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Problem-solving skills, skills needs and participation in lifelong learning in technology-intensive work in the Nordic countries[1][2]

Abstract: The article investigates the effects of technology-intensive work on participation in lifelong learning, job-skills, skills needs and problem-solving skills in technology-rich environments. Technology development and its consequences are the driving force behind most of the changes in jobs and at workplaces and, thus, behind continuous learning and skills development throughout people's careers. The following four hypotheses were tested: Those in technology-intensive work (H1) have higher technology-related problem-solving skills, in all age groups; (H2) participate more in job-related learning and training, in all age groups; (H3) have (therefore) fewer general, job-related skills needs, in all age groups; and (H4) have fewer ICT-specific learning needs, in all age groups, than those in non-technology-intensive work. The hypotheses testing was adjusted for gender and educational background. The study draws from data from the OECD's Programme for the International Assessment of Adult Competencies (PIAAC). PIAAC is ground-breaking in the sense that it assessed problem-solving skills in technology-rich environments for the first time ever on a large scale and as a single dimension. The study is limited to those aged 40–65 years, currently working, in the four Nordic countries: Denmark, Finland, Norway and Sweden. The findings confirmed the first and the second hypothesis but not the third and fourth. The implications of the findings are discussed in regard to theory and practice in job-related lifelong learning.

Keywords: problem-solving skills, participation in lifelong learning, technology-intensive work

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Scientific article

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[2] *Statement of originality*: The study presented in this paper has not been published previously. An early version of this study was presented (as Power Point, without presenting the regression tables) in the Int'l Conference on *Skills for the Future: Training, employment, occupations and employability in turbulent times,* 18-19 September 2014, Toulouse, France.

Introduction

Lifelong learning[3] (LLL) is not just an option but an 'obligation' in current working life on individual, organisational and national levels. A recent article by McKinsey called for putting LLL on the **CEO agenda, arguing that** there is a need for a 'new emphasis on lifelong learning' because in the future increasing numbers of employees will need to use complex cognitive skills for increasingly more of their working time, and skills renewal is happening ever more rapidly (Edmondson & Saxberg 2017). Correspondingly, in its special report on lifelong education, *The Economist* (14.1.2017) called for developing a new ecosystem of strong and continuous connections between education and employment, in new ways, throughout people's lives. These trends are largely driven by technology development. Carrying out work tasks increasingly includes the use of information-rich tools and problem-solving skills, among others. LLL is no longer just a means to new knowledge and skills – it has become an essential skill, as such. Indeed, theories of workplace learning have been proposing for decades that most job-related learning and development during one's career takes place in the context of work (e.g. DeFilippi & Arthur 1994), making workplaces one of the most important arenas for continuous learning and skills development (Malloch et al. 2011, Tikkanen 2014).

Thematically this article is located at the intersection of two broader topics. One is continuous, job-related learning and skills development, particularly in relation to technology-intensive work. The other is the changing demographics in workplaces, particularly workforce ageing. Given that technology development is one of the main drivers of skill development, it is reasonable to assume that employees in technology-intensive work, throughout their careers, have a skills advantage compared to employees in non-technology-intensive work.

The proportion of workers aged 40+ is increasing in workplaces due to population ageing, and this trend is predicted to accelerate in many countries in the

[3] European Commission has defined LLL as 'all purposeful learning activity, whether formal, non--formal or informal, undertaken on an ongoing basis with the aim of improving knowledge, skills and competence. The intention or aim to learn is the critical point that distinguishes these activities from non-learning activities, such as cultural or sporting activities'. (Eurostat 2016, p. 69)

years to come (UN 2013). Statistics show that LLL has indeed become a part of work and working life in all age groups, albeit varying greatly depending on educational background, type of a job, age group and country in question, among others. In the Nordic countries, LLL participation rates have been significantly above the European average right from the launching of the EU benchmark of 15% under the Education and Training 2020 strategy. Of adults employed full-time or part-time in the EU27, 12.3% of those aged 25–64 years and 8.5% of those aged 55–74 years participated in LLL[4] in 2016 (Eurostat 2017). In the four Nordic countries, which participated in the Program for the International Assessment of Adult Competencies (PIAAC) by the OECD (2013a), both of these averages were over twofold (26.8% and 20.5%, correspondingly). The apparent homogeneity of these four countries in terms of LLL participation (Tikkanen 2016, Tikkanen & Nissinen 2016) and their special standing in that regard compared to other European countries and beyond are the reasons why only they were selected from PIAAC in this study.

