



# Evaluation of the level of problem solving skills of Turkish higher education graduates in technology-rich environments

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## Abstract

This study aims to evaluate the level of Turkish higher education graduates' problem-solving skills (PSSs) in technology-rich environments (TREs) at work and daily life as information and communication technologies are increasingly used in economic and social structure. It also investigates the effects of socio-demographic factors including gender, age, the field of study, and higher education attainment level on their PSSs in TREs. In this context, the data concerning Turkish higher education graduates' PSSs released by the Programme for the International Assessment of Adult Competencies (PIAAC) in 2016 was used. With regard to methodology, we employed descriptive and logistic regression analyses to investigate the data. The descriptive statistics results indicated that the participants use computer at a basic level in TREs and work in small and medium enterprises where technology is not highly demanded at moderate and advanced levels. The logistic regression analysis results revealed that gender and higher education level have significant impacts on their level of PSSs in TREs as opposed to age and the field of study variables. The significant differences are in favor of the female participants and associate and bachelor degree levels. These findings accounted for nearly 4% of their level of problem solving skills. Based on the study findings and the changing expectations of labor market, the policy proposals were discussed to increase the level of Turkish higher education students' PSSs in TREs. The study can contribute to the literature, thereby assisting the development of new practices or policies in Turkey to advance higher education graduates' PSSs in order to meet the needs of TREs at both work and in daily life.

**Keywords** Digital competence · PIAAC · Problem-solving skills · Technology-rich environment · Higher education · Turkey

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## Introduction

The knowledge-based economy paradigm originated in the early 1980s, at the same time as computer-related technologies and the promise of new information technologies emerged. Knowledge-based economies are described by the Organization for Economic Cooperation and Development (OECD) as economies that are directly based on the creation, distribution, and use of knowledge and information (OECD, 1996, p. 3). As a result, knowledge has become more relevant than ever before as a result of both the applications and effective use of various technological resources, also known as Information and Communication Technologies (ICTs) (Blinder, 2000; DeLong & Summers, 2001; Fuente & Ciccone, 2002; Godin, 2006; Harris, 2001). The rapid and widespread adoption of ICTs has ushered in a radically new competitive economic environment in which information creation, distribution, storage, implementation, and transition have always been critical to socio-economic development. ICTs have not only altered or disrupted many economic and social practices, but they have also produced new jobs, markets, and services (Nyíri, 2002). This transition has resulted in the creation of a knowledge-based society, in which technology plays an important role and knowledge is used to create process, disseminate, and use information for human growth (UNESCO, 2005). While mobile communication and the internet have become inseparable parts of economic and social life, as well as increased access to higher education, the value of getting ICT skills to survive in this modern society has grown (Singh, 2012). ICT skills, for example, allow people to use ICTs and participate in simple online activities, particularly when mobility is limited (Morandini et al., 2020).

In parallel with these developments, new ICT applications are now the primary drivers of radical change in work environments and sectors around the world, with newly developed jobs differing from those that are being lost due to increased demand for advanced digital skills (Nyíri, 2002; OECD, 2018; UNESCO, 2018). In this sense, the World Economic Forum's (WEF) Future of Work Report 2020 predicted that by 2025, 85 million jobs may be lost due to a shift in the division of labor between humans and machines, when the Covid-19 effects are taken into account. Furthermore, among the business leaders polled, 84% are speeding up the digitalization of work processes, and 50% are planning to speed up the automation of jobs in their organizations (WEF, 2020a). As a result, the future workplace will be different, with many workers working in technology-rich environments (TREs). It is specifically characterized as an environment in which appropriate access to the proper types of technology for efficient use and culture exist, allowing for the development of digital skills. TREs are created to teach and employ digital technology to assist learners in achieving the objectives of the lesson (Lajoie & Azevedo, 2006). Furthermore, the use of ICTs at work is increasing demand for digital skills in the job market and forcing people to acquire them in order to thrive in TREs (Care, 2018; Dolton & Makepeace, 2004; Hämmäläinen et al., 2019; OECD, 2016a; Van Laar et al., 2017; WEF, 2020b). Small and medium enterprises (SMEs) in developed countries, on the other hand, do not have as much of a need to use digital skills because of a lack of ICT infrastructure (Dewan et al., 2005; Duggan, 2008; Taylor, 2019).

