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The Fourth Industrial Revolution and Changes to Working Life: What Supports Adult Employees in Adapting to New Technology at Work?

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1 Introduction

This chapter aims to increase the current understanding of adults' individual learning pathways and needs, when they adapt to new technology. In this chapter, we review adults' overall technology-skills and depict, through chosen examples, how adults have adapted to the

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technological change in their working lives. We present prior research on the challenges that the Fourth Industrial Revolution poses to adults' further education, and based on the Programme for the International Assessment of Adult Competencies (PIAAC), we review adults' problem-solving skills in technology-rich environments.

We analyse interviews of adults, who participated in initial education, to show how focal considerations, such as the usability of new technology, the economic or personal advantages of technology, and the social factors pertaining to the use of technology are influential for adults, when learning about and implementing new technology. Overall, the findings indicate the importance of design-based education and the need for companies to flexibly address adults with skill-shortages and adults who need to develop their problem-solving abilities in technology-rich environments.

The Fourth Industrial Revolution and Education

The Fourth Industrial Revolution is not limited to industrial production—rather, it is present in all fields of society and enables diverse innovation through digital technology [1, 2]. The drivers of the Fourth Industrial Revolution comprise digital, physical, and biological technologies. The revolution has changed labour markets throughout the world [3] and has set new demands for adult re-education and further education [1].

According to the OECD's *Employment Outlook* [2], roughly one-sixth of jobs in OECD countries can be easily replaced by automation, and roughly one-third may be radically transformed by technological progress. It is expected that almost half of the world's current professions will be computerised or automated to some extent [4, 5]. An estimate based on the European Skills and Jobs Survey has shown that the existing skills of the workforce in the European Union (EU) fall short roughly one-fifth of what is needed from workers to carry out their jobs at their highest productivity level [6]. In general, unemployment is more typical among those who have not reached tertiary education, and it is expected that a considerable number of jobs will be filled by those with higher education (HE) in numerous countries [2, 7].

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The assumption has been that the more repetitive and identical tasks of services and industries will be replaced with artificial intelligence and developments in manufacturing technology [3] and that automation will remove job opportunities for unskilled workers and lead to increased inequality. However, technology also creates new jobs while the old job titles and tasks are being taken over by machines and software [8]. Frank et al. [9] note that technology is typically designed to perform a specific task and thus alters the demand for specific workplace skills. At the same time, additive manufacturing contributes to the creation of jobs [10]. To take advantage of new technology, employees should be educated to collaborate with intelligent technologies in a broader sense [3]. In this context, education has been recognised as having a crucial role to play in enabling humans to adapt to the demands set by technological change. The following quote by Frey and Osborne exemplifies this:

> "While the concern over technological unemployment has so far proven to be exaggerated, the reason why human labour has prevailed relates to its ability to acquire new skills. Yet this will become increasingly challenging as new work requires a higher degree of cognitive abilities. At a time when technological change is happening even faster, a main hurdle for workers to adapt is thus the surging costs of education". [11]

Adaptation to Technology

As stated above, the Fourth Industrial Revolution sets certain demands in relation to adults' level of adaptation to technology. Adaptation is needed on societal and individual levels. Even though there cannot be a consensus as to the precise competency-demands for adaptation to technology on a task-by-task basis [9], both researchers and policymakers are unanimous in their belief that many adults need to change their profession and embed technology into their job profiles.

Meeting the competence needs created by the Fourth Industrial Revolution is challenged by somewhat interrelated obstacles. On the individual level, the development of technology skills is hampered by the low levels of participation in adult education. According to the OECD's *Employment Outlook* [2], one in five adults reported that they did not participate in training offered by their employer, because they were not sufficiently motivated, or did not find the content meaningful. It was also reported that the challenges adults faced during training reduced their

interest in training [2]. The lack of participation of low-skilled adults in education and training is often due to the expense of the training, a lack of time at work or at home, or due to insufficient prerequisites to participate in training. However, our previous research provides some surprising results concerning participation in continuing education, as participation activity and problem-solving skills in technology-rich environments (TRE) seem to be unrelated [12]. The content, its relevance to the context, and the pedagogy of further education also play a crucial role in the development of problem-solving skills in TRE—participation alone does not amount to technology adaptation.