The goal of this article is to increase our knowledge on the effect of technology-intensive work on problem-solving skills in technology-rich work environments, skills needs and participation in LLL. To this end, the following four hypotheses were tested:

Those in technology-intensive work

- H1: have higher technology-related problem-solving skills, in all age groups than those in non-technology-intensive work;
- H2: participate more in job-related LLL, in all age groups than those in non-technology-intensive work;
- H3: report of fewer general, job-related learning skills needs, in all age groups, than those in non-technology-intensive work than those in non-technology-intensive work; and
- H4: report fewer skills needs related to information and communication technology (ICT), in all age groups, than those in non-technology-intensive work.
- The analyses of all hypotheses were adjusted for education and gender. The data were obtained from PIAAC.

Theoretical starting points

Based on existing knowledge and what can be assumed based thereupon, in the following we shall briefly highlight some of the interactions between workplace, skills and participation in LLL and the role age, education and gender may play in these interactions.

[4] According to the definition by the EU, lifelong learning refers to persons of the indicated age-groups who stated that they received education or training in the four weeks preceding the survey (European Commission 2013). The OECD definition of adult education and training participation refers to persons who stated that they participated in formal (towards a certificate, diploma, degree, etc., incl. distance and open education) or non-formal (e.g. on-the-job training, seminars, workshops, private lessons, etc.) organized education or training in the 12 months preceding the survey (PIAAC 2013).

Workplace as an arena for LLL and skills development

A necessary precondition to keep workers motivated to learn and develop throughout their careers is that work invites and stimulates learning. However, not all types of work are necessarily learning-conducive (Skule, Reichborn, & Leren 2002), and not all workplaces are learning-intensive or even learning-friendly (Cedefop 2012a). Some environments are enabling and some constraining (Ellström 2011), also in regard to establishing age-oriented corporate working and learning environments (Tullius 2012). Finally, the same type of work is not experienced as equally learning-intensive by employees in different phases in their job careers (Tikkanen 2002). From a lifespan perspective, then, the nature of one's work and job tasks – as well as the extent to which that work and workplace calls for, promotes and enables continuous skills development – are among the main determinants of the currency of one's skills throughout one's career. In this study, the focus is on technology-intensive work versus non-technology-intensive work and their effect on problem-solving skills in technology-rich work environments, skills needs and participation in LLL.

Based on what we know of skills development in relation to employees' age and career development, it is fair to assume that the technology-intensity of work may play out differently according to the needs for learning and skills development of employees of all age, even beyond technology-related skills and, consequently, their participation in LLL. When it comes to mature workers, on one hand, we could expect them, with their 'lacking' and/or 'obsolete' skills, to report stronger learning and development needs. On the other hand, with their arguably 'less positive learning attitudes' and 'eroded learning skills', they could be expected to show less interest in skills development than younger workers. However, there is some research which shows that such 'old truths' are changing. In a 20-year time period, from 1986 to 2006, a change has taken place in that older workers no longer occupy relatively low-skilled positions in the labour market compared to young workers, and the closure of the skills gap is due to gains made by older workers (Felstead 2010).

Existing knowledge on the relationship between the technology intensity of work and its effects on skills, skills needs and participation in LLL as a function of employees' age is very limited. We still know little about the skills content of older workers' jobs in general and how their experiences differ from those of younger workers (Felstead 2010). Indeed, research that focuses on the employment experience of older workers is relatively rare (ibid.). One of the main reasons for this shortage of knowledge has been the lack of high-quality, abundant data comprising such information. Furthermore, where existing data would have allowed for such analyses, very few studies have taken explicit focus on an age perspective (ibid.). PIAAC, which is one of the largest studies, in depth and scope, of adult skills and competence, provides a unique source to explore skills, and a wide range of other aspects of work, as a function of age.

Mature workers, especially in non-managerial positions, may be in a particularly vulnerable position in the labour market in regard to the continuous development of knowledge and skills. At the very core of their vulnerability are often shortcomings in, or lack thereof, technology-related skills and competence (Lee, Czaja, & Sharit 2008). However, the research is inconclusive in terms of age-related skills differences, especially in technology-rich environments (Siegel 2003).

The four hypotheses in this study have been tested controlling for education and gender. Previous studies have shown education to be strongly related to skills, skills needs and participation in LLL. PIAAC has shown that basic skills, such as problem-solving skills in technology-rich work environments, are generally of crucial importance in adults' participation in labour market and education and training (OECD 2013, p. 28). High proficiency in information processing skills is strongly related to education and age but only weakly to gender (OECD 2016). This study investigated only the effects on problem-solving skills in technology-rich environments (PS-TRE) of the three information-processing skills measured by PIAAC. PS-TRE were, for the first time ever, assessed in PIAAC on a large scale and as a single dimension (OECD 2013).