However, the widespread use of ICTs in society has an effect on not only the workplace but also education (Siddiq et al., 2017). According to the OECD (2020), global educational opportunities have increased the number of highly skilled people who are more likely to find work. Due to lack of digital skills, the spread of Covid-19 would undoubtedly have a significant impact on the labor market, especially for those with lower educational attainments (OECD, 2020; WEF, 2020a). On average across OECD countries, upper secondary

or post-secondary non-tertiary education graduates have a 77% employment rate, whereas higher education graduates have an 86% employment rate. Similarly, 25–64 year-olds with a higher education degree earn on average 54% more than those with an upper secondary education in OECD countries. Despite the fact that most higher education graduates are familiar with digital technology, they lack adequate understanding and application skills to use it in their jobs and daily social tasks (Bulduk & Köker, 2017; Hazar, 2019; Leung, 2010; Trilling & Fadel, 2009). In this regard, higher education competences in today's world must include new skills such as problem solving and digital skills, as one of the main goals of higher education is to ensure that students have these skills to meet the demand of a knowledge-based society (Hämäläinen et al., 2019; Noble & Billett, 2017; Van Deursen et al., 2015; Tynjälä et al., 2014). As a result, in 2006, the European Parliament and Council designated digital competence as one of eight key competencies for active citizenship and social life (European Commission [EC], 2006), and higher education institutions (HEIs) in the European Higher Education Area (EHEA) are obliged to identify digital skills and incorporate them into their educational programs (EC, 2018).

Some studies have found a connection between ICT adoption and economic growth in countries (Jorgenson & Vu, 2016; Niebel, 2018). Overall, value of global competitiveness increased by 1.3 points in 2019, owing to a rise in ICT adoption around the world (WEF, 2019). However, since there are major differences in access, usage, and skills across countries, the effects of ICTs on economic growth are not the same across countries (Watanabe et al., 2015). In this context, the digital divide is defined as the differences in access to ICT and use of the Internet for a several activities among individuals, households, businesses, and geographic areas at numerous socioeconomic levels (OECD, 2001, p. 5). According to the Global Competitive Index Report 2020, despite the fact that global internet users have doubled since 2010, the digital divide still persists, with just 53.6% of the world's population using the internet today (WEF, 2020b). Since ICTs were critical in responding to the Covid-19 crisis, many countries have established national digital strategies and are focusing more on ICT adoption and digital skills enhancement (OECD, 2021a, 2021b).

On the other hand, Turkey has followed an aggressive growth strategy since 2006 and established 126 new universities across the country since this year. Today, total number of universities is 203 (129 of them public and 74 of them non-profit foundation) and each of 81 provinces of Turkey, including the socioeconomically least developed ones, now has at least one public university within their boundaries (Özoğlu et al., 2016; Council of Higher Education [CoHE], 2021a). Parallel to the rapid increase in the number of universities in Turkey especially in the last decade, the number of students and academic staff in the higher education system has also increased considerably. Total number of students exceeded 8 million 200 thousand in 2021 while the share of open and distance education is nearly 54%. Moreover, the number of academic personnel nearly reached 182 thousand in 2021 (CoHE, 2021b). The courses on using the computers are currently being taught in every university in Turkey. Besides, CoHE and HEIs in Turkey work currently together to improve learning outcomes by developing innovative pedagogical instructional technologies in education such as Massive Open Online Courses (MOOCs), Open Educational Resources (OERs), blended learning, flipped classroom learning and distance education to enable them to acquire their PSSs in TREs. In this regard, a project titled “Digital Transformation” has been launched by HEI to incorporate courses in digital media in 54 universities. About 10.000 faculty members and 60.000 students took digital literacy courses within the scope of this project to increase their digital competences (CoHE, 2020). Moreover, the Covid-19 has accelerated the digital transformation of Turkish higher education and deepening of digitalization in teaching and learning in higher education of Turkey like

other countries: in course design, instruction, assessment, learning analytics and credentialing, among others (OECD, 2021a, 2021b).

This research is based on the concept of problem-solving skills (PSSs) in TREs defined as the use of digital technology to create, access, and evaluate information, interact with others, and perform practical tasks (OECD, 2009). That requires problem solving as well as basic ICT and digital skills (OECD, 2016a). This concept has been used as a variable to test adults' digital competence to solve problems at work and in daily life in the OECD's Programme for International Student Assessment (PISA) and Programme for the International Assessment of Adult Skills (PIAAC) surveys (OECD, 2016a).

The findings of PIAAC might shed light on the problem solving skills that higher education graduates need in TREs. Due to lack of previous research, this study aims to investigate the relationships between problem solving skills in TREs and Turkish higher education graduates by using PIAAC data. In addition, this study used empirical analysis to determine the level of PSSs of Turkish participants not only descriptive statistics but also logistic regression analysis. In this regard, the study might contribute to the literature, thereby assisting the development of new practices or policies in Turkey to promote higher education graduates' PSSs in order to meet the needs of TREs at both work and in daily life. These could help boost the Turkish economy's productivity, efficiency, and ultimately competitiveness in today's knowledge-based economy and knowledge-based society in order to avoid people from social life and labor market exclusion.

