in level of intentionality (van de Wiel, van den Bossche, & Koopmans, 2011).

Besides the level of intention to learn, the types of learning could be based on the structure (context) in which learning takes place, according to Colardyn and Bjørnavold (2004). Formal learning occurs within an organised and structured context that is designed as learning. Furthermore, non-formal learning is embedded in planned activities that are not explicitly designated as learning, but which contain an important learning element. Informal learning, however, results from daily life activities related to work, family, or leisure. It is often referred to as experiential learning and can be partly understood as accidental learning (Colardyn & Bjørnavold, 2004).

Moreover, another example of informal learning is given by Lave and Wenger (1991). They see learning as an integral and inseparable aspect of social practice. They use *legitimate peripheral*

participation (LPP) as a notion for learning as a situated activity in social practice. The theory of LPP could be applied in the technical organizations because it means that when a young graduate starts his learning as a newcomer in the organization, he observes and works together with an old-timer (an experienced worker) and gradually, as his participation increases, he becomes an old-timer himself (Lave & Wenger, 1991).

According to these mentioned theories, informal learning, in the context of this study, can be described as unintentional, implicit learning as a result of daily life activities related to work. The workplace ensures social practice where a young technician could learn from an experienced co-worker.

Hereafter, the outcomes of informal learning are described. Especially the 21st century- and technical skills because of the focus of this study.

2.2 Learning outcomes

'Workplace learning outcomes are defined as the sustainable changes in knowledge, skills or attitudes that result from engagement in informal and formal learning processes and that influence individuals' present and future professional achievement and/or organisational performance' (Kyndt, Dochy & Nijs, 2008, p.4). In this study, learning outcomes are divided into 21st century- and technical skills.

2.2.1. 21st century skills in technical sector. The *new industrial reality* competences, like management skills, functioning in changing teams, dealing with pressure and flexibility are not new in education. There are different definitions for the competences that are important nowadays, like 'soft skills' and '21st century skills'. Characteristic for the different definitions is the combination of knowledge, attitude, skills and reflection (Corporaal, Alons, & Vos, 2015).

There are different models for distinguishing 21st century skills. The Onderwijsraad (2014) divides them into three clusters. First, there are skills required to successfully participate in society, like ICT-literacy, problem-solving capabilities, critical thinking and creativity. Second, there a social competences like cooperation, communication, social skills and cultural sensitivity. Third, metacognition, the knowledge of your own cognitive functioning and the ability to control your learning is required (Onderwijsraad, 2014). Moreover, Christoffels and Baay (2016), for example, use another model, they distinguish: digital-, thinking-, interpersonal- and intrapersonal skills. To conclude, recurring skills in different models are: cooperation, communication, digital skills, social and cultural skills, creativity, critical thinking and problem-solving capabilities (see table 1).

Table 1

Four clusters of 21st century skills

Cluster	Skills
Digital skills	Instrumental skills
	Media literacy
	Information skills

Interpersonal skills	Communication
	Cooperation
	Social and cultural skills
Intrapersonal skills	Metacognition
	Self-regulation
	Entrepreneurship
Thinking skills	Critical thinking
	Problem-solving capabilities
	Creativity

Note. Adapted from "De toekomst begint vandaag: 21-eeuwse vaardigheden in het beroepsonderwijs" by Christoffels, I. & Baay, P., 2016, p. 7, 's-Hertogenbosch: Expertisecentrum Beroepsonderwijs.

Not all the 21st century skills mentioned above apply to the future technician. Some of the mentioned skills are important, some important employee's skills are missing. Corporaal et al. (2015) mention the need for knowledge that crosses traditional disciplines. The employee should be capable to consult other disciplines' employees and therefore should have some knowledge about the other disciplines. Moreover, in the new industrial reality a blurring occurred between engineers and managerial workers. An engineer should have far-reaching understanding of processes, supply chain and business models. Furthermore, the ideal engineer is a kind of marketer. Someone who is able to connect people, knows how to sell himself and focus on new possibilities. According to Corporaal et al. (2015) technicians should function into project-based environments that are featured by an increasing complexity, complex outcomes and pace. This requires skills like functioning in changing teams, dealing with pressure and working in different projects at the same time.

The technical organizations expect an engineer who can cooperate and communicate, adapt easily, has analytic skills and works accurate and quality-oriented (Corporaal et al., 2015). None of these competences can be taught only by education or at the company (Ebenau, 2016). According to the research of Corporaal, Vos, van Riemsdijk, and de Vries (2018) attitudinal aspects, like proactivity, dealing with uncertainty and flexibility, should be taught in vocational education. Furthermore, vocational education should engage the learning of expert knowledge, analytic skills and creativity. However, companies have an important role in learning communication, commercial skills and cooperation (Corporaal et al., 2018).

2.2.2. Technical skills. The speed at which technology changes also influences the importance of learning. As technologies are developed into the workplace, new knowledge and skills are needed to install and operate machines and to manage the processes used to control the technologies. These

changes demand that we have to learn in order to gain the understanding and required skills to adapt to the workplace changes (Corporaal et al., 2018).

Technical skills overlap the 21st century skills because technical skills include problem-solving and instrumental skills. There are different definitions of technical skills. Ebenau (2016) describes expert skills including knowledge of robotics and automation, programming, reading and interpreting technical drawings, and knowledge of production techniques. These skills are very job-specific. The Netherlands Trade Union Confedaration (FNV) however, set up a list with more general definitions of technical skills including; using procedures and methods; dealing with tools and materials; technical functional designing and spatial designing (van Nieuwkuijk, 2012). Because it is difficult to find a clearly defined definition of technical skills, this study will contribute to a better understanding of the content of technical skills.

According to Ebenau (2016) technical knowledge aspects are better taught on the job than in educational institutions. This is especially remarkable for the aspect of 'specialist knowledge'. This suggests that practical experience contributes more to specialist knowledge than education does. Moreover, analytic skills become more important because the employee should implement the complex data that engines supply.

Besides the learning outcomes, the way the employees learn these 21st century- and technical skills is important in this study. Therefore different processes and activities of learning at the workplace and the factors for this workplace learning are described in the next paragraph.

2.3 Learning processes and -activities

Workplace learning includes several learning processes and -activities. Eraut and Hirsh (2007) classify these learning processes according to whether their principal object was working or learning. They give a typology of early career learning, consisting of work processes, learning processes and learning activities.

Work processes, with learning as a by-product, include participation in group processes, working alongside others, consultations, tackling challenging tasks and roles, problem solving, trying things out, consolidating, extending and refining skills, and working with clients. However, learning processes at or near the workplace, whose prime object is learning, include (listed in terms of their proximity to the workplace) being supervised, being coached, being mentored, shadowing, visiting other sites, conferences, short courses, working for a qualification, and independent study. Between work- and learning processes, Eraut and Hirsh (2007) place learning activities. These learning activities are embedded within most of the processes, but the main difference between the processes and activities are the frequency and quality of their use. Learning activities are more frequent used and relatively smaller actions than the working- and learning processes. Learning activities include asking questions and getting information, listening and observing, learning from mistakes, reflection, giving and receiving feedback, and mediating artifacts (Eraut & Hirsh, 2007).

The typology of Eraut and Hirsh (2007) could be extended with learning activities proposed by Conner (2008). In contrast to Eraut (2004), Conner (2008) uses, besides a social perspective, also a more individual perspective on learning activities. Therefore, work processes can be extended with teaming and playing while learning processes can be extended with reading (Conner, 2008). Based on the classifications of Eraut and Hirsh (2007), and Conner (2008), an overview of the learning processes and -activities at the workplace that are used in this study, are given in table 2.

Table 2

Learning processes and -activities at the workplace

Work processes ***With learning as a by-product***	**Learning activities** ***Located within work or learning processes***	**Learning processes** ***At or near the workplace***
Participation in group processes	Asking questions	Being supervised
Working alongside others	Getting information	Being coached
Consultation	Locating resource people	Being mentored
Tackling challenging tasks and roles	Listening and observing	Shadowing
Problem solving	Reflecting	Visiting other sites
Trying things out	Learning from mistakes	Conferences
Consolidating, extending and refining skills	Giving and receiving feedback	Short courses
Working with clients	Use of mediating artifacts	Working for a qualification
Teaming		Independent study
Playing		Reading

Note. Adapted from "The significance of workplace learning for individuals, groups and organisations" by Eraut, M., & Hirsh, W., 2007, Oxford: University of Oxford, p. 25

There are some factors an organisation should meet to stimulate these informal learning activities at the workplace, as discussed in the next section.

2.3.1. Facilitating workplace learning: factors. Organisations can facilitate informal learning by means of culture, policy and specific procedures (Marsick and Watkins, 1990). Billett (2004) states that the workplace needs to provide an optimal context for the individual to develop and grow in his job. It is important that the affordances of the organisation match the individual engagement of the employee (Billett, 2001). After all, 'while the organisation of work sets the context and conditions for learning, it is still the reciprocal interaction between the individual and the workplace that determines learning' (Tynjäla, 2008, p.12).

Onstenk (1997) summarized these conditions as the *learning potentials* of the workplace. The chance of learning process taking place in the workplace depends on the existing competences and

learning skills of the employee; the willingness to learn of the employee; the learning opportunities; and the training programs provided at the workplace.

Many other researchers have investigated factors that could have an influence on workplace learning. Kyndt, Dochy and Nijs (2008) focus in their study on the stimulating conditions given by earlier descriptive and explorative studies of several researchers, including Onstenk (1997). They made a distinction between *context factors* and *learning factors*. Context factors refer to conditions present in the context of the learner, whereas learning factors directly relate to the learning process. An overview of the most important (general) stimulating learning conditions that were found in literature by Kyndt, Dochy and Nijs (2008) and are used in this study, is given in table 3 (for the complete table of learning conditions found in the literature see p.371 in Kyndt et al. (2008)).