While women and men participate almost evenly in working life in the Nordic countries (48% women vs 52% men) (Nordic Statistics 2016), segregation in the labour market still prevails, related to a disadvantage in learning opportunities in female-dominated occupations (Georgellis & Lange 2009). Women tend to be in a disadvantaged position in the types of employment they engage (more part-time and temporary work and lower pay compared to men; more women than men in low-paid service jobs and in public administration) (Eurofound 2016). Women work predominantly in the public sector, especially in education and health services, while men work predominantly in industry. In 2014, in Denmark, Sweden and Finland about 40 to 44% (30% in the EU) of female employment was in the female-dominated sectors of education and health and social work activities, compared with 8% of men – that is, they are more likely than men to be employed in the public sector (ibid., p. 15). A recent study found that work has been strongly intensifying, especially among female workers and those working in the public sector (Felstead & Green 2017). Increasingly technology-intensive work may have contributed to this development, at least in the health sector.

Participation in LLL tends to decrease by age (e.g. Aldridge & Hughes 2012, Boeren, Nicaise, & Baert 2010, Tikkanen 1998, Tikkanen & Nissinen 2016). This is commonly explained through human capital theory as lower net returns of investments (ROI theory) in training due to a shorter payback period in older age, thus discouraging both workers and employers from investing in training (Fourarge & Schils 2009). Older workers have been found to have fewer training needs, and also in the Nordic countries (Tikkanen & Nissinen 2016). When older workers participate in LLL, it appears to be of slightly poorer quality (experienced as less useful and with little effects on the job or wages) (Felstead 2010). In the four Nordic countries, gender differences in participation in LLL have only been found in Norway, with females participating more than men, and also after controlling for age, education and a number of job-related factors (Tikkanen & Nissinen 2016).

Methodology

Data

The present study forms part of an international multi-year research project, *Skills development for REALizing the workforce competence reserve (SkillsREAL)* (2014–2017), financed by the Norwegian Research Council. We use data from the first round of data from the Programme for the International Assessment of Adult Competencies (PIAAC) survey conducted by the OECD, for 2013 in 20 countries, representing responses from approximately 166,000 adults aged 16v64 years (OECD 2013a). The analysis presented here focuses on mature/aging adults aged 40–65 years currently working in four Nordic countries – Denmark, Finland, Norway and Sweden. Our analyses are based on a sample of N = 9,746 survey responses (unweighted). The findings are presented and discussed as aggregated, not separately for each country.

Variables

The variables included in the analysis are from the PIAAC skills assessment survey (OECD 2013c). Complete details on the variables (skills measurement and PIAAC background questionnaire), including definitions, are available online (OECD 2010b, 2013c, 2013d).

Dependent variables

The dependent variables were (1) problem-solving skills in technology-rich environments (PS-TRE), (2) participation in job-related lifelong learning, (3) general, job-related skills needs and (4) skills needs related to ICT.

PS-TRE is defined by the OECD as follows:

[The use of] digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks. The first PIAAC problem-solving survey focuses on the abilities to solve problems for personal, work and civic purposes by setting up appropriate goals and plans, and accessing and making use of information through computers and computer networks. (OECD 2013c, p. 39)

PS-TRE is one of the three types of information-processing skills assessed in PIAAC. The survey assessed PS-TRE proficiency[5] on a scale from 0 to 500, with tasks at the lower end being easier than those at the higher end of the scale (OECD 2013d, p. 512). The scale is divided into four levels of proficiency: below Level 1 (less than 241 points), Level 1 (241–290 points), Level 2 (292–340 points) and Level 3 (341 points and above). The largest proportion (28.7%) of population (16–65 years) performs the tasks on Level 1, while about one in four performs on Level 2 (OECD 2016).

Participation in job-related LLL, analyzed as a binary yes/no variable, refers to *participation in formal or non-formal AET [adult education or training] for job-related reasons in the 12 months preceding the survey*. Participation in formal AET

[5] In the PIAAC dataset, PS-TRE is measured across ten plausible values (PVPSL 1-10) generated by IDB Analyzer software, that was specifically generated for analyzing PIAAC data.

included undertaking studies in schools, colleges, universities or other education institutions that were work-related. Non-formal AET included open or distant learning courses, organised learning activities for on-the-job training or training by supervisors or co-workers (planned periods of training, instruction or practical experience), seminars or workshops and courses and private lessons.