In the following sections, existing studies in the literature that investigating the relationship between the PIAAC results and higher education is presented then the PIAAC data used in this study is described. Next, the methodology of the study is put forward and the main findings are analyzed. Finally, the problems and shortcomings observed in Turkish higher education graduates' PSSs in TRE are discussed and a conclusion is made based on the findings of the study.

## Theoretical background

PSSs refer to the ability to solve problems in the workplace or in daily life by using critical thinking, creative thinking, and reasoning (Csikszentmihalyi, 1996; Maudsley & Strivens, 2000; Xiao et al., 2019). People must also pursue the correct sequence of decisions and actions in order to reach a solution; otherwise, they would be unable to accomplish their goals or solutions by following routine actions (OECD, 2016a). ICT skills, on the other hand, are characterized as an individual's ability to use ICT tools and applications appropriately (Lennon et al., 2003), while digital skills are a collection of abilities to use digital technology to access and manage information (UNESCO, 2018). Overall, digital competence is defined as the confident, vital, and responsible application of digital technology in the workplace and in everyday life (EC, 2018). In this way, people can use computers to access, store, develop, and share digital content, interact and collaborate, and solve problems for effective and creative self-fulfillment at work and in daily life (Ilomäki et al., 2011; UNESCO, 2018).

PSSs in TREs can be labelled as one of the important skills to survive in today's world, given that access and efficient use of ICTs are necessary for successful involvement both at work and in daily life (Care, 2018; Iñiguez-Berrozpe & Boeren, 2020). According to Bocconi et al. (2016), future work skills based on digital technology are now also essential for children and young people since lack of PSSs in TREs can keep people out of the

labor market and social activities in the coming years (Iñiguez-Berrozpe & Boeren, 2020; Iñiguez-Berrozpe et al., 2018; Vanek, 2017).

From this perspective, Hämäläinen et al. (2019) found that having a higher education degree is strongly linked to adults' PSSs and higher education graduates' performance is associated with certain socio-demographic factors (especially age, gender, parental education, and native speaking skills), as well as work-related and daily life factors in Europe by the logistic regression analyses. Moreover, Hämäläinen et al. (2015) built on Finnish PIAAC data to understand adults' skills for solving problems in TRE by the multiple linear regression models, and they found that more than two-thirds of adults with vocational education and training have weak skills or lack the skills of problem solving in TRE. Besides, Iñiguez-Berrozpe and Boeren (2020) indicated that educational level and the use of different skills (reading, numerical, and ICT) at home and at work, as well as participation in non-formal education activities, decisively relate to a higher level of PSS in TRE by a multivariate analysis. Similarly, Desjardins and Ederer (2015) revealed that the level of higher educated adults' skills is significantly higher than that of adults with a lower educational level by applying multivariate model. However, for Tukey, Köker et al. (2017) and TED-MEM (2016) conducted only descriptive studies using Turkish PIAAC data.

### Characteristics of PIAAC data

This study used data from the PIAAC survey, which assesses adults' literacy, numeracy, and PSSs and provides the most comprehensive source of information and data on how they apply their skills at both work and daily life (PIACC, 2016). Between 2011 and 2018, the OECD conducted a survey for 16–65 year-old adults in more than 40 countries across Europe, the Americas, and Asia (OECD, 2019). Since this study focuses solely on PSSs, the main objective of assessing PSSs in TREs is not to measure adults' ability to use ICT tools and applications, but rather to evaluate adults' ability to use these tools and applications to access, produce, process, and analyze information effectively in problem solving tasks (OECD, 2016a).

PIAAC is held every ten years, and there have been two cycles so far. Data was collected in three rounds for the PIAAC 1st Cycle: Round 1 (2011–2012), Round 2 (2014–2015), and Round 3 (2017). Turkey, in particular, took part in Round 2 of the data collection, and the data collection and assessment was conducted in Turkish. The survey was administered to the respondents under the guidance of trained interviewers. On a 500-point scale, the scale is divided into four proficiency levels for PSSs in TREs (from below Level 1—the lowest—to Level 3—the highest). Level 1 consisted of scores ranging from 241 to 290 points, Level 2 of scores ranging from 291 to 340 points, and Level 3 of scores equal to or greater than 341 points (OECD, 2016a). The 2nd Cycle of the Survey began in 2018, with findings will expect to be published in 2024.

Furthermore, descriptions of problem solving proficiency levels in TREs show that tasks at Level 1 usually necessitate the use of commonly accessible and familiar technology applications, such as e-mail or a web browser. Level 2 tasks usually necessitate the use of both broad and certain technology applications, as well as some navigation between pages and applications to solve the problem. Level 3 adults can successfully perform the same tasks as Level 2 adults, but their tasks also require several computer application steps (OECD, 2016a, 2016b). Participants who score below Level 1 can complete their tasks using just one function or a few steps, requiring no information transformation (OECD, 2016a).