Table 3

Factors for learning at the workplace

Context factors	**Learning factors**
Communication and interaction (Collin, 2002; Education Development Center, 1998; Ellström, 2001; Eraut, 1994; Onstenk, 1997; Sterck, 2004)	*Feedback* (Ashton, 2004; Ellström, 2001; Eraut, 1994; Onstenk, 1997; Skule, 2004; Sterck, 2004)
Participation (Collin, 2002; Ellström, 2001)	*Evaluation* (Collin, 2002; Ellström, 2001)
Cooperation (Collin, 2002; Education Development Center, 1998)	*Reflection* (Ellström, 2001)
	Information (Ashton, 2004; Sterck, 2004)
	Coaching (Ellström, 2001; Sterck, 2004)

Note. Adapted from "Learning conditions for non-formal and informal workplace learning" by Kyndt, E., Dochy, F. & Nijs, H., 2008, *Journal of Workplace Learning, 21,* 5 p. 369-383

2.4 Knowledge and skills transfer

Once the employees acquired new skills, the question is if they are able to transfer the skills to another situation. Several examples show that students who are taught a new procedure fail to apply the procedure when it is relevant (Johnson, 1997). Knowledge and skills do not transfer easily because students may learn how to perform a strategy, but they do not learn when it is appropriate to use it.

Eraut (2009) defines knowledge transfer as '*the learning process involved when a person learns to use previously acquired knowledge/skills/competence/expertise in a new situation.'* (p. 76). According to Perkins and Salomon (1992) '*transfer of learning occurs when learning in one context or with one set of materials impacts on performance in another context or with other related materials.'* (p. 3). Therefore, in the context of this study, the transfer of learning can be described as the learning process where previously acquired skills, which are learned in one context of with one set of materials, have an impact on the use of these skills in another context or with other related materials.

Transfer can be divided into two types: positive and negative transfer. Positive transfer takes place when learning in one context improves performance in another context. In contrast, negative

transfer occurs when learning in one context influence negatively on performance in another context (Perkins & Salomon, 1992).

Eraut (2004) distinguished five stages of positive transfer of knowledge at the workplace. The first stage is the extraction of relevant knowledge from the context and previous use. Next, there is understanding of the new situation. According to Eraut (2004), this process often depends on informal social learning. Moreover, the third stage is recognizing what knowledge and skills are relevant. The fourth stage is transforming the extracted knowledge and skills to fit the new situation. Finally, the fifth stage is about integrating them with other knowledge and skills in order to think and communication in the new situation.

A second reason why knowledge and skills do not transfer easily is because of differences between the prior situation and the situation where the transfer is to occur. Perkins and Salomon (1992), therefore, distinct two mechanisms within positive transfer: high road and low road transfer. According to Perkins and Salomon (1992) low road transfer happens when stimulus conditions in the transfer context are similar to those in a prior context of learning. This transfer between very similar contexts is also called near transfer. Low road transfer triggers well-developed semi-automatic responses. On the other hand, Perkins and Salomon (1992) describe high road transfer as a deliberative search for connections between different contexts. The learner is aware of the abstraction of the learning context and high road transfer is not in general reflexive. It can easily achieve far transfer, between contexts that seems remote to one another (Perkins & Salomon, 1992).

The distinction between low road and high road transfer can be broadened with the typology of transfer of Nelissen (2007). When there is traditional transfer, it is about the use and the application of previously acquired knowledge and skills. Nelissen (2007) called this reproductive transfer. This reproductive transfer corresponds with low road integration in terms of similar contexts and the trigger of a spontaneous response. Productive transfer, however, is based on the exploitation of the acquired skills and knowledge (Nelissen, 2007). It requires a certain degree of flexibility of thinking, which is enabled by reflection. This corresponds with high road integration in terms of abstraction and the competence to connect dissimilar contexts.

To conclude, transfer of learning at the workplace can be divided into negative and positive transfer. In turn, positive transfer can be subdivided into low road transfer and high road transfer. Therefore this study will focus on three types of transfer: negative transfer, low road transfer and high road transfer.

According to Johnson (1997), the issue of enhancing learning transfer through technical education is an important one. Students in many technical courses have been trained for activities that involve specific job tasks and specialized types of equipment. However, with the rapid changes that are occurring in the workplace, technical programs cannot keep up with those changes (Johnson, 1997).

2.5 Research question

In order to guide this research, the following research question is posed: '*How do young technical employees learn at the workplace?'*. There are several sub questions that need to be answered in order to answer the main research question:

1. What 21st century and technical skills do they learn?
2. What learning processes and -activities do they use to learn those skills?
   2.1. Which factors contribute to this learning?
3. To what extent and in what way do they transfer these skills to another problem or context?

3. Method

This section will start with an overview of the respondents (3.1). Elaboration on the procedure of the research and instrumentation of this research will follow (3.2 and 3.3) and finally, a description of the data analysis will be given (3.5).

3.1 Respondents

This study focusses on 'young' technicians. In the Netherlands, a technical study at vocational education takes about four years, and most of the students (64% in 2015) are younger than age 18 at the start of the study (Dienst Uitvoering Onderwijs [DUO], 2016). Theoretically, these students could enter labour market around age 22. However, according to the Central Bureau for Statistics (CBS, 2015), the average age entering the labour market is 32 for students following the vocational supervision learning track (BBL) and 23 for students following the vocational study learning track (BOL). The average technical student will enter the labour market around age 25.

According to Ericsson, Krampe and Tesch-Römer (1993) becoming an expert takes a long time of effortful engagement in deliberate practice. The general rule is that at least ten years of practice are required to attain expertise. Moreover, ten Berg (2016) identified several age cohorts for technical employees. Ten Berg (2016) adapted the first age cohort from Darcy, McCarthy, Hill and Grady (2012), namely <35, and called it *early career.* Because of the cohorts used in prior research and the notion of Ericsson, Krampe and Tesch-Römer (1993), the *young technicians* in this research will be up to age 30.

Twenty young male technicians from different technological organisations from the eastern of the Netherlands are interviewed. They all completed vocational technical education level 3 and 4, and are currently working in the technical field as technician, installer or electrician. They are between 20 and 30 years old.

3.2 Procedure

This study is an exploratory qualitative research because there is little information about informal workplace learning. Interviews were needed to gain in-depth insights.

The respondents were contacted by email or phone explaining the research and to ask if they would like to participate in the study. There were individual interviews, which would take approximately 30 till 45 minutes, with the young technicians. The interview was recorded and a summary was written of every interview. Thereafter, the summary was send to the interviewee and verified using member check.

3.3 Instrumentation

In order to investigate which learning activities learners engage in and which factors contribute to this learning, interviews were conducted. The interview started with general questions about age, educational level and working experience. Thereafter the interviewees received a form with four cases: two cases about technical skills and two cases about 21st century skills. These cases will be used to get more information about informal learning at the workplace, which is hard to gain in interviews and to activate the knowledge of the employee. The cases consisted of a short description of a problem at the workplace. The cases were formulated after research of course materials like textbooks, films and articles. However, examples of cases about technical and 21st century skills were not found. Therefore a young engineer who followed a training at the workplace, devised possible real workplace problems, together with his trainer. These problems were used to design the cases as are used in this study.

The interviewees were asked to rank the learning processes and -activities from the given list from most probable to most improbable action for them. The answers were explained orally afterwards. The list with possible learning processes and - activities are based on the Structured Learning Report, developed by Endedijk (2010). This instrument is a structured diary log, with multiple choice options, aiming to examine concrete self-directed learning activities on the micro-level. This generate quantitative data could be used to support the qualitative outcomes of the interviews. After the discussion of the cases, the interview proceeded with open questions based on the Open Question Learning Report of Endedijk (2010), for example *What did you learn?, How did you learn this?, Why did you learn it in this way?,* and *How did you realise that you had learned something?* (p. 102). For the interviews an interview scheme was made with, among others, the open questions of the Open Question Learning Report. When necessary in-depth questions were asked or questions were rephrased. See Appendix A for the interview scheme and the cases.

The answers of the cases will be given a number to rank the learning activities from the given list from most probable to most improbable action for them. In this way, the ranking order could be easily defined. To answer the second sub questions; '*What learning processes and -activities do they use to learn those skills?'* and '*Which factors contribute to this learning?'* the outcomes of the ranking could be used besides the interview outcomes.

3.4 Data analysis

The ranking of the answers of the cases are divided into a top 3 most likely learning activities and the least likely learning activities. This means, per case, the given answers on place 1 till 3 are counted and a graph is made to display the number of answers that is given in the top 3. To gain in-depth answers on the research questions, the interviews were used. The interviews were, due to large amount of data, summarized by focussing on the research questions, and validated by using member check. Lincoln and Guba (1985) describe member check as a research phase during which 'the provisional report (case) is taken back to the site and subjected to the scrutiny of the persons who provided information' (p. 236).

During this process, the interviewees are able to determine if their stories are accurately reported. Thereafter, the summaries were coded through Atlas.it with a coding scheme (see Appendix B). In a first coding attempt, the coding scheme was based on the five stages of Eraut (2004). However, this turned out to be too narrow to be useable. The final coding scheme consisted of 45 codes, categorized based on the four sub questions. The codes were based on earlier research, as discussed in the literature section. The codes referring the first research question '*What is learned*?' were based on the four clusters of Christoffels and Baay (2016). This categorisation is used to code all the following sub questions because this supports the analysis of the results. Furthermore, the codes referring to the second research question '*What learning processes and -activities do they use to learn those skills?*' were based on the typology of learning processes and -activities of Eraut and Hirsh (2007). Next, the overview of context and learning factors of Kyndt, Dochy, and Nijs (2008) were used for the codes referring to the third research question '*Which factors contribute to this learning?*'. Last, the fourth category of the coding scheme involving the research question '*To what extent and in what way do they transfer these skills to another problem or context?*' was based on the distinction of Perkins and Salomon (2007) and Nelissen (2007). Reliability was measured with Cohen's Kappa with 20% of all assigned codes. The measure of agreement showed k = .742, which indicates substantial agreement. The next chapter discusses the results of the present research.