In general, job-related skills needs were assessed with a dichotomous (yes/no) measure that represents the question: '*Do you feel that you need further training in order to cope well with your present duties?*' Job-related ICT skills needs were measured as a binary yes/no variable, representing responses to the PIAAC question: '*Do you think you have the computer skills you need to do your job well?*'

Independent variables

The independent variables were technology-intensive work, gender and education. The variable used for technology-intensive work was a pre-defined PIAAC variable, derived from six questions on the use of various ICT skills at work with responses expressed on a quintile scale. For this study, we recoded the variable into a dichotomy where 'technology-intensive work' represented the two highest quintiles (60th percentile and higher) and 'non-technology-intensive work' represented the lowest three quintiles (lower than 60th percentile). The variable used for education was a three-level PIAAC-derived variable: 'low', covering International Standard Classification of Education (ISCED) categories from 1 to 3 (shorter than two years), 'medium', with categories 3 (2 years or more) to 4 and 'high', covering 5 to 6A (see PIAAC Background Questionnaire 2010b).

We stratified our analyses using the age variable. Age was categorised into five-year intervals: 45–49, 50–54, 55–59 and 60–64 years.

Table 1 shows the distributions of the variables by age groups.

Variable		Age groups (years)						X^2 sig
		40–44	45–49	50–54	55–59	60–64	All	
Gender	**Females**	46	49	49	48	46	48	ns.
	Males	54	51	51	52	54	52	
Education	**Low**	10	12	19	20	22	17	p<.001
	Medium	50	53	49	49	46	49	
	High	41	35	31	31	32	34	
Technology-intensive work (yes)		38	40	34	33	28	37	p<.001

Table 1. Distributions of the independent variables by age groups (%) (figures rounded to the nearest whole number).

Data analysis

Data were analyzed using the IDB Analyzer, a software program developed by the International Association for the Evaluation of Educational Achievement (IEA) for analysing surveys including PIAAC and PISA, and STATA software version 11.0 (StataCorp, College Station, TX, USA). Hypothesis testing was carried out using regression analyses. To examine whether those in technology-intensive work have higher technology-related problem-solving skills than those in non-technology-intensive work, among all age groups (H1), a linear regression with IDB Analyzer was carried out using all 10 plausible values of PS-TRE. To examine hypotheses 2–4, we conducted binary logistic regression analyses using both unadjusted (M1) and adjusted (M2) models (for gender and education) stratified by age group.

All analyses were weighted using the final full sample weight in PIAAC (SPFWT0), which represents 80 replicate weights.

Results

Do Nordic mature-age adults in technology-intensive work have higher technology-related problem-solving skills than adults in non-technology-intensive work, in all age groups? (H1)

Proficiency in PS-TRE in technology-intensive work was higher (mean = 293, s.e. = 0.85) than in non-technology-intensive work (mean = 269, s.e. = 0.73), in all age groups (Figure 1). Thus, H1 was confirmed. There was a linear decline with a clear and stable level difference (22–27 points) across the age groups between the two types of work. The proficiency of all employees in non-technology-intensive work was on the PIAAC Level 1, while in technology-intensive work it was on Level 2, up to the age of about 54 years, dropping thereafter to Level 1 in the two oldest age groups.

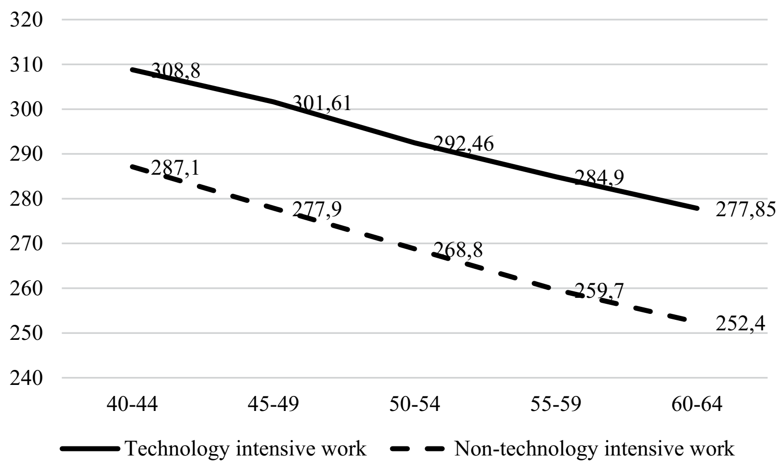

Figure 1. Technology-related problem-solving skills by age in technology-intensive and non-technology-intensive work in the four Nordic countries (aggregated). (PVPSL1-10, unadjusted, non-weighted)

Technology-intensive work was a significant predictor of PS-TRE across all the age groups, accounting for 9–11% of the variance, and the effect increasing by age (Table 2, M1s). H1 was also supported after adjusting for gender and education (Table 2, M2s). The effect was slightly smaller but statistically significant in all age groups ($p < .001$). Technology-intensive work, gender and education explained 17–20% of the variation in PS-TRE. PS-TRE proficiency among women was about five points lower than among men, in all age groups ($p < .05$). The average PS-TRE score was significantly higher on education levels 2 and 3 compared to those with the lowest education, after controlling for gender and technology-intensive work.