## Objective of study

Despite the relevance of this subject in the digital economy of the twenty-first century, adults in Turkey have lower-than-average proficiency in the domain of PSSs in TREs as compared to adults in other OECD countries. In this regard, on average, 31.1% of adults in OECD countries scored at Levels 2 and 3. In Turkey, however, the proportions are smaller, with just 8% of adults achieving one of the two highest levels of proficiency in this domain (OECD, 2016a).

As a result, studying PSSs and related socio-demographic factors in TREs will be extremely important for Turkey. In this regard, the PIAAC's comprehensive research findings, which focus on Turkish higher education graduates in particular, may provide empirical evidence to help Turkish adults for improving their digital competence proficiency level. According to the PIAAC results, the first aim of this study is to assess the level of PSSs of Turkish higher education graduates in TREs at work and in daily life. Since the needs of workplaces, the labor market, and daily life are continuously changing, the second aim of this study is to determine which socio-demographic factors, such as gender, age, field of study, and higher education attainment level in adults' backgrounds, are related to their PSSs in TREs. This will be the first study in Turkey to look at the link between PSSs in TREs and adults' higher education attainment. As a result, answers to the following three research questions are sought in the light of these aims:

- RQ 1 How often do the Turkish graduates of higher education use ICT tools and applications at their work and in daily life?
- RQ 2 In TREs, how much or to what extent do the Turkish higher education graduates use their PSSs?
- RQ 3 Which socio-demographic factors, such as gender, age, field of study, and level of higher education attainment, are associated with PSSs in TREs among Turkish higher education graduates?

## Method

In this study, descriptive statistics and logistic regression analyses were used to analyze the participants' PSSs in TREs. Descriptive statistics is a quantitative research method, which was employed on the data set concerning the Turkish participants derived from the official website of the PIAAC as quantitative data exist independently from researchers and enable them to re-use the data in the future to assess the reliability and validity of particular findings (Gillies & Edwards, 2005). To begin, descriptive statistics are applied to summarize the data set's characteristics in order to gain insight into the level and distribution of PSSs in TREs for the selected community, based on the PIAAC results. Second, logistic regression analyses were used to identify the factors that explain differences in adults' PSSs in TREs. To put it another way, a valid model is created to determine the relationship between independent and dependent variables (Tabachnick & Fidell, 2013). Furthermore, this study allows researchers to construct a regression model in which the normality, continuity, covariance, and multi-variable normality assumptions are not met (Yıldırım, 2018).

In the social sciences (Chuang, 1997; Janik & Kravitz, 1994; Tolman & Weisz, 1995) and in educational research, especially in higher education (Austin et al., 1992; Cabrera,

1994; Peng et al., 2002), the use of logistic regression analyses has increased. With a binomial response variable, logistic regression functions similarly to linear regression. As opposed to other models such as the Mantel–Haenszel OR, the main advantage is that researchers can use continuous explanatory variables and it is easier to manage more than two explanatory variables at the same time. Since the probability of an outcome is a ratio and logistic regression will model the probability of an outcome based on individual characteristics, what will be actually modeled is the logarithm of the probability given by (Sperandei, 2014):

$$\text{loglog}\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_mx_m$$

where  $\pi$  indicates the probability of an event, and  $\beta_i$  are the regression coefficients associated with the reference group and the  $x_i$  explanatory variables. Those individuals presenting the reference level of each variable  $x_1\dots x_m$  constitute the reference group, represented by  $\beta_0$ . In this study, logistic regression analysis was used to determine the socio-demographic factors have a significant effect on the level of PSSs of adults in TREs. Age, field of research, degree of higher education attainment, and gender are all factors included in this analysis. The socio-demographic factors of age and gender are chosen because they are essential moderators of the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). To begin with, evaluating information processing skills over the course of a lifetime is a natural or biological mechanism through which cognitive abilities improve as people grow and evolve, and then eventually decline as they age (Desjardins & Warnke, 2012; OECD, 2016a; Paccagnella, 2016). In TREs PSSs are inextricably linked to age, and when one gets older, they deteriorate (Schaie, 1996; Xiao et al., 2019). For example, according to the OECD (2016b), on average, about 32% of 55–65 year-olds in OECD countries skipped the problem solving assessment due to lack of computer experience, but this ratio is nearly 71% in Turkey. Second, despite the fact that the expansion of education in many countries over the past decades has resulted in a significant reduction in the gender gap in educational attainment, it remains a hot topic of debate around the world.