4. Results

This chapter will elaborate on the qualitative results of the submitted cases, and the outcomes of the interviews. Aim of this research was to find out how young engineers learn 21st century- and technical skills at the workplace. Therefore, the chapter will be divided into two sections: 21st century skills and technical skills. Each section will start with practical examples of these skills. After that, the results of the submitted cases will be given to define what learning activities contribute to the learning. Thereafter, the practical examples of the interviewees will be presented, and finally the learning factors contributing to this learning and the transfer of acquired skills are described. This chapter will end with a summary of the key findings and a comparison between the learning of 21st century- and technical skills.

4.1 21st century skills

The first research question is *What 21st century and technical skills do they learn*?. The respondents were asked to give examples of what they had learned recently at the workplace. Remarkably, learning *digital skills* is mentioned only once, namely learning to program a machine.

Four respondents mention *interpersonal skills,* like consulting clients as an example of something they had learned recently. It occurs that customers provide their own plans, without a clear description, therefore they learned to listen carefully to the client and asking in-depth questions to analyse the wish of the client. Two of the respondents are working in an international organisation. Therefore, they mention they had to learn to deal with cultural differences and the hierarchy in other countries.

In terms of *intrapersonal skills*, an example is given about acting as a team leader. One of the respondents feels responsible to help his team and to have the required expertise. He learned to take responsibility and to be the helpdesk, by learning the knowledge and skills that are required to help his team. Furthermore, one interviewee mentions he had to learn to keep overview on all work activities. He is active at the workplace at daytime, and has to do work preparation, invoicing and calculation in the evenings and weekends. Therefore he can be very busy and he learned to plan and keep overview on all the activities. Other respondents pointed out they wish to learn an intrapersonal skills, respectively manage projects and finish projects at a time. Furthermore, one respondent has learned to be more prudent in all situations.

Additionally, examples of *thinking skills* are given. One respondent points out he had learned to recognize problems and to solve small problems (e.g. “Often the department ‘Quality’ or the ‘Technical Service’ are brought in for problems, but at some point you learn to recognize the problems and could inform them about the issue yourself. Every problem needs to be reported but every day you come closer to the solution. After a few faults, you can solve the small problems yourself.”). Another example of thinking skills that is given by three respondents, is about improvisation and creativity. When working for a client or under time pressure, they learned to come up with a rapid or creative solution to solve a small problem before it causes major problems.

To conclude, the respondents give examples of learned skills for all clusters. See table 4 for the complete overview of given examples of learned skills.

Table 4

Overview of 21st century skills learned by the young technicians

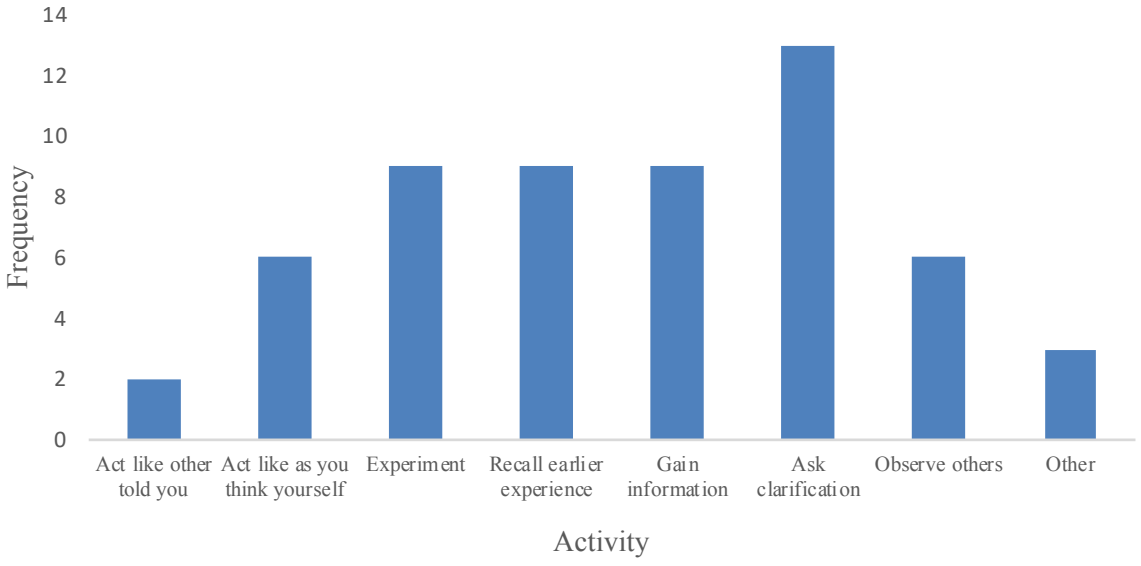
Clusters	Given examples (N)
Digital skills	Learned to: *Program a machine* (1)
Interpersonal skills	Learned to: *Consult clients* (2), *work with different cultures* (2)
Intrapersonal skills	Learned to: *Act as a team leader* (1), *keep overview* (1), *manage projects* (1), *be prudent* (1), and *finish projects* (1)
Thinking skills	Learned to: *Recognize problems* (1), *improvise and be creative* (3)

4.2 Learning activities 21st century skills

To answer the second sub question; *What learning processes and -activities do they use to learn those skills?* the outcomes of the cases could be used besides the interview outcomes. Therefore first the cases will be presented and afterwards the results of the interviews will be discussed.

4.2.1. Cases – learning activities 21st century skills. The first case was about having a dispute with a new colleague about the procedure. The respondents made a ranking out of the given learning activities about how they would learn from this situation, varying from 1 (most likely action) till 8 (least likely action). A graph is made with the number of times an action was in top 3 of a ranking (see figure 1).

Figure 1. Number of times action in top 3 when "learning to handle dispute with colleague"

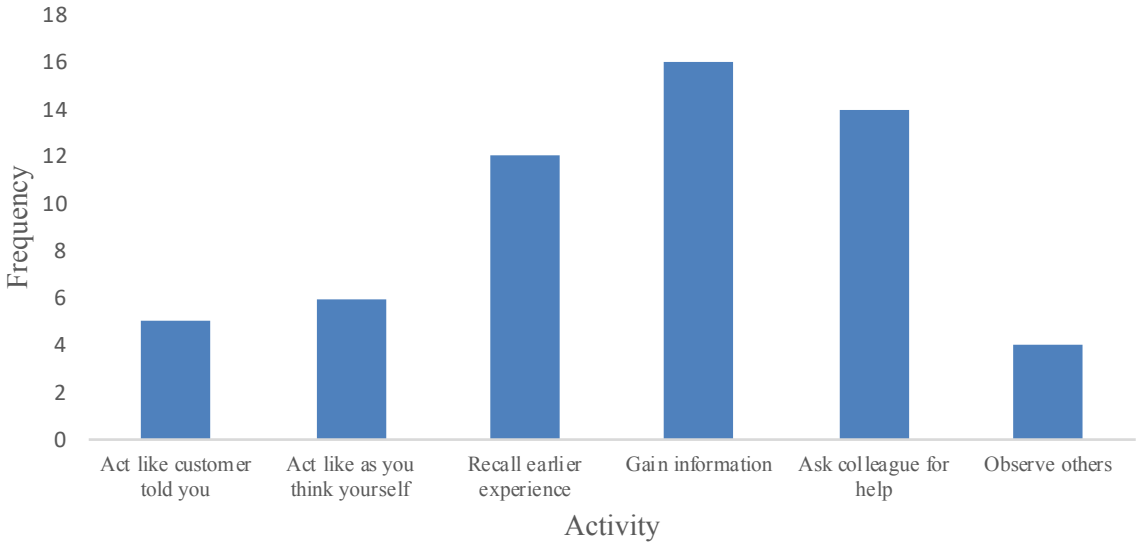


This means that the respondents are most likely to ask the colleague for clarification, gain extra information, experiment, and recall an earlier experience. Most respondents are unlikely to act in their own way, observe others, and act as the other told you when they learn to handle a dispute with a

colleague. Two respondents chose 'other', they mentioned that they first will explain their approach, then discuss and consider the best approach.

The second case was about learning to work with the demands of the costumers. The costumer asks for an unknown product or service. The respondents made a ranking out of the given learning activities (see figure 2 with the top 3) about how they would learn from this situation, varying from 1 (most likely action) till 6 (least likely action).

Figure 2. Number of times action in top 3 when "learning to work with customers"



This means that the respondents are most likely to gain extra information about the demands of the client, ask a colleague for help, and recall an earlier experience. Most respondents are unlikely to observe others dealing with the unknown service or product, act in their own way, and act as the costumer told you when they learn to work with customers.

4.2.2. Outcomes interview – learning activities 21st century skills. This paragraph gives an overview of practical examples of learning activities at the workplace, in terms of 21st century skills, that are collected during the interview. As found in literature, the learning experience could be gained during work processes, learning activities or learning processes.

The respondents learn *thinking skills* when a problem occur more frequently, they recognize the problem, and thus improve their problem-solving capability (e.g. "At some point you learn to recognize the problems and you could inform them about the issue"). In one case, the respondent learned thinking skills by working under time pressure and in adverse conditions (e.g. "The production should always continue therefore sometimes a temporary solution is necessary and you could tackle the actual problem later"). According to the interviewees thinking skills are learned during learning activities and work processes. This means the young engineers gain information or ask a colleague when they work in adverse conditions or develop creativity when they work with clients.