The discrepancy between adults' skill-levels in technology and the learning needs set by the changing world of work calls for societal action. Numerous governments have already taken steps to cope with this issue. For example, the EU has declared its interest in improving the innovation ability [3]. Many countries have also assembled a cast of experts to forecast technological adaptation. For example, the German Ministry of Social and Employment Affairs [13] and the Finnish Ministry of Economic Affairs and Employment [14] have published reports on the ways in which supportive policies can be implemented. Financing adult education has also been reviewed by European countries as a method of enabling learning [15]. Guoping et al. note that "the government should require and encourage enterprises to organise skill training courses and assist them to adapt to new technologies" [3]. In the case of skill shortages in relation to new technology, the governments should encourage labour-mobility between industries, and equal education rights should be ensured to promote societal equality and cohesion [3].

The adaptation to the new era of technology demands that attention be placed on how formal education and workplace learning at various enterprises can be enhanced and renewed. From the perspective of developing adult education more generally, Raivola et al. [16] have underlined the importance of offering multiple alternatives for accessing internet-based learning platforms to enable continuous participation in education and training. Furthermore, they underline that adults should be given an opportunity to complete studies that lead to acknowledged qualifications in smaller modules and that they should be credited for prior learning, work experience, and informal as well as formal learning. Finally, they emphasise that financial support should be offered to adults who are participating in further education.

The role of the workplace in providing accurate and targeted education becomes central, when industries invest in the latest technology and need their employees to adapt to technological changes. Therefore, managers should enhance staff training to enable staff members to work with intellectual technologies [3]. In this regard, three considerations influence the adoption and implementation of workplace technologies [17–19]. First, the usability of technology is a fundamental consideration—it must be natural and easy to use [20, 21]. Individuals assess the usability of technology by determining whether it increases efficiency, whether it is effective, and whether it leads to user satisfaction. The second consideration is the economic and/or personal advantage that the technology lends an individual. A threshold question when beginning to learn a new technology is whether it brings any advantage to the individual or organisation. If yes, the individual is more likely to learn how to use technology. The third consideration is the social aspects of the technology; these aspects play an essential role in the acceptance of the technology [17]. If one's peers use a specific technology, then the individual is more likely to adopt it [22].

2 Problem-Solving Skills of Adults in Technology-Rich Environments and the Demand for Design-Based Education

In this section, we detail the existing research on problem-solving skills of adults in technology rich environments (TRE) and recommend approaches for developing adult learning based on the findings.

Large-scale international comparative studies, such as the OECD's PIAAC, provide a comprehensive understanding of the varying nature of adults' skills in TRE and indicate how the skills differ between age-groups and educational backgrounds [12, 23, 24]. PIAAC provides the most pervasive overview of proficiency levels in problem-solving skills in TRE. The OECD defines problem-solving skills in TRE in the following way: "Problem-solving in technology-rich environments involves using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks" [25]. The first PIAAC problem-solving survey focused on "the abilities to solve problems for personal, work and civic purposes by setting up appropriate goals and plans, accessing and making use of information through computers and computer networks" [25].

In the PIAAC study, the scale of problem-solving skills was divided into four proficiency levels. On average, more than one-third of participants did not reach Level 1 [26], meaning that they did not take the computer-based test because they only had some or no previous experience of computers. The first proficiency level out of four differentiated groups was formed of those who did not reach Level 1. Level 1 was reached by those who were able to use familiar technological applications such as e-mail and browsers. The tasks at this level did not demand navigation or only did so to a minor extent, and they involved completing just a few of tasks. At Level 2, the tasks required advanced abilities in relation to more specific technologies, where participants had to navigate and integrate information. At Level 3, both the generic and specific use of technologies and inferential reasoning were required.

The findings from the PIAAC study [12, 23, 24] have highlighted that problem-solving skills in TRE are unevenly distributed among adults and that there is a need to develop new approaches to adult education. The problem-solving skills of adults with vocational education and training (VET) backgrounds in TRE are weaker than the problem-solving skills of adults who have completed HE. At the same time, for those adults with HE and strong problem-solving skills in TRE, having a skilled occupation led to them having stronger problem-solving skills [24].