Thirdly, higher education attainment is considered as another factor influencing positively adults' PSSs in TREs since adults with higher education degree are more likely to be working, which allows them more chances to use their skills and avoid (or slow) the cognitive deterioration that comes with aging (OECD, 2016a). Willis et al. (2006) found that adult reasoning instruction contributes to fewer reductions in instrumental tasks in everyday life, implying that educational intervention may enhance PSSs. According to the OECD (2016a), educational attainment has the closest relationship with adult proficiency levels, both before and after other socio-demographic factors are taken into account. Lastly, Aslan and Zhu (2017) found that pre-service teachers' incorporation of ICT into their teaching programs is influenced by subject-teaching programs. Hence, the impact of adults' field of study on their PSSs in TRSs is also taken into account as another explanatory variable.

Before applying the model, we recoded our four socio-demographic factors (age, the field of study, education level and gender) because logistic regression involves identifying one of the factors as a reference category. We selected the first factor as reference; therefore, all factors variable were recoded with "0" and others with "1". In this regard, we recoded 16–19 aged participants as "0" and the other age groups "1"; male recoded as "0" and female "1"; general programs in the field of study recoded as "0" and the



others “1”; and higher education level for ISCED 5B recoded as “0” and the others “1”. The analyses were conducted through SPSS version 15.0.

The PIAAC data for Turkish adults were obtained from publicly accessible data and research on the OECD’s official website. Furthermore, since the International Standard Classification of Education (ISCED) is the reference international classification for organizing education programs and related qualifications by levels and fields, it was used to assess the level of higher education qualifications in PIAAC (UNESCO, 2013). In this context, ISCED 5A refers to bachelor’s and master’s degrees, while ISCED 5B mainly refers to associate’s degrees, which are awarded in Turkey’s post-secondary vocational and technical schools. ISCED 6 denotes advanced research training, such as a doctorate (UNESCO, 1997).

## Results

### Participants

The sample consists of 966 Turkish higher education graduates among the 5,277 Turkish adults aged 16 to 65 who took part in the PIAAC survey (40.3% females and 59.7% males). Table 1 shows the socio-demographic profiles of the participants. 82.3% of the participants are in the 20–24 and 25–29 age groups. When looking at their educational levels, it can be seen that they were mostly densely clustered in bachelor’s degree (61.2%) and associate’s degree (30.7%), consecutively. Social sciences, business, and law (31.3%), teacher training and education science (19.6%), and engineering, manufacturing, and construction programs are the most common study areas (14.1%). Furthermore, more than half of them (54.5%) work in the private sector rather than the public or non-profit organizations. When it come to their job status, the majority of them (63.4%) are employees, not supervisors, and 80.3% of them work in SMEs.

### Descriptive statistics for participants’ use of digital competences at their work and in daily life

Table 2 shows the descriptive statistics for the Turkish participants in terms of using digital competences at their work and in daily life. It appears that the participants use e-mail and the internet to better understand the issues related to their tasks at work and in daily life at least once a week. Besides, they conduct their transactions through the internet at work and in daily life less than once a month. Moreover, they use spreadsheet software at work less than once a week but in daily life less than once a month. When their use of a word processor is concerned, they use it at work at least once a week but in daily life less than once a month. Nevertheless, they hardly ever use a programming language to program or write computer at work and in daily life. Also, they rarely join real time discussions on the internet at work and in daily life. Participants think that they need computer use to perform their job at an almost moderate level and have the digital competences to perform their job. They also consider that lack of digital competences does not significantly affect their chances of being hired for a job or getting a promotion or pay rise. It is noteworthy that the level of their digital competences is limited to the basic level when particularly their age group and education level are considered. Therefore, it might be said that there is no much problem for Turkish participants to use computers or the internet for the basic tasks



**Table 1** Descriptive statistics about participants

Variables	N	%	Total
<b>Gender</b>			
Female	389	40.3	966
Male	577	59.7	
<b>Age</b>			
16–19	31	3.2	962
20–24	590	61.3	
25–29	202	21.0	
30–34	71	7.4	
35 or older	68	7.1	
<b>Education level</b>			
Associate's degree	297	30.7	966
Bachelor's degree	591	61.2	
Master's degree	71	7.3	
Doctorate degree	7	.72	
<b>Field of study</b>			
General programmes	91	9.4	964
Teacher training	189	19.6	
Humanities	30	3.1	
Social sciences	302	31.3	
Science	106	11.0	
Engineering	136	14.1	
Agriculture and veterinary	18	1.9	
Health and welfare	63	6.5	
Services	29	3.0	
<b>Economic sector</b>			
The private sector	352	54.5	646
The public sector	289	44.7	
A non-profit organisation	5	.8	
<b>Status</b>			
Employee, not supervisor	396	63.4	625
Employee, supervising fewer than 5 people	56	9.0	
Employee, supervising more than 5 people	108	17.3	
Self-employed, not supervisor	31	5.0	
Self-employed, supervisor	34	5.4	
<b>Number of people working for employer</b>			
1 to 10 people	144	24.7	583
11 to 50 people	191	32.8	
51 to 250 people	133	22.8	
251 to 1000 people	55	9.4	
More than 1000 people	60	10.3	