Interpersonal skills are learned by communicating with colleagues and by consulting clients (e.g. "Some people propose plumbing themselves (…) then it is very important to consult the client about how they want it exactly"). Furthermore, some respondents mention they learned cultural and social skills by working in different countries and with international clients (work processes). Moreover, learning activities were used when one respondent learned to communicate with the right person after making a mistake and when the employee was called during a dispute between colleagues.

The interviewees learn *intrapersonal skills* when they want to act as a team leader or when they try to keep overview on all activities. Furthermore, they learned being stress resistant during learning activities as working under pressure and they learned to focus when doing two things at a time failed. Moreover, they learn to work with uncertainty by preparing the project well (e.g. "It is hard to deal with the uncertainty of a new project (…) When a new project starts (…) we check the drawings, the demands of the client and the deadline").

To conclude, the respondents give particularly examples of learning activities and working processes they use to learn 21st century skills. See table 5 for the complete overview of given examples of these activities and processes.

Table 5

Overview of activities and processes used by the young technicians to learn 21st century skills

Clusters	**Given examples (N)**
Interpersonal skills	Learned by working processes: *Working with clients* (2), *working alongside others* (1), and by learning activities: *Locating resource people* (1), and *giving feedback* (1)
Intrapersonal skills	Learned by learning activities: *Gain information* (1)*, ask a colleague* (1) and, *learning from mistakes* (1) and by working processes: *Tackling challenging tasks and roles* (1), and *Participation in group processes* (1)
Thinking skills	Learned by learning activities: *Gain information* (1)*, ask a colleague* (1) and by working processes: *Working alongside others* (1)*, problem solving* (1)*, trying things out* (1), *and working with clients* (1)

4.3 Factors for learning: 21st century skills

To answer the sub question; *Which factors contribute to this learning?* this paragraph gives an overview of learning factors contributing to the informal learning of 21st century skills. They could be divided into learning factors and context factors.

The respondents mentioned several examples of *context factors* that facilitate their learning experience. Frequently they remark meetings as an important context factor. They provide room for knowledge sharing and problem solving. Especially when there is a transfer of work and the tasks are assigned. Furthermore, participation and cooperation is regarded as important factor for learning. A

respondent mentioned working in a small company as a positive factor for his personal development (e.g. “I could grow well into my work because of the small company”).

In terms of *learning factors*, reflection is an important factor for the learning process of the young engineers. The respondents pointed out they consider all possible problem solving stages where it could be gone wrong when dealing with a problem at work. Furthermore, two young engineers mention the importance of direct feedback at their learning because there is no room for error (e.g. “We only have one chance to do it properly. We don’t have error margins”).

4.4 Transfer of 21st century skills

The third research question is *To what extent and in what way do they transfer these skills to another problem or context?*. The transfer of acquired 21st century skills to another problem could be divided into three types: negative transfer, reproductive transfer and productive transfer. During the interviews, it seems the respondents did not confuse skills and contexts and therefore, no *negative transfer* is found.

In terms of *low road transfer*, one respondent mentioned he had learned a problem-solving skill because there was a failure with a security system. The respondent learned from colleagues that there are five possible solutions for this specific failure, however in this case another solution was necessary. Nonetheless, the technician will take the proposed solutions into account the next time the same failure in a security system will occur. In this example there is reproductive transfer because it is about transferring problem-solving skills, trying the five proposed solutions, to a similar context.

In terms of *high road (or productive) transfer* reflection is needed. Three respondents mention the transfer of thinking skills such as problem-solving capabilities and creativity. One would determine again the order of possible solutions, when a new problem occurs. Another respondent will reflect the possible result (“It is a pity when you put energy into a solution and halfway through it turned out to be a wrong idea”) and come up with a creative solution when necessary. At last, one respondent uses his problem solving skills when a problem recurs. He investigates the underlying causes to resolve them and to prevent future problems.

4.5 Technical skills

Besides 21st century skills, the interviewees especially mentioned several technical skills they had learned at the workplace. One of these skills that is mentioned by several young engineers is converting and installing machines. Moreover, they had to learn to deal with an unfamiliar product or technique. Especially to install or to place several specialist products like heat pumps, solar panels, climate computers and alarm systems. These are examples of products that are relatively new in the Netherlands or require very specific knowledge and therefore they had to learn to work with this products at the workplace instead of at school. At last, the respondents mention the importance of learning work preparation like calculation and the making of a cost estimate. However, most of the respondents do not find it difficult anymore due to experience and preparatory classes at school.

To conclude, the respondents give examples for different technical skills. See table 6 for the complete overview of given examples of learned skills.

Table 6

Examples of technical skills learned by the young technicians

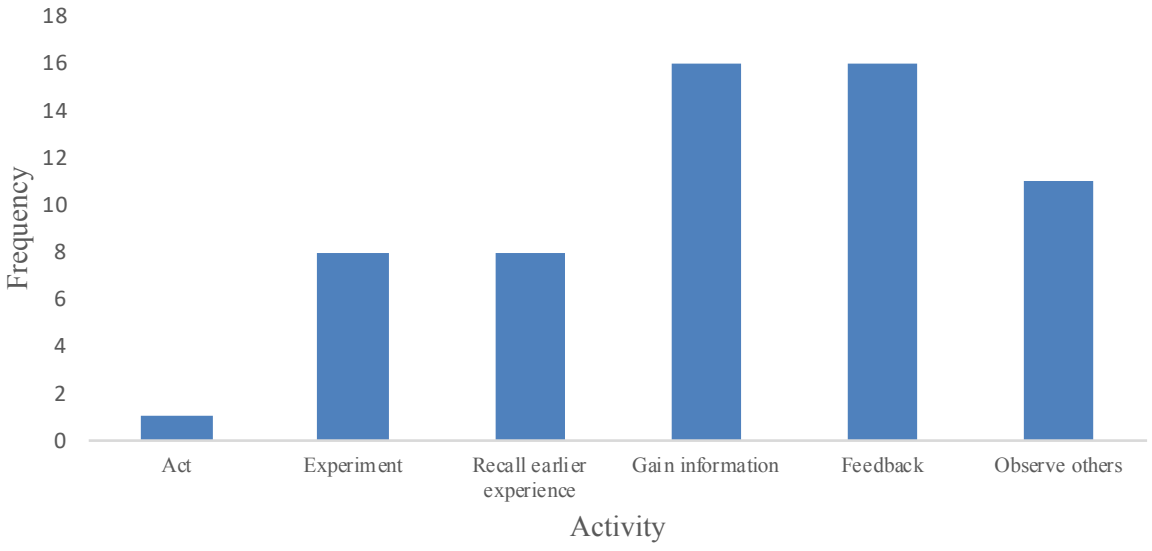
Cluster	Given examples (N)
Technical skills	Learned to: *Meet quality standards* (1), *converting and installing machines* (3), *deal with unfamiliar products or techniques (e.g. installing heat pumps, solar panels, climate computers and alarm systems)* (8), *work preparation (e.g. calculation, invoicing, technical drawings)* (5), *welding* (5), *do maintenance* (3), *soldering* (1), *innovate* (2), *electrotechnical skills* (2)

4.6 Learning activities technical skills

As for the 21st century skills, to answer the second sub question for technical skills; *What learning processes and -activities do they use to learn those skills?* the outcomes of the cases could be used besides the interview outcomes. Therefore first the cases will be presented and afterwards the results of the interviews will be discussed.

4.6.1. Cases – learning activities technical skills. The third case was about working with an unfamiliar machine. The respondents made a ranking out of the given learning activities about how they would learn from this situation, varying from 1 (most likely action) till 6 (least likely action). A graph is made with the number of times an action was in top 3 of a ranking (see figure 3).

Figure 3. Number of times action in top 3 when "learning to work with unfamiliar machine"

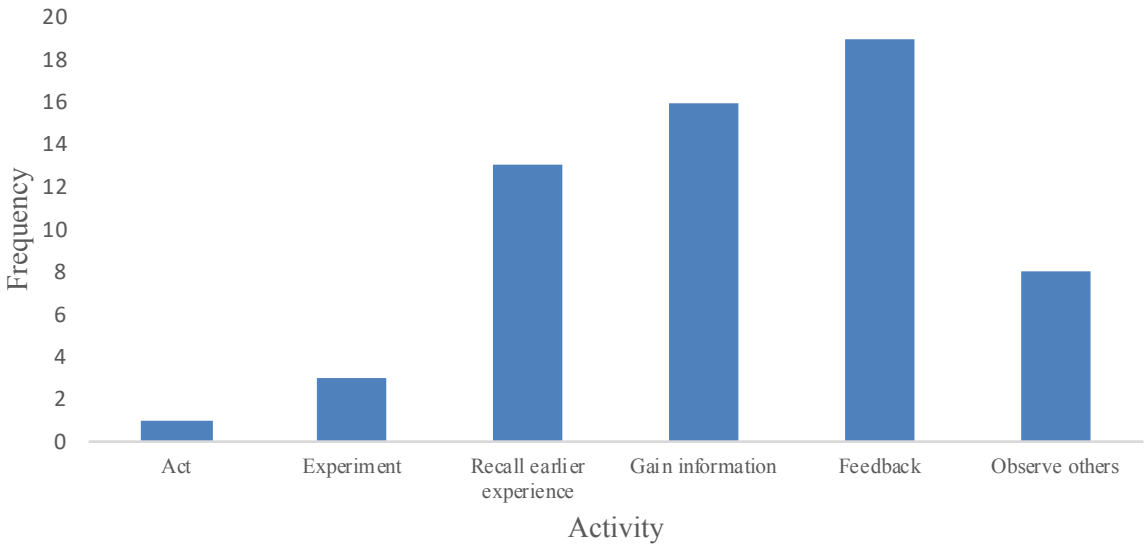


This means that the respondents are most likely to gain extra information about the machine, ask for feedback from colleagues, and observe them working with the machine. Most respondents are unlikely

to act in their own way, experiment, and recall an earlier experience, when they learn to work with an unfamiliar machine.