Age group	M	Variables	B	SE	t	P	r^2
40–44	M1	Technology-intensive work	21,67	2,12	10,22	***	0,09
	M2	Technology-intensive work	17,14	2,15	7,97	***	
		Gender (female)	-5,04	2,18	-2,31	*	0,18
		Education L2 (vs L1)	11,43	5,28	2,16	*	
		Education L3 (vs L1)	30,58	5,27	5,80	***	
45–49	M1	Technology-intensive work	23,71	1,99	11,91	***	0,10
	M2	Technology-intensive work	19,11	2,02	9,46	***	
		Gender (female)	-3,94	2,02	-1,95	a)	0,17
		Education L2 (vs L1)	17,09	4,58	3,73	***	
		Education L3 (vs L1)	31,66	4,64	6,82	***	
50–54	M1	Technology-intensive work	23,68	2,50	9,47	***	0,10
	M2	Technology-intensive work	18,95	2,52	7,52	***	
		Gender (female)	-5,03	2,19	-2,30	*	0,18
		Education L2 (vs L1)	13,91	4,07	3,42	**	
		Education L3 (vs L1)	29.45	4,08	7,22	***	
55–59	M1	Technology-intensive work	25,22	2,24	11,26	***	0,11
	M2	Technology-intensive work	21,01	2,28	9,21	***	
		Gender (female)	-4,77	2,05	-2,33	*	0,20
		Education L2 (vs L1)	12,43	3,68	3,38	**	
		Education L3 (vs L1)	28,53	3,73	7,65	***	
60–64	M1	Technology-intensive work	25,45	2,55	9,98	0,000	0,10
	M2	Technology-intensive work	21,80	2,56	8,52	0,000	
		Gender (female)	-5,99	2,49	-2,41	0,016	0,18
		Education L2 (vs L1)	15,68	4,02	3,90	0,000	
		Education L3 (vs L1)	26,84	4,03	6,66	0,000	

Table 2. Linear regression analysis on problems-solving skills (PV1-10) (IDB Analyzer).

*M1 = unadjusted, M2 = adjusted for gender and education. *p < .05; ** p < .01; ***p < .001. a) 0,051*

Do those in technology-intensive work participate more in job-related LLL, in all age groups, than those in non-technology-intensive work? (H2)

Those in technology-intensive work participated more often in job-related LLL (mean = 75%) than those in non-technology-intensive work (mean = 62%), in all age groups (Figure 2). Thus, H2 was also confirmed. The effect of technology-intensive work was strongest in the oldest age group, but the increase was not linear by age (Table 3, M1s). The odds of participation in LLL were almost two times greater among the oldest employees (OR = 1,90) in technology-intensive work compared to non-technology-intensive work.

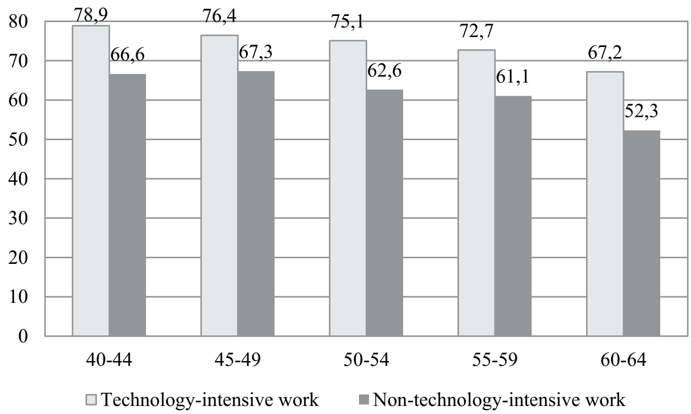

Figure 2. Participation in job-related learning by age in technology-intensive and non-technology-intensive work in the four Nordic countries (unadjusted, non-weighted) (%)

H2 was also supported after adjusting for gender and education (Table 3, M2s). The effect of technology-intensive work decreased slightly, but it was still significant, in all age groups ($p < .01$). Other things being equal, gender did not have a significant effect in the two youngest age groups ($p < .05$), while in the oldest the odds of participation among females were close to two times (OR = 1,78) greater than among men. Also, among those with the highest education the odds of participation were 2,6–3,4 times greater than among those with the least education, controlling for the other variables.