**Table 2** Descriptive statistics concerning participants' digital competences at work and in daily life

Questions	Min		Max	At work		Daily life	
	N	Mean		N	Mean	N	Mean
Frequency to use e-mail?	1.0	5.0	624	4.12	1.40	879	3.96
Frequency to use the internet to better understand issues related to your work?	1.0	5.0	624	4.27	1.15	879	3.69
Frequency to conduct transactions on the internet?	1.0	5.0	624	2.85	1.64	878	2.82
Frequency to use spreadsheet software?	1.0	5.0	624	3.33	1.56	878	1.92
Frequency to use a word processor?	1.0	5.0	624	3.60	1.44	879	2.23
Frequency to use a programming language to program or write computer code?	1.0	5.0	624	1.36	.998	879	1.20
Frequency to join in real-time discussions on the internet?	1.0	5.0	624	1.53	1.09	879	1.77
Need computer use at your current job?	1.0	3.0	624	1.69	.588		
Having the computer skills you need at your current job well?	1.0	2.0	624	1.03	.172		
A lack of computer skills affects your chances of being hired for a job?	1.0	2.0	848	1.81	.391		

Mean values refer to (1) never; (2) Less than once a month; (3) Less than once a week but at least once a month; (4) At least once a week but not every day; (5) Everyday.

at their work and in daily life though their digital competences are not enough to perform their jobs.

The descriptive statistics concerning the Turkish adults' current work are displayed in Table 3. Participants think that their studies for the qualification for the job or business

**Table 3** Descriptive results concerning participants' current work

Questions	N	%	Total	Mean
Useful for your studies for this qualification for the job you had at that time?				
Not useful at all	35	19.4	180	2.85
Somewhat useful	27	15.0		
Moderately useful	48	26.7		
Very useful	70	38.9		
This qualification necessary to do your job satisfactorily?				
This level is necessary	445	77.7	573	1.33
A lower level would be sufficient	69	12.0		
A higher level would be needed	59	10.3		
If applying today, what would be the usual qualifications?				
No formal qualification or below	11	1.9	584	
ISCED 1	15	2.6		
ISCED 2	6	1.0		
ISCED 3C 2 years or more	23	3.9		
ISCED 3 (without distinction A-B C, 2 years +)	62	10.6		
Associate's degree	99	17.0		
Bachelor's degree	345	59.1		
Master' degree	18	3.1		
Doctorate degree	5	.9		
Someone with this level of qualification was applying today, how much related work experience would be needed?				
None	162	27.7	584	3.51
Less than 1 month	22	3.8		
1 to 6 months	114	19.5		
7 to 11 months	36	6.2		
1 or 2 years	145	24.8		
3 years or more	105	18.0		
Frequency to involve learning-by-doing from the tasks you perform at your job?				
Never	49	7.6	649	3.39
Less than once a month	171	26.3		
Less than once a week but at least once a month	115	17.7		
At least once a week but not everyday	106	16.3		
Everyday	208	32.0		
Frequency to involve keeping up to date with new products or services at your job?				
Never	69	10.6	648	3.25
Less than once a month	169	26.1		
Less than once a week but at least once a month	125	19.3		
At least once a week but not everyday	101	15.6		
Everyday	184	28.4		

they had at that time are mostly very useful and their perceptions for their qualification level for the job or business they had at that time are nearly moderately useful. Their perceptions for their qualifications are satisfactory to perform their tasks at their work. When they are posed what qualifications the others need to get their jobs, they mostly consider that particularly having a bachelor's degree (59.1%) and then an associate's degree (17%) is enough for participants. According to most of the participants, no work experience is required to apply for a job (27.7%) but 24.8% of them consider that these candidates should at least 1 to 2 years of work experience after graduation to get the current participants' jobs. Moreover, Turkish participants mostly have an opportunity to learn by doing from the tasks they perform and keep up to date with new products or services every day or less than once a week when performing their jobs.