The fourth case was about learning to meet quality standards. The respondents made a ranking out of the given learning activities (see figure 4 for the top 3) about how they would learn from this situation, varying from 1 (most likely action) till 6 (least likely action).

Figure 4. Number of times action in top 3 when "learning to meet quality standards"



This means that the respondents are most likely to gain extra information about the quality standards, ask a colleague for feedback, and recall an earlier experience. Most respondents are unlikely to observe others dealing with the quality standards, acting in their own way, and experiment, when they learn to meet quality standards.

4.6.2. Outcomes interview – learning activities technical skills. This paragraph gives an overview of practical examples of learning situations at the workplace, in terms of technical skills, that are collected during the interview. Because technical skills are not clearly defined in literature, examples of these skills, given by the interviewees, are mentioned in this paragraph. The learning experience could be gained during work processes, learning activities or learning processes.

Dealing with an unfamiliar product or technique is one of the technical skills the respondents learned during *work processes*. They learned about a product because of the demand of the costumer and they keep up to date with new techniques because of the cooperation with colleagues with another expertise. Furthermore, one of the respondents mentioned the learning of reproducing reports by making them on a frequent basis for costumers. Moreover, four young technicians mention they first trying things out themselves, before undertaking other actions.

During *learning activities* like asking questions, gaining information and observing others, the young engineers learned to master the pipeline system and to convert machines. Furthermore, two

respondents learned to install or to place several specialist products like heat pumps, solar panels, climate computers and alarm systems by making mistakes the first time and six young technicians asked the team leader or colleagues for help. Two interviewees mentioned they had to learn to work with unfamiliar machines, this learning happened by making mistakes and repairing the damage (e.g. "I thought I set the press brake correctly but it turned out to be not so and the whole upper blade shattered"). Moreover, two interviewees mentioned it is very important to keep up with the ever-changing technology by looking for information because the technique is becoming more complex. Additionally, learning activities are used to get familiar with the quality standards. One of the young engineers asks his colleagues many questions because there a numerous criteria and standards that it is impossible to know all the quality standards by heart.

However, besides learning activities, *learning processes* like coaching and formal courses are essential for learning to meet quality, according to an interviewee, because quality standards are hard to learn at the workplace. Moreover, eight technicians use formal training and courses to keep up with new technologies in their specialist field, like installing heat pumps or security technology. One of these respondents followed a formal training from the supplier (e.g. "Installing a heat pump is relatively new in the Netherlands, therefore, I had a training from Nefit"). Four respondents followed training and courses because they had to expend their skills for their employer, for example in the area of welding or electrical engineering. Two respondents followed a course for a qualification. The car mechanic takes training courses for trends in the automotive field. However, the installation engineer keep up to date with new trends by reading professional journals. Furthermore, for two young engineers there was an orientation and training plan when they entered the workplace. Lastly, another skill that is important in the technical field is work preparation including planning, calculation and invoicing. This skill is mentioned five times by the interviewees and, according to them, it is hard to learn during work processes. Therefore they are glad they had some training in work preparation at school.

To conclude, the respondents give particularly examples of learning activities, working- and learning processes they use to learn technical skills. See table 7 for the complete overview of given examples of these activities and processes.

Table 7

Overview of activities and processes used by the young technicians to learn technical skills

Cluster	**Given examples (N)**
Technical skills	Learned by working processes: *Working with clients* (2), *working alongside others* (1), and *trying things out* (4)
	Learned by learning activities: *Asking questions (7), gain information* (2)*, observing others (1) learning from mistakes* (4),
	Learned by learning processes: *Short courses* (8), *working for a qualification* (2), *reading professional journals* (1), and *being mentored* (2)

4.7 Factors for learning: technical skills

This paragraph gives an overview of learning factors contributing to the informal learning of technical skills to answer the sub question *Which factors contribute to this learning?*. They could be divided into learning factors and context factors.

The respondents mentioned several examples of *context factors* that facilitate their learning experience. Like learning 21st century skills, for three respondents meetings are an essential moment to learn about adjusting the procedure, quality standards or work methods (e.g. "Because of the shift handover, I knew I should not completely deflate the pipeline system"). Especially when there are several employees from different departments during the meeting, a lot of technical knowledge is shared. Furthermore, according to an interviewee, the employer should listen to the ideas of the employees to help them to learn to innovate.

In terms of *learning factors*, coaching is an important factor for the learning process of the young engineers. Two respondents pointed out they learn best when someone is supervising them after a task and give them feedback on their work, while another respondent pointed out he learned to write a report when he revises together with his employer.

To support the learning of the young engineers, all the employers of the respondents help facilitating learning by compensating the costs of the training or even by compensating the costs and time. Moreover, the respondents notice that, besides compensating time and money, the employer could help them with learning by giving the opportunity to grow in their work, letting them work at another department, being innovative and progressive and listening to the ideas of the employees.

Sixteen respondents would like to learn theory in a formal setting and then practice at the workplace because learning theory in a formal setting will be faster than at the workplace and they will obtain a certificate or diploma. The practice at the workplace is very important in their opinion because repetition is important to master a technical skill, they remember better when they practice, and the practical application of the learned skill is important to them. The other four respondents prefer learning at the workplace above learning in a formal setting because they think they learn better in practice.

4.8 Transfer technical skills

To answer the third research question for technical skills; *To what extent and in what way do they transfer these skills to another problem or context?*, the transfer of acquired technical skills to another problem could be divided into three types: no/negative transfer, reproductive transfer and productive transfer. Negative of no transfer is about confusing acquired skills to the right context, or there is no transfer at all. During the interviews, it seems the respondents did not confuse skills and contexts and therefore, no *negative transfer* is found.

The respondents used *low road transfer* when they implement the already learned skill. A respondent mentioned he had learned to solve a small problem by himself after a few similar problems. When a technical problem occurs once again, the young engineers will mostly repeat the actions they

used before (e.g. “The next time I will call again the supplier or someone at the office”). Furthermore, after a mistake they will first look up for information or ask a colleague before starting a task again to avoid a new mistake (e.g. “The next time I will consider this and ask the quality employee for his approach before I start welding”).

In terms of *high road transfer* reflection is needed. Therefore good work preparation is required. Another example of productive transfer is using an offered solution yourself in the future and consider if it is the right solution for the problem (e.g. “The solution was not correct in this case, but could have been. Thus I will consider this solution during a following problem”). Moreover, one of the interviewees devised a solution to prevent future problems after a problem with a certain machine. He hung up the settings to the machine and even did it for all the other machines at the workplace.

4.9 Key findings

To conclude the results, a summary of the key findings (table 8) and a comparison between the learning of 21st century- and technical skills is given.

Table 8

Comparison between learning 21st century- and technical skills

21st century skills	Technical skills
Rank order learning activities (cases) Most likely learning activities: gain extra information, ask colleague for help and recall earlier experience. Unlikely learning activities: Acting in your own way, observing others and acting as the other told you.	**Rank order learning activities (cases)** Most likely learning activities: gain extra information, ask colleague for help, observing others (working with machine)/recall earlier experience (in case of quality standards). Unlikely learning activities: Acting in your own way, experiment and recall earlier experience (working with machine)/observing others (in case of quality standards).
What they learn *Digital skills:* Program a machine *Interpersonal skills:* Consult clients, work with different cultures *Intrapersonal skills:* Act as team leader, keep overview, manage- and finish projects, and be prudent *Thinking skills:* Problem recognizing and solving, improvisation, and creativity	**What they learn** Dealing with unfamiliar product or technique Master pipeline system and convert machines Install or place specialist products Dealing with unfamiliar machine Keep up with new technology Meeting quality standards Work preparation

What learning processes and -activities they use *Work processes:* working for clients in adverse conditions, working with and for international clients, and working under pressure *Learning activities:* gaining information or ask a colleague, work preparing, and learning from mistakes **Factors for learning** *Context factors:* meetings, participation and cooperation, room for individual insights and ideas *Learning factors:* reflection on problem solving, direct feedback **Transfer** *Reproductive:* problem solving *Productive:* decision-making procedure, more prudent, determine order of possible solutions, reflect possible result	**What learning processes and -activities they use** *Work processes:* working with and for clients *Learning activities:* asking questions, gaining information, observing others, making mistakes *Learning processes:* formal training and courses for quality standards, new technologies and products, to expend their competence with a new skill, and to learn work preparation. **Factors for learning** *Context factors:* meetings, access to information and room for training and mistakes *Learning factors:* coaching **Transfer** *Reproductive:* solve small problem after similar previous problems, repeat previous actions, gain information or ask colleague *Productive:* reflect on previous failures, imagine future problems, consider offered solution, devise solution to prevent future problems

In the proposed cases about learning 21st century- and technical skills, the young engineers choose overall the same learning activities as most likely and most unlikely, except for working with an unfamiliar machine (observing others in top most likely actions) and meeting quality standards (recall earlier experience in top most likely actions). In terms of how they learn, work processes, such as working with and for clients, and learning activities, like gaining information, are important for the respondents for both type of skills. However, in contrast to 21st century skills, for technical skills learning processes, like formal training, are also essential. Furthermore, context factors, such as meetings are important for the learning of both type of skills. However, learning 21st century skills requires participation, cooperation and room for individual insights and ideas, whereas learning technical skills requires access to information and room for training and mistakes. The transfer of these skills occurs to be both reproductive and productive. Similarly to 21st century skills, the transfer of

technical skills have a reproductive character in the area of problem solving and a productive character in terms of considering solutions and reflecting results.

5. Conclusion and discussion

5.1 Outcomes

The aim of the current study was to determine how young engineers learn at the workplace. With this research a contribution to existing theories about workplace learning is aimed to made, along with providing insights about the 21st century- and technical skills that needed to be learned, how these skills are learned and the transfer of these skills. The present research started with a literature review about the four main topics of workplace learning of technicians.