Further exploration of the PIAAC data has indicated that the association between formal learning and problem-solving skills in TRE seems to be quite weak and that informal learning activities are heavily associated with capable problem-solving skills in TRE. Thus, design-based learning activities should be provided and studied through interventions and case studies [27]. Accordingly, in line with the PIAAC findings, researchers have suggested implementing tutoring programmes and scaffolding at work to support the enhanced adoption of technological skills [24]. Adults should be provided with group-based working and learning approaches that support problem-solving skills in TRE. They note that adults' non-formal and informal learning as well as the development of their professional competencies, knowledge, and skills should be supported to enable them to respond to future workplace needs [23].

3 Reflections and Experiences from Adults on the Adaptation to Technology at Work

In the following three subsections, we reflect on the experiences of the participants of this study, who are four adult learners ($N = 4$) who found employment through technology-based training that was organised by a company who adopted new technology in metal processing. The company had difficulties in finding employees who were competent with this new technology. Thus, there was a special interest in organising training to meet the recruitment needs of the company. The training was organised in cooperation with the local vocational school.

The cases of the four participants are presented here to obtain a more detailed understanding of the experiences of adults who are already vocationally educated, have successfully completed the training demanded by their company, and have begun to work with technology. Based on the examples drawn from the analysed cases, we depict the main influential factors in relation to the adaptation and implementation of new technology. They are (1) the usability of the technology; (2) the economic and/or personal advantage the technology poses to an individual; and (3) the social factors that support adaptation to the technology [17, 20, 21]. We then conclude with the main viewpoints that should be considered when helping adults learn and adapt to changes in their working life due to the developments of Industry 4.0.

The participants were selected for training based on their applications to participate in the training offered by the company. Their initial training lasted three months. The adults spent two days a week at the local vocational school, which organised the training. The rest of the week was spent at work practicing what they had learned in training. The training at the local vocational school consisted of learning the basics about metals, work safety, first aid, LEAN basic training as well as reading graphic designs, practicing welding, and using the bending machine. During the training, the adults did not receive any salary from the company. As a form of financial compensation, however, they received unemployment benefit or a study grant from the government or trade union.

The participants ($N = 4$), three men and one woman, were aged between 20 and 55. They were interviewed at their workplace by the first author, and the topics of the thematic interviews comprised their previous experience with technology, how they make use of it at work on a daily basis and during their leisure time, how technology was related to their

social lives, what kind of benefits they saw in it, and how they viewed the usability of technology during their free time and while at work. Each of the participants are referred to here using pseudonyms.

The participants already had some previous work experience with metal, welding, and machines in general and they had an interest in technology. In the following paragraphs, we clarify, using detailed examples from the interviews, how they saw the usability of technology, the economic and personal advantages it provides, and the social factors that support adaptation.

The Usability of Technology

In this subsection, we explore the participants' views on the usability of technology at work and during their free time. The participants were asked to estimate how much technology is needed in their current role. It was notable that they *positively* described their adaptation to the technology used at work and that they found it usable in several ways. In the following two examples (see quotes from Anni and Tomi) describe what their daily work consists of, how technology makes their work faster, and how it increases their productivity, accuracy, and safety:

Anni: *You need them* [referring to technology] *a lot, for example, these programmes are running, and you see them on the computer. You can read the pictures and you are able to zoom in on the screen. You can send messages to your colleagues and ask "What is this and is this done right or wrong?" You can send a message with a picture to your boss and say, "Hey, I did this, is it okay" You can´t say that you could work without it* [technological skill], *because the pictures are made with a computer; you draw, measure. It would be more challenging and difficult without the computer.*

Tomi: *It is important* [referring to technological skills] … *You need to choose the right programme. Otherwise, you can spoil the piece if you don´t have the right programme.*

The participants describe the many ways they find technology meaningful, motivating, and emotionally satisfactory. They also reflect on their personal professional development and their transcendence of their earlier competence boundaries. When the participants were asked about their expectations when they began technology training, Anni reported that she wanted to learn to use the technologies in a fluent way, while Mika expected to get a permanent contract at work (Example 4):

Anni: *Mmm … That I would learn something that I could apply also in my free time and I would learn to understand why a product is like this, how it is made, what is it made of.*

Mika: *To get a permanent job in what I have now and well … well, well, and that the work would be as I had thought. Everything has hit the spot. Workmates are nice and stuff … I have liked it. There are no problems.*

When the participants were asked to reflect on themselves as learners of technology, Tomi and Mika were strong in their expressions. They seemed to be motivated and excited to begin something new and had made a committed decision to learn.