### Overview of socio-demographic factors

The results of logistic regression analysis indicated that the applied model for showing the relationship among age, field of study, higher education attainment level and gender was insufficient. Hence, Backward-Wald analysis was implemented to get a valid model by omitting the variables with the highest significant levels. Following these adjustments, we were left with only two functional socio-demographic factors, namely gender and higher education attainment level, and their impacts on Turkish higher education graduates' PSSs in TREs, as shown in Table 4. The value of Hosmer–Lemeshow Goodness of Fit test was firstly examined to test whether the model has a goodness fit. The value indicated that it has a goodness fit ( $\chi^2 = .267$ ,  $df = 3$ ,  $p = .966$ ) (Yıldırım, 2018). The Omnibus test of the model coefficients ( $\chi^2 = 21.398$ ,  $df = 5$ ,  $p = .001$ ) is significant. The Wald statistics revealed that education level and gender variables significantly predict the dependent variable of PSSs in TREs ( $p = .000$ ). Exp (B) of the model, which also indicated the odds value in logistic regression, was calculated as 3.351. This means that the validity of the model was high. Besides, the significance of the model was calculated as .001. This value referred that the socio-demographic factors (gender and higher education attainment level) used in our model make a significant contribution, and they account for nearly 4% of the participants' proficiency in PSSs in TREs (Nagelkerke  $R^2 = .033$ ). Besides, significant differences occur in favor of Turkish associate's and bachelor's degree graduates for their proficiency level in PSSs in TREs as expected to the OECD (2016a) results, which indicates that level of educational attainment has the positive impact on the adult proficiency levels.

As far as gender is concerned in Table 4, there is a significant difference in favor of the Turkish female participants as unexpectedly since women's exclusion from education and

**Table 4** The individual variables affecting participants' proficiency level in problem solving in technology-rich environments

Variables	B	S.E.	Wald	Df	Sig	Exp (B) e <sup>β</sup>
Gender						
Female	.333	.161	4.274	1	.001**	1.396
Education level						
Associate's degree	.644	.164	15.436	1	.000**	1.904
Bachelor's degree	.739	.343	4.640	1	.031**	2.095
Constant	.654	.373	3.075	1	.079	1.923

Numbers in parentheses are p-values. (\*), (\*\*) and (\*\*\*) denote statistical significance at 1%, 5% and 10%, respectively.

employment continue in Turkey due mainly to the cultural factors. When looking at the proportion of the Turkish working population aged 15 and greater in January 2021, the male citizens' labor force participation and employment rates are 68.8% and 60%, respectively, whereas the both rates for female ones' are 30.6% and 26.1%, consecutively (Turkish Statistical Institute [TÜİK], 2021). Hence, males are seen to make up the majority of the Turkish working population. In this regard, gender issues may provide new insights into their ICT use and applications at work and in daily life in Turkey.

## Discussion

When compared to adults in other OECD countries, it can be said that Turkish higher education graduates are usually not competent to demonstrate their digital competences in PSSs in TREs. Since according to the OECD (2016a), on average, 47.71% of adults with a higher education degree scored at Level 2 or 3 in OECD countries. In Turkey, however, 26.5% of adults with a higher education degree scored at Level 2 or 3. This study tried to explain why this is the case by looking at the digital competence levels of Turkish higher education graduates at work and in daily life, as well as the impact of socio-demographic factors on their PSSs in TREs. For this purpose, the OECD's PIAAC data for 966 Turkish higher education graduates are analyzed by using descriptive statistics and logistic regression analyses.

The findings of this study indicated that Turkish adults with a higher education degree mostly work in SMEs (80.3%) that are not expected to fully use digital technologies because ICT adoption entails several inherent risks and uncertainties for these enterprises (Dewan et al., 2005; Duggan, 2008). For example, the adoption and diffusion of ICTs are likely to result in changes in work processes relating to the use of such digital technologies, and the benefits may not be sufficient to cover the costs of ICT implementation due to lack of skilled personnel or the inability to adopt new ICTs (Dewan et al., 2005; Taylor, 2019).

As a result of this situation, Turkish adults need a moderate level of computer usage at work. Word processing, spreadsheets, and database management applications are the most popular programs they use on the computer. Furthermore, they believe that a lack of digital competence has no effect on their chances of getting a job, a promotion, or a raise in wage. It can be deduced that their jobs do not necessitate the use of ICTs. This is supported by the data presented, which showed that they infrequently use e-mail, spreadsheets, word programs, or the Internet to better understand issues relevant to their jobs. That is, their digital competences are limited in their jobs to a minimal level. In this respect, it should be noted that the types of applications that adults use on their smartphones (e.g., WhatsApp, Google Play Store) are not taken into account in this study. Likewise, they don't use computers or the internet too much in daily life. In addition, they rarely use a programming language to program or write computer code at work and in daily life. Similarly, they hardly participate in real time internet conversations at work and in daily life. On the other hand, the working environment of Turkish adults has a significant impact on their computer usage at work. Thus, one of the reasons why many Turkish higher education graduates lack adequate digital competences is that they do not feel obligated to improve their digital competences because their jobs do not demand use of digital technology, especially in SMEs. This deduction is also consistent with previous research (Açıklım, 2014; Aslan & Zhu, 2015, 2017), which found that teachers graduate from teacher training programs are incompetent users of digital competences in Turkey.