The first research question was '*What 21st century- and technical skills do they learn?'*. This research found out that, in terms of 21st century skills, especially thinking-, interpersonal-, and intrapersonal skills are learned at the workplace by the young engineers. This includes, among other things, problem solving, improvisation, cooperation, communication with clients and colleagues, keeping overview, and being stress resistant. These findings are in compliance with the study of Christoffels and Baay (2016) who mention these skills as 21st century skills. Furthermore, Corporaal et al. (2015) expected that the future technician needs to learn management skills, dealing with pressure and flexibility. This study shows that management skills, like 'learning to act as a team leader', which can be seen as a intrapersonal skill, is already important for the present young technicians. Moreover, dealing with pressure and flexibility is also relevant nowadays for the young engineers because in this study they mentioned they had to learn to work under time pressure and in adverse conditions, which improved their thinking skills. However, in contrast to the theories of the Education Council (2014) and Christoffels and Baay (2016), ICT literacy or digital skills are not found in this research. This can be explained by the diverse descriptions of digital skills and their relationship to the other 21st century skills. According to Voogt and Pareja Roblin (2010), some models about 21st century skills emphasize digital skills as technical- and information skills, while others emphasize the embedding of digital skills into 21st century skills, like critical thinking, problem solving, communication and cooperation. Therefore it is possible that the learning of digital skills only came up once in this research.

In terms of technical skills, the young engineers learned to install or place specialist products, keep up with new technology and quality standards, and learned how to do work preparation. Especially installing or placing specialist products, like heat pumps or solar panels, corresponds to the very job-specific expert skills Ebenau (2016) described. Moreover, because of the lack of a clearly defined definition of technical skills, these findings contribute to a better understanding of the content of technical skills.

The second research question was *'What learning processes and -activities do they use to learn those skills?'*. The cases in this study showed that 21st century skills are learned by learning activities like gaining extra information, asking colleagues for help or recalling an earlier experience. Furthermore, the young technicians use work processes, like working for clients in adverse conditions and working with and for (international) clients, to learn 21st century skills. As was stated by Eraut

(2004), working alongside others and working with clients are useful activities for learning according to the young technicians. However, Eraut (2004) also described participation in group activities and tackling challenging tasks as important types of work activity but these activities are less important for the learning of the young technicians.

In terms of technical skills, the cases in this study showed that these skills are learned by learning activities like gaining extra information, asking colleagues for help and observing others. Like the learning of 21st century skills, technical skills are also learned by work processes such as working with and for clients. However, remarkable is the fact that technical skills are preferably learned by learning processes like formal training and course to learn about quality standards, new technologies and products and to learn about work preparation. This is in contrast to Eraut (1994) who states that workplace learning is more efficient than formal training when it comes to learning job-related skills and obtaining knowledge, because these specific skills and knowledge are less appreciated in formal education and the learners frequently lack the necessary insight to put theory into practice.

The third research question was *'Which factors contribute to this learning?'*. In this study two types of factors were found; context factors and learning factors. According to this research, context factors, including communication and interaction, participation and cooperation are of greater importance than learning factors like feedback, evaluation, reflection, information and coaching. This suggests that a company can help their employees learning by offering room for communication and cooperation instead of focus on the learning process.

The last research question stated *'To what extent and in what way do they transfer these skills to another problem or context?*. A notable distinction could be made between 21st century skills and technical skills based on the use of skills transfer and learning activities. The young technicians show particularly low road integration (Perkins and Salomon, 1992) when transferring interpersonal- and intrapersonal skills to another problem, while they use high-road integration during the transfer of thinking- and technical skills. This means the young technicians understand the new situation and recognize what 21st century skills are relevant (stage 2 and 3 according to Eraut (2004)) but they are not able to integrate them with other skills to act in the new situation. Probably this low road integration is due to the informal character of learning 21st century skills. Because these skills are learned mostly unintentional, it is hard to recognize the learning moment and therefore the required reflection for high road transfer is missing.

In case of technical skills, there is a more productive transfer because the young technicians are able to transform the technical skills to fit in the new situation and they integrate them with other skills (stage 4 and 5 according to Eraut (2004)). The young technicians prefer more formal training and courses to learn technical skills than learning 21st century skills. This suggests that this formal training contributes to the transfer of the technical skill.

5.2 Limitations

The first major limitation includes gender and educational level of the respondents. All of the interviewees were man and graduated technical vocational education level 3 and 4. For future research it would be interesting to include women and to interview young technicians with different levels of technical vocational education. According to Borghans, Fouarge, de Grip & van Thor (2014) there is a difference in informal learning between women and men; women learn better from meetings and working together with an experienced colleague. Moreover, Borghans et al. (2014) state higher educated employees learn less from routine tasks than the low-skilled. Furthermore, this extra variety in background variables would make it more easy to compare the data based on this distinction.

The second major limitation is the ranking of the learning activities of the given cases. To process this data a top 3 was made, based on personal preference. It is possible that is gives a distorted vision of the data, because the likeliness is not distributed on a constant scale (Sanders, 1946). Therefore it is possible that one person finds it very likely to perform his number 1 till 4 actions, while another person only finds his first ranked action very likely to perform, and the rest less likely. This could be important information that is not displayed. However, presenting this top 3 was the best method to keep the data understandable and clear.

The third major limitation is the reliability of the answers. Although the questions in the interview scheme are based on the Open Question Learning Report of Endedijk (2010), the questions could lead to a focus on measurable learning, while the focus should be on informal (and less measurable) learning. It has to be said that the questions in the interview scheme were guidelines and therefore there was enough room for rephrasing and in-depth questions. However, it is possible that the phrasing of the questions has led to less information than expected. For example, the lack of information about digital skills could be caused by the unfortunate phrasing of the questions.

Furthermore, the development of the cases in this study was a difficult process. Because of inexperience with creating cases, the cases are superficial and not very solid. Moreover, the cases described technical skills and 21st century skills, including “learning to handle dispute with colleague” and “learning to work with customers”. These cases were used to activate the knowledge of the employee, but did not include digital skills. Therefore it is possible that respondent were little triggered to think about their digital skills.

The last limitation is the short duration of the study and the use of instruments. The interviews are a snapshot, while workplace learning is a process that could be better measured over time. Moreover, only one data source was used. It is recommended to expand the interviews with observations or logbooks.

5.3 Implications

5.3.1. Practical implications. On the one hand, in order to bridge the gap between education and the labour market, this research presented the lacked skills that the young engineers learned by

themselves at the workplace. These acquired skills are apparently of great importance and are not (enough) taught in the current technical vocational education. When the employer would like to hire a fully prepared employee, education should teach these skills. Particularly, there should be a focus on installing and placing specialist products and work preparation because these skills are preferred to be learned during formal training or education.

On the other hand, this research showed that 21st century skills are learned preferably by work processes. Therefore the organisation should focus on learning 21st century skills and give room to develop skills including problem solving, cooperation with clients and colleagues and keeping overview. The organisation should facilitate meetings, participation and room for individual insights and ideas. Moreover, managers and colleagues need to give feedback and support reflection to establish high road transfer.

5.3.2. Scientific implications. The present research, raises scientific implications and possibilities for future research (5.4). As the present research found, the young technicians are capable of learning some required skills in workplace and therefore Eraut's (1994) theory of workplace learning is mostly supported. However, Eraut (1994) also stated that learning specific skills are less appreciated in formal education and the learners frequently lack the necessary insight to put theory into practice. On this part, this study does not correspond to the existing theory of Eraut (1994) because one of the results of this research is that theoretical lessons in formal educational setting is of great importance for the young technician before practice at the workplace.

Moreover, despite the large number of recent studies about 21st century skills, research about learning technical skills was missing, especially for the young engineers with a vocational educational background. Therefore, this study contributes to the understanding of the informal learning of 21st century- and technical skills by young engineers.

5.4. Future research

There are a number of gaps in our knowledge around the learning of 21st century- and technical skills by young engineers that follow from our findings, and would benefit from further research. First, long term research is needed to measure the effective learning at the workplace and the transfer of this learning. This long term research can be completed, besides interviews, with logbooks and observations.

Second, the technical organisations and employers should be involved into the future research to gain information about the factors and conditions for learning at the workplace. According to Marsick and Watkins (1990), organisations can facilitate non-formal and informal learning by means of culture, policy and specific procedures. Billet (2004) states that the workplace needs to provide an optimal context for the individual to develop and grow his job. To measure learning factors, it is of great importance to determine the (learning) culture in the organisation, their structures and team work.

Third, during this research the *willingness to learn* appeared to be very important for the

informal learning of the young technicians. According to Marsick and Watkins (1990) many contextual factors influence the ability to learn well enough to successfully implement the desired solution. These include, besides appropriate resources like time and money, also willingness and motivation to learn, and the emotional capacity to take on new capabilities. Therefore it would be recommended to measure this important factor in future research.

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I. Appendix A

Interviewschema

Introductie:
Mijn naam is Laura en ik doe op dit moment voor mijn masterscriptie onderzoek naar leren op de werkvloer. Door middel van dit interview hoop ik een goed beeld te krijgen van hoe jij problemen op de werkvloer aanpakt. Ik maak gebruik van een recorder om ons gesprek terug te kunnen luisteren wanneer ik de antwoorden moet verwerken. Ik stuur je een samenvatting van dit interview via de mail, je hebt dan de mogelijkheid om te controleren of ik jouw antwoorden goed geïnterpreteerd heb of eventueel aanpassingen doen.
Heb je nog vragen?
[Deelnemer consent formulier laten lezen en ondertekenen.]
Mag ik je e-mailadres noteren zodat ik je de samenvatting van ons gesprek kan sturen zodat jij het kunt controleren of ik jouw antwoorden goed heb begrepen?