Age group	M	Variables	OR	SE	z	p	R^2
40–44	M1	Technology-intensive work	1,80	0,22	4,83	***	0,010
	M2	Technology-intensive work	1,63	0,21	3,54	***	
		Gender (female)	1,04	0,13	0,31	ns.	0,030
		Education L2 (vs L1)	1,44	0,44	1,19	ns.	
		Education L3 (vs L1)	2,59	0,81	3,37	**	
45–49	M1	Technology-intensive work	1,57	0,18	4,00	***	0,010
	M2	Technology-intensive work	1,39	0,16	2,82	**	
		Gender (female)	1,21	0,15	1,38	ns.	
		Education L2 (vs L1)	2,06	0,51	3,14	**	
		Education L3 (vs L1)	3,36	0,79	5,13	***	0,040
50–54	M1	Technology-intensive work	1,84	0,25	4,31	***	0,020
	M2	Technology-intensive work	1,74	0,25	3,57	***	
		Gender (female)	1,34	0,16	2,17	*	0,030
		Education L2 (vs L1)	1,54	0,31	1,95	a)	
		Education L3 (vs L1)	2,16	0,45	3,80	***	
55–59	M1	Technology-intensive work	1,68	0,20	4,25	***	0,010
	M2	Technology-intensive work	1,58	0,21	3,38	***	
		Gender (female)	1,37	0,16	2,58	**	
		Education L2 (vs L1)	2,46	0,48	4,56	***	
		Education L3 (vs L1)	3,40	0,70	6,16	***	0,050
60–64	M1	Technology-intensive work	1,90	0,28	4,29	***	0,020
	M2	Technology-intensive work	1,83	0,28	3,73	***	
		Gender (female)	1,78	0,24	4,15	***	
		Education L2 (vs L1)	1,53	0,29	2,11	*	0,050
		Education L3 (vs L1)	2,68	0,53	4,75	***	

Table 3. Binary logistic regression analysis on job-related LLL participation

*M1 = unadjusted, M2 = adjusted for gender and education. *p < .05; ** p < .01; ***p < .001. [a] 0,051*

Have those in technology-intensive work fewer general, job-related learning skills needs, in all age groups, than those in non-technology-intensive work? (H3)

About one-third of the employees reported general, job-related training needs, somewhat less in the oldest age group (24–27%) (Figure 3). The rate was slightly higher among those in technology-intensive work but statistically significant ($p < .01$) only among employees aged 45–54 years. There was no change after controlling for education and gender. Except for education in the age groups 50–54 and 55–59 years, none of the variables were significant in the adjusted models (the results from the binary logistic regression are not shown here). Thus, H3 must be rejected.

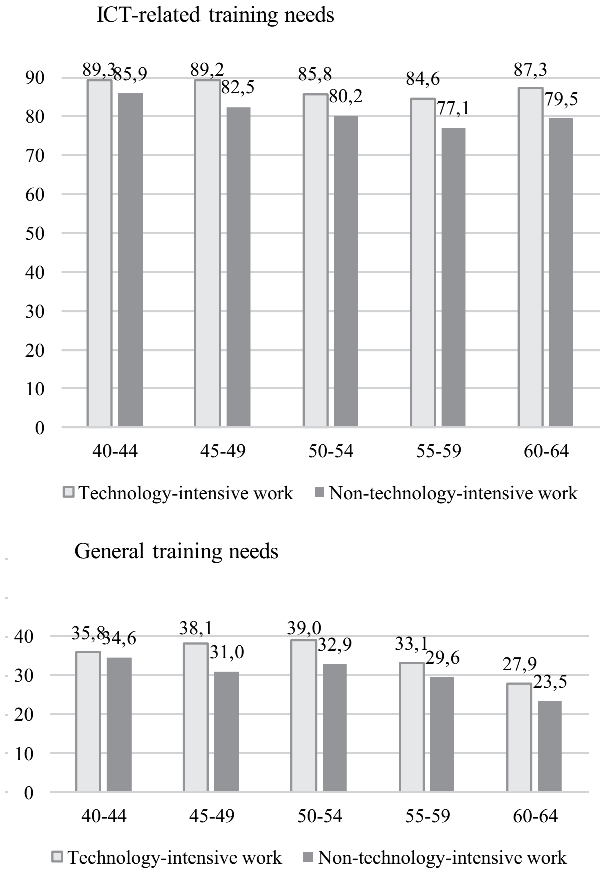

Figure 3. Skills needs (% yes) (unadjusted, non-weighed)

Have those in technology-intensive work fewer skills needs related to ICT in all age groups than those in non-technology-intensive work? (H4)

ICT-related skills needs were high, and two to three times higher than general, job-related training needs, both in technology-intensive (mean = 88%) and non-technology-intensive work (mean = 81%) (Figure 3). Furthermore, they were significantly higher in technology-intensive than non-technology-intensive work, in all age groups ($p < .01$) and also after adjusting for gender and education (Table 4). Thus, H4 must also be rejected.