When the impacts of the socio-demographic factors are concerned according to the logistic regression analyses of the PIAAC data on Turkish higher education graduates' PSSs in TREs, it was revealed that the field of study in higher education and age of Turkish adults have no major impact on their problem solving proficiency scores, as predicted (Aslan & Zhu, 2017; Desjardins & Warnke, 2012; Inan & Lowther, 2010; OECD, 2016a; Paccagnella, 2016; Venkatesh et al., 2003). Adults' gender and higher education degree level, however, are found to be significant predictors of problem solving scores, accounting for nearly 4% of the total. Furthermore, contrary to expectations, the results revealed a significant difference in favor of female adults (Aslan & Zhu, 2017; Önder et al., 2011).

Therefore, it is not just sufficient to train adults to acquire digital competences and rather it is crucial for them how to evaluate adults' ability to use these tools to access, process, evaluate and analyze information effectively in accomplishing complex problem solving tasks (OECD, 2016a). In this context, it is worth noting that, like the European Qualifications Framework (EQF), digital competence is specified as one of the eight key competencies of the Turkish Qualifications Framework (TQF) in Turkey (Vocational Qualifications Authority [VQA], 2018). Regarding this, updating higher education curricula, and expanding investment in digital competences as well as PSSs needed for jobs in the digital economy should be a priority policy to prepare students for Turkey like all nations considering the changing expected skill requirements in TREs.

These results show that despite the emphasis on digital competences in higher national policy documents of Turkey, they have not been adequately considered in practice. For this reason, Turkish policy-makers should develop some innovative policies to increase higher education graduates' digital competences as well as PSSs. In this context, students at their university training should be enabled to acquire the competency to develop problem-based programming in digital technology to contribute to the economic efficiency of the enterprises where they will be employed. The other innovative policy might be to train high digital skilled teachers in higher education in the mid and long term because teachers are the significant agents of change in training highly skilled citizens to participate in a knowledge-based economy. Meroni et al. (2015) found that teachers' digital competences have positive impacts on student achievement and account for the variation in students' achievement among the countries. Adults having low digital competence might improve their competences through non-formal and informal learning in the context of lifelong learning. Within this scope, continuing education centers and public education centers should be supportive institutions to upgrade adults' digital competences.

The impact of the Covid-19 serves as a wake-up call for all countries like Turkey that need to embrace the digitalization process, and invest in ICT adoption and digital competences (WEF, 2020b). Also, individuals who can survive in the digital economy, and those suited to the skill requirements of future jobs, are those who do not only possess digital competences but also cognitive skills such as problem solving (CEDEFOP, 2018). OECD (2016a) and CEDEFOP (2018) presented digital technology users are more likely to be employed in jobs that need more digital competence, which need a higher level of PSSs to learn, use, adapt and apply new applications and digital technologies at work. In parallel to these developments, Turkish policy-makers should develop new policies for higher education students and implement them to survive in the knowledge-based economy since future jobs will demand more digital competences and problem solving skills. For example, the higher education curricula should be upgraded and improved in collaboration with the representatives of state and private sectors. In this way, the digital competences and PSSs and eventually the human capital quality of higher education graduates might be improved. Furthermore, the findings presented in this study may be helpful when developing global

higher education practices and policies as well as new approaches to foster higher education adults' PSSs to meet the needs of technological advancement at work and in daily life. Also, this study might guide the universities around the world to equip higher education students with digital skills in order to prevent them from any exclusion in digital economy and knowledge-based society. Hence, the proficiency level differences of PSSs in TRE might be eliminated for higher education graduates' globally.

Briefly, this study is limited to the PSSs of Turkish higher education graduates in TREs. Future studies could be conducted to investigate their problem solving skills in other education levels such as ISCED 2 and 3. Similar quantitative and qualitative studies could be employed to identify and explore the proficiency of the Turkish adults in literacy and numeracy domains of the PIAAC. Besides, comparison between countries might be done by using the PIAAC data.

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**Data availability** The study data is available upon request.

## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest.

**Research involving human participants/animals** Turkish higher education graduates' problem-solving skills in technology-rich environments at work and daily life were examined through the data released by the Programme for the International Assessment of Adult Competencies (PIAAC) by OECD in 2016.

**Informed consent** The data concerning Turkish higher education graduates' problem-solving skills in technology-rich environments is available at the official website of OECD. So, the informed consent from the participants was not obtained.

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