Dan heb ik allereerst wat algemene vragen:

1. Wat is je leeftijd?
2. Wat is je vooropleiding?
3. Hoe lang werk je al bij dit bedrijf?
4. Welke functie heb jij? / wat zijn je dagelijkse taken?
5. Heb je eerdere werkervaring?
    a. Zo ja, hoe lang en bij welk bedrijf?
6. Denk eens terug aan je allereerste werkdagen als XXX. Was je hier goed op voorbereid of miste je bepaalde kennis of vaardigheden?
    a. Kun je dat uitleggen?
7. Wat vind je makkelijk aan het werk dat je nu doet?
8. Wat vind je moeilijk aan het werk dat je nu doet?
    a. Hoe probeer je hiermee om te gaan?

Cases: Wat doe je en waarom? Waarom zou je een bepaald antwoord juist doen en waarom juist een ander antwoord niet. [Deze casussen in onderstaand blok worden op papier aan de deelnemers voorgelegd zodat ze het rustig kunnen doorlezen en ook de antwoorden goed kunnen overwegen]

Het bedrijf waar je werkt heeft een machine waar je nog niet eerder mee gewerkt hebt. Er wordt van je verwacht dat je met de machine aan het werk gaat maar je kent deze dus nog niet.
Welke van onderstaande antwoordmogelijkheden is voor jouw het meest waarschijnlijk om te doen om te leren met deze machine te werken? Waarom? En welke actie zou je echt niet doen om van te leren? Waarom?

A. Uitvoeren
B. Iets uitproberen/experimenteren
C. Terugdenken aan oplossing bij vergelijkbare eerdere situatie
D. Informatie opzoeken
E. Feedback of hulp van anderen krijgen
F. Observeren hoe anderen het doen
G. Anders, namelijk:

Uit onderzoek blijkt dat je werk niet voldoet aan de gestelde kwaliteitseisen. Welke van onderstaande acties kies jij om te leren aan de kwaliteitseisen te voldoen? Waarom? En welke actie zou jij niet kiezen om van te leren? Waarom?

A. Uitvoeren
B. Uitproberen/experimenteren
C. Terugdenken aan oplossing bij vergelijkbare eerdere situatie
D. Informatie opzoeken
E. Feedback of hulp van anderen krijgen
F. Observeren hoe anderen het doen
G. Anders, namelijk:

Je collega vraagt je om te helpen bij een opdracht. Je hebt nog niet eerder met deze collega samengewerkt. Hij geeft je een opdracht en jij zou het anders aanpakken. Hoe leer je van deze situatie? Waarom? En welke actie zou je echt niet doen? Waarom?

A. Uitvoeren wat hij zegt
B. Je probeert de opdracht te doen zoals je zelf denkt dat het moet
C. Zijn en jouw eigen aanpak allebei uitproberen/experimenteren
D. Terugdenken aan hoe je iets uitgevoerd hebt bij vergelijkbare eerdere situatie
E. Informatie opzoeken over het uitvoeren van deze opdracht
F. Om verduidelijking vragen aan je collega
G. Observeren hoe anderen aan de opdracht beginnen
H. Anders, namelijk:

Een nieuwe klant van je heeft vraag naar een product of dienst. De klant wil iets van je wat je nog nooit eerder hebt gedaan. Hoe leer jij van deze situatie? Waarom? En welke actie zou je echt niet doen? Waarom?

A. Uitvoeren wat de klant wil
B. Je probeert de opdracht uit te voeren zoals je zelf denkt dat het moet
C. Terugdenken aan hoe je dit opgelost hebt bij vergelijkbare eerdere situatie
D. Informatie opzoeken om meer over het product te weten te komen
E. Om hulp vragen aan je collega
F. Observeren hoe anderen een onbekende dienst/product aanpakken
G. Anders, namelijk:

1. We hebben nu een aantal verschillende situaties besproken waarin je iets te weten wilde komen. Kun je me nog een voorbeeld geven van een probleem of uitdaging, waar je onlangs mee te maken hebt gekregen waarvan je hebt geleerd?
2. Hoe heb je hiervan geleerd?
    a. Waarom op die manier?
3. Wanneer realiseerde jij je dat je hier iets van geleerd had?
4. Verwacht jij deze kennis/vaardigheid in de toekomst weer nodig te hebben?
    a. Zo ja, op welke manier?
    b. Zo nee, waarom niet?
5. Zijn er problemen waar je vaker tegenaan loopt?
6. Wat zou jij anders aanpakken als het probleem zich in de toekomst weer voordoet?
7. Wat zou jij juist wel weer doen wanneer het probleem zich in de toekomst voordoet?
8. Zijn er nog dingen die je zou willen of zou moeten leren?
    a. Hoe kan het bedrijf je daar bij helpen?
    b. Zou je liever cursussen en trainingen volgen of heb je liever dat je leert tijdens het werk?
    c. Wat kan jou helpen bij het leren? Wat heb je nodig om te leren?
    d. Wat houd jou tegen bij het leren? Wat werkt het leren tegen?

II. Appendix B

Schema 1. What 21st century and technical skills do they learn?	
Vaardigheid	**Voorbeeld & code**
21e eeuwse vaardigheden: Digital skills Hierbij gaat het om de digitale vaardigheden zoals ICT-basisvaardigheden, informatievaardigheden en computational thinking (creatief denken over het inzetten van digitale tools om een probleem op te lossen).	'Ik heb geleerd hoe ik met de computer informatie kan opzoeken.' Digital
21e eeuwse vaardigheden: Thinking skills Hierbij gaat het om creatief denken (een oplossing kunnen vinden voor een bestaand probleem) en probleemoplossend vermogen (bewust zijn van eigen invloed op problemen).	'Ik heb een creatieve oplossing bedacht met beperkte middelen.' Thinking
21e eeuwse vaardigheden: Interpersonal skills Hierbij gaat het om samenwerken, communiceren en sociale & culturele vaardigheden (dit betekent dat men rekening houdt met de verschillen tussen mensen).	'Ik heb geleerd om met klanten met diverse culturele achtergronden te werken.' Inter
21e eeuwse vaardigheden: Intrapersonal skills Hiermee worden invloeden van binnenuit die invloed hebben op de persoon bedoelt. Zoals werkervaring, zelfbeeld en emotionele intelligentie. En ook verantwoordelijkheid en initiatief nemen, rustig blijven bij stressvolle situaties en met tegenslag om kunnen gaan.	'Ik heb geleerd om rustig te blijven in een stressvolle situatie.' Intra
Technische vaardigheden: Technische vaardigheden zijn de vaardigheden die nodig zijn om wiskundige, bouwkundige, wetenschappelijke en technologische taken te volbrengen. Het gaat vaak om het gebruik van bepaalde tools om een technisch probleem om te lossen. Daarom gaat het vaak om praktische vaardigheden in plaats van puur theoretische. Het gaat hier om de vaardigheden om met een bepaald product of instrument om te kunnen gaan. Omdat technische vaardigheden niet heel duidelijk gedefinieerd zijn, worden hier voorbeelden gegeven van producten of instrumenten die geleerd moeten worden.	'Ik heb geleerd om zonnepanelen te installeren.' Techn

Schema 2. How do they learn those skills?			
Vaardigheid	**Learning processes and –activities**		
	Work processes Hierbij gaat het om processen waarbij leren als bijproduct voorkomt, zoals deelnemen aan groepsactiviteiten en samenwerken, maar ook dingen uitproberen en mét en vóór klanten werken.	Learning activities Hierbij gaat het om activiteiten binnen werk- of leerprocessen, zoals vragen stellen, informatie vergaren, naar anderen luisteren of observeren en leren van fouten.	Learning processes Hierbij gaat het om leerprocessen op of vlakbij de werkvloer, die gericht worden aangeboden; zoals gecoacht worden, andere werkplekken bezoeken maar ook trainingen en cursussen.
21e eeuwse vaardigheden: Digital skills Hierbij gaat het om de digitale vaardigheden zoals ICT-basisvaardigheden, informatievaardigheden en computational thinking (creatief denken over het inzetten van digitale tools om een probleem op te lossen).	'Ik heb geleerd hoe ik met de computer informatie kan opzoeken doordat een klant daarna vroeg.' DigitalWP	'Ik heb geleerd hoe ik met de computer informatie kan opzoeken doordat ik met een collega heb meegekeken.' DigitalLA	'Ik heb geleerd hoe ik met de computer informatie kan opzoeken doordat ik een computercursus gevolgd heb.' DigitalLP
21e eeuwse vaardigheden: Thinking skills Hierbij gaat het om creatief denken (een oplossing kunnen vinden voor een bestaand probleem) en probleemoplossend vermogen (bewust zijn van eigen invloed op problemen).	'Met creativiteit en de middelen voor handen heb ik het probleem van de klant weten op te lossen.' ThinkingWP	'Met creativiteit en de middelen voor handen heb ik het probleem opgelost door anderen om hulp te vragen.' ThinkingLA	'Met creativiteit en de middelen voor handen heb ik het probleem opgelost door de begeleider die mij ondersteunt heeft.' ThinkingLP
21e eeuwse vaardigheden: Interpersonal skills Hierbij gaat het om samenwerken, communiceren en sociale & culturele vaardigheden (dit betekent dat men rekening houdt met de verschillen tussen mensen).	'Ik heb geleerd om te communiceren met mensen met verschillende culturele achtergronden doordat het klanten van mij zijn.' InterWP	'Ik heb geleerd om te communiceren met mensen met verschillende culturele achtergronden door informatie over deze culturen op te zoeken.' InterLA	'Ik heb geleerd om te communiceren met mensen met verschillende culturele achtergronden door buitenlandse bedrijven te bezoeken.' InterLP
21e eeuwse vaardigheden: Intrapersonal skills Hiermee worden invloeden van binnenuit die invloed hebben op de persoon bedoelt. Zoals werkervaring, zelfbeeld en emotionele intelligentie. En ook verantwoordelijkheid en initiatief nemen, rustig blijven bij stressvolle situaties en met tegenslag om kunnen gaan.	'Ik heb geleerd om rustig te blijven in een stressvolle situatie doordat de deadline bij de klant erg krap was.' IntraWP	'Ik heb geleerd om rustig te blijven in een stressvolle situatie door te observeren hoe anderen met deze druk omgaan.' IntraLA	'Ik heb geleerd om rustig te blijven in een stressvolle situatie doordat mijn begeleider mij ondersteunt heeft.' IntraLP
Technische vaardigheden: Technische vaardigheden zijn de vaardigheden die nodig zijn om wiskundige, bouwkundige, wetenschappelijke en technologische taken te volbrengen. Het gaat vaak om het gebruik van bepaalde tools om een technisch probleem om te lossen. Daarom gaat het vaak om praktische vaardigheden in plaats van puur theoretische. Het gaat hier om de vaardigheden om met een bepaald product of instrument om te kunnen gaan. Omdat technische vaardigheden niet heel duidelijk gedefinieerd zijn, worden hier voorbeelden gegeven van producten of instrumenten die geleerd moeten worden.	'Ik heb geleerd om zonnepanelen te installeren door de klant die daar om vroeg.' TechnWP	'Ik heb geleerd om zonnepanelen te installeren door mijn collega's om hulp te vragen.' TechnLA	'Ik heb geleerd om zonnepanelen te installeren door een training van de producent te volgen.' TechnLP