Tomi: *Like, whatever comes, I'll take the bull by the horns. I'll just learn new things. It is about yourself. You will learn it, or you will not.*

Mika: *Well, I just decided that I will learn this; it helped. I was so interested in this job, and I was also interested in learning. I put a lot of effort into this. And it worked! At least on some level.*

Combining learning from work experience with professional education has been modelled to take place best through a combination of theoretical, practical and self-regulated knowledge in the integrative pedagogical (IP) model [28]. In recent elaborations on the (IP) model, the importance of paying attention to emotions of a learner has been highlighted. The IP model has been used internationally to design learning environments and combine learning at school and at the workplace. The examples show how, in addition to enabling the integration of theoretical, practical, and self-regulative knowledge in learning environments, the meaning of emotions related to self, context, tasks, and performance should be understood [29–31].

Economic and Personal Advantages of Adapting to Technology

In this subsection, we highlight how determining the economic and personal advantages of technology utilisation promotes its adoption [17]. The participants were asked how they viewed their future employment opportunities in the field of production (where they were working). They anticipated the employment as good and stable (see quote from Anni). They appeared to be satisfied with their decision to participate in re-training.

Anni: *You can work with a variety of things. Metal is the thing that people like. Interior design is a good example, you see a lot of metal* [used in interior design] *at the moment. You can design something that you never believed you could until you see it by yourself. The future seems quite bright.*

The participants also described how they had enjoyed the personal advantages of technology through information retrieval and communication with their friends and family. Anni also mentioned the convenience of being able to take care of one's own business on a constant basis, being able to follow the most up-to-date news, and the ease of being able to conduct online banking (see quotes from Anni):

Anni: *Well, sending messages, basic banking things; you don't have to queue at the bank to pay your bills. You see your account information and you get real-time information. You don't need to wait many days for a newspaper.*

Anni: *… An app for a doctor's office to make an appointment … And then there is the veterinarian's FirstBeat app, if something happens to your dog. You get a direct connection through the internet, and you don't need to worry about what is wrong.*

These examples show how the participants have been able to find meaningful ways of using technology in their private and professional lives, thus lowering their barriers in relation to new technology. They had positive experiences with the usability of the new technology at home and at work. It has been found that individual values, personal history, and engagement in other social practices are central definers of participation in workplace practices and learning through work [32, 33]. The practice of commanding work-related assignments by professionals in the workplace is ´situated, dynamic, founded in and relational to the practice´ where it is embedded [33]. Thus, merely paying attention to the affordances of learning, i.e. what kind of cues and learning opportunities are provided by supervisors and colleagues or through the guiding manuals and programmes as learning materials is insufficient. In addition, the learners should have opportunities to explore the meaning of what they have learnt, to reflect on their experiences and to construct their understanding about the technology, themselves as its users and the meaning of the

technology for the broader context of the workplace and their social context. However, the utilisation of technology may be selective and based on personal preferences, as the following example (quote from Mika) shows:

Mika: *I have watched a few videos on YouTube and practiced afterwards.*

In contrast, Tomi stated that although he owns a computer and a couple of tablets, he is lazy and lacks the motivation to use them at home, where he mostly uses technology for communication and for retrieving information. Even though he used technology on a daily basis at work, it was not as important at home. He found the old-fashioned way of taking care of things during his leisure time to be preferable and found comfort in not having to put extra effort into the old ways of doing things. In sum, his use of technology at work did not predict his use of technology at home:

Tomi: *Well, quite a bit, I use it myself … I don´t know what it is … I´m kind of an old-fashioned man. In the market, I prefer to pay for my shopping using a real person, and the post office is the same: I prefer to go through the cashier than use the automaton.*