Technology-intensive work had a somewhat weaker effect among the youngest employees (OR = 1,62), especially compared to the oldest. Among the oldest employees in technology-intensive work the odds of experiencing ICT-related skills needs were 2,1 times ($p < .01$) greater than those in non-technology-intensive work (Table 4). Adjusting for gender and education weakened the effect slightly in the two youngest age groups but increased it in all the older age groups (Table 4).

Again, among the oldest employees the odds of experiencing ICT-related skills needs were about 1,5 times greater among women than men, other things being equal.

Age group	M	Variables	OR	SE	z	p	R^2
40–44	M1	Technology-intensive work	1,62	0,29	2,75	**	0,010
	M2	Technology-intensive work	1 ,51	0,29	2,18	*	
		Gender (female)	0,79	0,13	-1.41	ns.	0,020
		Education L2 (vs L1)	0,87	4,06	-0,05	ns.	
		Education L3 (vs L1)	1,26	3,89	0,02	ns.	
45–49	M1	Technology-intensive work	1,92	0,30	4,13	***	0,010
	M2	Technology-intensive work	1,85	0,30	3,69	***	
		Gender (female)	1,23	0,19	1,13	ns.	0,020
		Education L2 (vs L1)	1,43	0,44	0,85	ns.	
		Education L3 (vs L1)	1,55	0,48	1,17	ns.	
50–54	M1	Technology-intensive work	1,67	0,24	3,57	***	0,010
	M2	Technology-intensive work	1,78	0,27	3,73	***	
		Gender (female)	1,05	0,15	0,00	ns.	0,020
		Education L2 (vs L1)	0,93	0,25	-0.45	ns.	
		Education L3 (vs L1)	0,77	0,21	-1,52	ns.	
55–59	M1	Technology-intensive work	1,67	0,26	3,57	***	0,010
	M2	Technology-intensive work	1,79	0,29	3,80	***	
		Gender (female)	1,15	0,15	0,77	ns.	0,020
		Education L2 (vs L1)	1,01	0,23	-0,04	ns.	
		Education L3 (vs L1)	0,81	0,20	-1,38	ns.	
60–64	M1	Technology-intensive work	2,11	0,49	3,32	**	0,020
	M2	Technology-intensive work	2,17	0,49	3,53	***	
		Gender (female)	1,48	0,27	2,00	*	0,030
		Education L2 (vs L1)	1,32	0,31	1,22	ns.	
		Education L3 (vs L1)	1,56	0,45	0,45	ns.	

Table 4. Binary logistic regression analysis on skills needs related to ICT
M1 = unadjusted, M2 = adjusted for gender and education. $*p < .05$; $** p < .01$; $***p < .001$

Discussion

The purpose of this study was to explore the effect of technology-intensive work on problem-solving skills in technology-rich work environments (PS-TRE), skills needs and participation in LLL. The findings showed that technology-intensive work had a strong effect on all three areas. Compared to employees in non-technology-intensive work, those in technology-intensive work had better problem-solving skills, and they participated more in job-related LLL, and also after adjusting for gender and education. Indeed, in technology-intensive work, regardless of their better PS-TRE and their higher participation rates in job-related LLL, employees' ICT-related skills needs were still stronger than among those in non-technology-intensive work. Controlling for gender and education did not have a significant effect on the results. However, among 50+ employees it slightly strengthened the effect of technology-intensive work on ICT-related skills needs. Interestingly, in the oldest age group females reported higher ICT-related skills needs than men, controlling for education and type of work. This may reflect the different types of occupations between men and women. While females work less often in ICT-intensive work (technology and industry), and more in caregiving and other public services, such as in education, in these types of work the use of technology has also been rapidly increasing in the four Nordic countries in question, setting increasing demands for ICT-related skills on the employees.

Not unexpectedly, technology-intensive work appeared strongly learning conducive (Skule, Reichborn, & Leren 2002). Working means learning, and learning means working in such an environment. Gaining new skills and knowledge only further feeds new learning needs, regardless of age, education or gender. In all the four Nordic countries, the problem-solving skills in technology-rich work environments were predominantly on an average level and to a lesser degree on high level (OECD 2013a).

Technology-intensive work also had a strong effect on proficiency PS-TRE, in all age groups. There was a clear level difference between the two types of work, across all age groups, in regards to the advantage of employees in technology-intensive work. This suggests that the types of job tasks are more demanding in technology-intensive work, with the exception of the two oldest age groups. Furthermore, while (biological) age plays a role in skills development, technology-intensive work seems to provide a skills advantage to employees of all ages. If age as such would be the main factor explaining variation in proficiency in information-processing skills, there should be little variation across countries. However, PIAAC-related studies have found clear variation across countries, suggesting that policies can also influence the maintenance or loss of proficiency among older adults (OECD 2016, p. 26).