Schema 3. Which factors contribute to this learning?		
Vaardigheid	**Factors**	
	Context factors Contextfactoren verwijzen naar de condities die aanwezig zijn in de omgeving van de lerende. Voorbeelden van contextfactoren: zijn ruimte voor communicatie & interactie, participatie en samenwerken en de toegang tot informatie.	Learning factors Leerfactoren hebben rechtstreeks betrekking op het leerproces van de werknemer. Voorbeelden van leerfactoren zijn: feedback, evaluatie, reflectie en coaching.
21e eeuwse vaardigheden: Digital skills Hierbij gaat het om de digitale vaardigheden zoals ICT-basisvaardigheden, informatievaardigheden en computational thinking (creatief denken over het inzetten van digitale tools om een probleem op te lossen).	'Ik heb geleerd hoe ik met de computer informatie kan opzoeken omdat er ruimte is om mijn collega's vragen te stellen.' DigitalContext	'Ik heb geleerd hoe ik met de computer informatie kan opzoeken omdat een meer ervaren collega mij heeft gecoacht.' DigitalLearning
21e eeuwse vaardigheden: Thinking skills Hierbij gaat het om creatief denken (een oplossing kunnen vinden voor een bestaand probleem) en probleemoplossend vermogen (bewust zijn van eigen invloed op problemen).	'Doordat wij goed naar elkaar luisteren komen we tot creatieve oplossingen.' ThinkingContext	'Omdat ik steeds reflecteer op mijn werk kom ik steeds vaker tot creatieve oplossingen.' ThinkingLearning
21e eeuwse vaardigheden: Interpersonal skills Hierbij gaat het om samenwerken, communiceren en sociale & culturele vaardigheden (dit betekent dat men rekening houdt met de verschillen tussen mensen).	'Ik heb geleerd om te communiceren met mensen met verschillende culturele achtergronden omdat er ruimte is om mijn collega's vragen te stellen.' InterContext	'Ik heb geleerd om te communiceren met mensen met verschillende culturele achtergronden omdat ik regelmatig feedback krijg op mijn communicatie.' InterLearning
21e eeuwse vaardigheden: Intrapersonal skills Hiermee worden invloeden van binnenuit die invloed hebben op de persoon bedoelt. Zoals werkervaring, zelfbeeld en emotionele intelligentie. En ook verantwoordelijkheid en initiatief nemen, rustig blijven bij stressvolle situaties en met tegenslag om kunnen gaan.	'Ik heb geleerd om rustig te blijven in een stressvolle situatie omdat het bedrijf mij de ruimte geeft om fouten te maken.' IntraContext	'Ik heb geleerd om rustig te blijven in een stressvolle situatie omdat ik na een stressvolle situatie mijn eigen handelen reflecteer.' IntraLearning
Technische vaardigheden: Technische vaardigheden zijn de vaardigheden die nodig zijn om wiskundige, bouwkundige, wetenschappelijke en technologische taken te volbrengen. Het gaat vaak om het gebruik van bepaalde tools om een technisch probleem om te lossen. Daarom gaat het vaak om praktische vaardigheden in plaats van puur theoretische. Het gaat hier om de vaardigheden om met een bepaald product of instrument om te kunnen gaan. Omdat technische vaardigheden niet heel duidelijk gedefinieerd zijn, worden hier voorbeelden gegeven van producten of instrumenten die geleerd moeten worden.	'Ik heb geleerd om zonnepanelen te installeren omdat de baas mij vroeg deel te nemen aan de groep collega's die het project gingen uitvoeren.' TechnContext	'Ik heb geleerd om zonnepanelen te installeren omdat een meer ervaren collega mij heeft gecoacht.' TechLearning

Schema 4. To what extend and in what way do they transfer these skills to another problem or context?			
Vaardigheid	**Knowledge and skills transfer**		
	Geen of negatieve transfer Hier gaat het om het verwarren van de geleerde vaardigheden bij de juiste context, of er vind helemaal geen transfer plaats. De geïnterviewde ziet geen link met een toekomstig probleem	Reproductieve transfer (low-road integration) Hier gaat het over het toepassen en gebruiken van de reeds geleerde vaardigheid. Kan automatische handeling zijn. De geïnterviewde weet de vaardigheid toe te passen, eventueel met hulp, in dezelfde situatie in de toekomst.	Productieve transfer of transformatie (high-road integration) Hier gaat het over het exploiteren van het geleerde. Het vraagt een bepaalde mate van flexibiliteit van denken. Vaak met reflectie. De geïnterviewde weet de vaardigheid zelfstandig in te zetten voor verschillende toekomstige situaties.
21e eeuwse vaardigheden: Digital skills Hierbij gaat het om de digitale vaardigheden zoals ICT-basisvaardigheden, informatievaardigheden en computational thinking (creatief denken over het inzetten van digitale tools om een probleem op te lossen).	‘Ik heb geleerd hoe ik met de computer informatie kan opzoeken maar nu werk ik met een tablet.’ DigitalNo	‘Ik heb geleerd hoe ik met de computer informatie kan opzoeken en maak daar vaak gebruik van als ik iets niet weet.’ DigitalRepro	‘Ik weet hoe ik gericht de nodige informatie over machine A kan zoeken op het internet. Ik weet dus ook hoe ik snel informatie kan vinden over machine B.’ DigitalPro
21e eeuwse vaardigheden: Thinking skills Hierbij gaat het om creatief denken (een oplossing kunnen vinden voor een bestaand probleem) en probleemoplossend vermogen (bewust zijn van eigen invloed op problemen).	‘Elke keer wanneer ik tegen een probleem aan loop, loop ik vast. Een collega moet mij dan op weg helpen.’ ThinkingNo	‘Hoe ik iets moet aanpakken schiet mij ineens te binnen.’ ThinkingRepro	‘Ik weet hoe ik het de vorige keer aan heb gepakt en ik zal de volgende keer de volgorde van mogelijke oorzaken anders bekijken.’ ThinkingPro
21e eeuwse vaardigheden: Interpersonal skills Hierbij gaat het om samenwerken, communiceren en sociale & culturele vaardigheden (dit betekent dat men rekening houdt met de verschillen tussen mensen).	‘Ik ga op dezelfde manier om met Chinese klanten, zoals ik dat ook bij Russische klanten doe.’ InterNo	‘Het is vanzelfsprekend dat ik met de c Chinese klanten communiceer zoals zij dat gewend zijn.’ InterRepro	‘Ik weet hoe ik het bedrijf moet bekijken om mijn rol en rang te bepalen zodat ik weet hoe ik iemand moet aanspreken’ InterPro
21e eeuwse vaardigheden: Intrapersonal skills Hiermee worden invloeden van binnenuit die invloed hebben op de persoon bedoelt. Zoals werkervaring, zelfbeeld en emotionele intelligentie. En ook verantwoordelijkheid en initiatief nemen, rustig blijven bij stressvolle situaties en met tegenslag om kunnen gaan.	‘Altijd als iets niet zo snel gaat als het moet dan verlies ik mijn geduld, al brengt mij dat natuurlijk niets.’ IntraNo	‘Als iets fout gaat, dan doe ik het gewoon weer opnieuw.’ IntraRepro	‘Ik weet hoe ik reageer op stressvolle situaties dus ik probeer hier van te voren al rekening mee te houen.’ IntraPro
Technische vaardigheden: Technische vaardigheden zijn de vaardigheden die nodig zijn om wiskundige, bouwkundige, wetenschappelijke en technologische taken te volbrengen. Het gaat vaak om het gebruik van bepaalde tools om een technisch probleem om te lossen. Daarom gaat het vaak om praktische vaardigheden in plaats van puur theoretische. Het gaat hier om de vaardigheden om met een bepaald product of instrument om te kunnen gaan. Omdat technische vaardigheden niet heel duidelijk gedefinieerd zijn, worden hier voorbeelden gegeven van producten of instrumenten die geleerd moeten worden.	‘Bij het lassen gebruik ik de aanpak zoals ik die bij het solderen geleerd heb.’ TechnNo	‘Ik kijk altijd even snel op de handleiding bij het afstellen van de machine. Het is al eens fout gegaan.’ TechnRepro	‘Voor het lassen van een opdracht maak ik altijd een proef, omdat ik weet dat de afstellingen per opdracht verschillen.’ TechnPro