The Social Factors That Support Adaptation to Technology

The following examples show how social factors intervene when learning new technology. Social relations can afford informal technology learning, but they can also restrict it. The participants were asked to describe their use of social media and other communication technologies. The participants used these technologies mostly because they wanted to stay connected with their friends and families, many of whom live far away (see quote from Anni):

Anni: *I think it´s useful when you have friends and you can send messages asking how they are and stuff. My parents live 400km from my home, so calling them and sending messages is important. You maintain your relationships.*

The participants were also asked where they got help with technology issues if they needed it. Anni and Mika reported that they got help from their friends, family members, and colleagues (see quotes from Anni and Mika):

Anni: *Friends. Mmm … Well, friends are those who help you … when they know a lot of stuff and they have the education and they know computers.*
Mika: *I get help from my friends and workmates.*

When the participants were asked about the social support they received when applying for and beginning their training, they mentioned they support they received from their families. When they were at work, they were supported by their co-workers in their training (see quotes from Mika):

Mika: *Family. Family largely. Mom and Dad.*
Mika: *Well … the management in some way, and then the workmates, and … everybody says that they can help, and everyone has been nice to me. No one is against me. You get along with everyone.*

The final example (see quote from Martti) shown here is typical of the contradictory attitude in general towards technology. Even though Martti agrees that technology is very useful and that its applications can be widely used in everyday life, he is not satisfied with it. He uses technology at work but says that he does not want to use it at home:

Martti: *Technology is very useful. You can take care of things 24/7. You are not tied to time. And then there are the robots in manufacturing, and in medicine, and even the cars work with technology. But me, I am very poor with technology. At home, we have the scribe* [referring to his wife]. *She does everything because she knows it better. Even though I know that I could and would learn if I wanted to … I am not interested. It is a necessary evil.*

4 Discussion

The Fourth Industrial Revolution is making demands for education and training, especially on those who have to adapt to technology and re-educate themselves. The participants in this study already had a background in vocational education and training qualifications before participating in the training provided and demanded by their company. According to the results of the PIAAC, VET-educated adults are more likely to have insufficient problem-solving skills in TRE [25]. In the

OECD *Employment Outlook* [2], the respondents reported that they were not sufficiently motivated or did not find the content sufficiently meaningful to participate in training to enhance their technology skills.

The interviews conducted in this study reveal the individual pathways that adults are taking to adapt to technology at work. In contrast to the results of the PIAAC and the *Employment Outlook*, the participants in this study were motivated and positive regarding their adaptation to technology. The participants described their daily work routines and how technology has increased the productivity, accuracy, and safety of their work [20, 21]. As the examples show, they also believed that their working life was stable and that the rate of employment in their field was good. In addition, they stated that technology was useful for their leisure time [17]. As well as this, social factors played a role in their adaptation to technology. All of the participants stated that they used messenger apps and social media to communicate with their family and friends, although the level of use differed among the participants. They all acknowledged the usability of these communication tools. They also stated that they got help from their friends and family in relation to any technology issues they had [17, 22]. Nygren et al. [27] note that adults' informal learning activities are highly associated with sufficient problem-solving skills in TRE. Everyday life learning and skills used outside the workplace are clearly related to sufficient skills in TRE [12, 27].

To foster the adaptation of technology, three elements should be considered when designing training programmes for adult technology learners. These elements are usability, the economic and/or personal advantage it bestows, and the social factors that support its adaptation [17–19]. Based on the reflections of the participants, it appears that these elements assist technological learning. According to the OECD *Employment Outlook*, "A comprehensive adult learning strategy is needed to face the challenges of a changing world of work and to ensure that all workers, particularly the most vulnerable, have adequate opportunities for retraining throughout their careers" [2]. Adults who need to adapt to technology should be provided with design-based, safe, and supportive learning activities [27]. It should also be noted that technological skills and competencies are also learned in formal and informal contexts. As presented in this study, new approaches to adult education [12, 23, 24] should ease adults' adaptation to technology and respond to the educational needs of the Fourth Industrial Revolution.

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