While general, job-related skills needs were moderate in both types of work and across age groups, ICT skills needs were very strong, also in non-technology-intensive work, albeit on a somewhat lower level than in technology-intensive work. Thus, the findings lend support to the role of technology as the driving force in job-related skills development, regardless of employees' age.

PIAAC findings have shown that men use information-processing skills more than women, possibly because the genders tend to work in different types of occupations (men more often in the technology sector, women more often in low-level jobs with less intensive skills use) or because of gender discrimination (OECD 2013a). In our study, the positive effect of technology-rich work environments on PS-TRE, skills needs and participation in LLL were still clear after controlling for gender and education. This suggests that technology-rich work has a strong impact on PS-TRE, skills needs and participation in LLL, regardless of gender and education.

Thus, the findings have underscored the strong effects of technology-intensive work on problem-solving skills, skills needs and participation in LLL. The analyses were limited to the four Nordic countries that participated in PIAAC and can, thus, reliably only be generalised to them. These countries are generally technologically advanced, with an intensive use of technology, to the extent that the conduct of everyday lives has become increasingly dependent on it. Still, in the PIAAC data only about 35–40% of the respondents in the four Nordic countries were working in technology-intensive workplaces, as defined in this study.

The PIAAC data are unique but complex. To make most of them, through more advanced analyses, a very good command of quantitative research methods, proper understanding of and high-level skills in operating with large databases are crucial. However, in education and the social sciences, the last (approximately) couple of decades have marked an erosion of those skills in favour of qualitative research methods with small databases and often with case studies – at least in Northern Europe. This is very unfortunate since not only large but also international databases have been made freely available to researchers. Clearly, there is a call to higher education to invest more in a better balance of researchers' methodology skills to make better use of the great opportunities available through these large databases.

Future research should test the hypothesis that these countries are highly similar in many regards – 'the Nordic model' (Tikkanen 2016) – by testing the four hypotheses separately for each country. Furthermore, it would be interesting to compare the findings with other regions and in other countries in Europe to also increase our knowledge of the possible effects that the structural differences across them might bring about.

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SPRETNOSTI REŠEVANJA PROBLEMOV, POTREBE PO SPRETNOSTIH IN SODELOVANJE V VSEŽIVLJENJSKEM UČENJU V TEHNOLOŠKO INTENZIVNIH OBLIKAH DELA V NORDIJSKIH DRŽAVAH

Povzetek: Članek analizira učinke tehnološko intenzivnega dela na udeležbo v vseživljenjskem učenju, spretnosti, povezane s poklici, potrebe po spretnostih in spretnosti reševanja problemov v tehnološko bogatih okoljih. Tehnološki razvoj in njegove posledice so gonilna sila večine sprememb v poklicih in na delovnih mestih ter s tem tudi stalnega učenja in razvoja spretnosti v poklicnem razvoju posameznika. V članku preverjamo naslednje štiri hipoteze: zaposleni v tehnološko intenzivnih vrstah dela (H1) imajo v vseh starostnih skupinah bolje razvite spretnosti reševanja s tehnologijo povezanih problemov; (H2) v vseh starostnih skupinah več sodelujejo v s poklicem povezanem učenju in usposabljanju; (H3) imajo (zatorej) v vseh starostnih skupinah manj splošnih s službo povezanih potreb po spretnostih in (H4) imajo v vseh starostnih skupinah manj specifično informacijsko-komunikacijskih potreb po učenju kot zaposleni v tehnološko neintenzivnih oblikah dela. Preverjanje hipotez smo prilagodili glede na spol in izobrazbo anketirancev. Prispevek črpa podatke iz OECD-jevega Programa za mednarodno ocenjevanje kompetenc odraslih (PIAAC). Raziskava PIAAC je prelomna, saj je prva, ki na tako velikem vzorcu ocenjuje spretnosti reševanja problemov v tehnološko bogatih okoljih kot enotno dimenzijo. Članek se omejuje na odrasle v starosti 40–65 let, in sicer tiste, ki trenutno delajo v štirih nordijskih državah: na Danskem, Finskem, Norveškem in Švedskem. Ugotovitve potrjujejo prvo in drugo hipotezo, ne pa tretje in četrte. Članek ugotovitve postavi ob teorijo in prakso z delom povezanega vseživljenjskega učenja.

Ključne besede: spretnosti reševanja problemov, sodelovanje v vseživljenjskem učenju, tehnološko intenzivno delo

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