VET ADULTS’ PROBLEM-SOLVING SKILLS - PROSPECTS FOR WORKPLACE LEARNING

Raija Hämäläinen¹, Bram De Wever², Sebastiano Cincinnato³ and Antero Malin⁴

¹ University of Jyväskylä Faculty of Education
Finland

² Department of Educational Studies, Ghent University
Belgium

³ Vrije Universiteit Brussel, Department of Educational Sciences
Belgium

⁴ University of Jyväskylä, Finnish Institute for Educational Research
Finland

ABSTRACT

The technological landscape in the European workplace is changing rapidly and this is challenging adults’ problem-solving skills in technology-rich environments (TRE). This study builds on the Programme for the International Assessment of Adult Competencies (PIAAC) data to understand the skills for solving problems in TRE of adults with vocational education and training (VET). Firstly, this presentation focuses on gaining insight into the problem-solving skills in TREs of adults with a VET background (N=50 369) in eleven European countries. Secondly, the presentation develops better understanding on adults’ problem-solving skills in TRE in Finland. When examining the similarities and differences in VET adults’ problem-solving skills in TREs across 11 European countries, our results show the critical issue that only a minority of VET adults perform at a high level. A detailed examination of the Finnish adults indicate that more than two thirds of VET adults have weak skills or lack the skills in solving problems in TRE. Furthermore, we will illustrate that the likelihood of having fragile problem-solving skills is six times higher for adults with VET than for adults with at least upper secondary qualification. Since the need for TRE problem-solving is likely to increase in the future, this study also identifies the indicators for problem-solving skills differences. In this presentation, the models predicting problem-solving skills on the basis of theoretical assumptions as well as empirical support are presented. Our results indicate that VET adults’ lower performance does not seem to be associated with the VET educational system itself, but is mostly due to age, education in years, occupation, and gender, as well as work-related and everyday life factors. An important implication of this study is that our results bring out new prospects for the development of VET adults’ professional competences to meet future workplace needs.

THEORETICAL BACKGROUND

According to Billet (2006) requirements for professional skills and competences are increasing in all forms of work. In current working life, more high-level skills are
required than ever before (OECD; 2012a). The global workplace is developing radically. For example, while the industrial sector in Europe was previously strongly based on mass-production technology, nowadays it is moving towards more and more flexible production methods. As a direct result of this advancement, most countries with advanced industrial sectors needed to increase their flexibility and the adaptability of their jobs and ways of effective work (Harteis & Billett, 2013). The interesting question for the future working life is how well adults’ vocational skills and professional expertise match to the changing needs of European workplace. There is a critical notion that if the adults’ expertise and future workplace needs do not match, this will result in three extremes: (1) workers will have to change occupations and complete different training programmes because their previous jobs have been outsourced or replaced by technology (see Bresnahan, Brynjolfsson, & Hitt, 2002; Crafts, 2004), (2) workers will stay at the same workplace, but their job descriptions will change considerably (Maclean & Wilson, 2009; Tuomi-Gröhn & Engeström, 2003), or (3) at the worst case workers will be excluded from the labour market due to insufficient skills and abilities they have (OECD, 2012a). In all these cases, the current European workplace is challenging adults’ professional expertise and there seems to be a continuing rise in workers’ need for better interpersonal and cognitive skills (OECD, 2012a). Thus, professional development is a key approach in helping adults to meet the needs of the working life. Therefore, we need novel ways to enhance lifelong, life wide and workplace learning. In practice, to meet the workplace needs - over the past two decades the interest in research focusing on learning taking place at work, through work and for work has considerably increased (Tyynjälä, 2013). In addition, Tyynjälä (2013) has proposed that we need studies focusing on (1) the nature of workplace learning, (2) work identities and agency, (3) the development of professional expertise, (4) the competence development in education–work contexts in vocational education and training as well as in higher education, (5) communities of practice, and (6) organisational learning.

Probably one of the biggest challenges in current working life concerns technological development. The current trend at the workplaces seems to be that technologies are used more and more for routine tasks, while workers are needed to accomplish non-routine tasks (Goos, 2013). As a direct result of this development, work tasks are becoming less fixed (Billet, 2006) and are more varied. In the case of adults with vocational education and training (VET) (e.g. in the industrial context often previously performing in-routine, intensive work tasks), an increasing amount of work tasks are now automated (see Frey & Osborne, 2013). On the other hand, the current technological development does not only involve new challenges for VET workers, but also new opportunities. For example, technological development and the access to the open Internet has created new possibilities for entrepreneurs with VET background. An increasing number of small business services (e.g. hairdressing, restaurants and bars) are gradually using electronic booking systems and taking advance of social media (e.g. using Facebook for marketing). Furthermore, at their best, with the aid of new technologies small companies are gaining new access to global markets (Kende, 2015). As a direct result of that advancement, nowadays VET workers (e.g. small business owners) may increasingly benefit from their technological skills and abilities. In line with this, competence needs are changing because the ways of working are changing (OECD, 2012a). The demand to deal with emerging technical solutions is rising and workers develop professional competencies to deal with the evolving characters of technology (e.g. Kende, 2015;
Herder Koesling, Olmedilla, Hummel, & Schoonenboom, 2006; Brand-Gruwel & Stadtler, 2011). As a direct result of this development problem solving in technology-rich environments (TRE) is a useful skill for the changing work life (e.g. Goos, 2013). Currently skills for handling and producing new information as well as solving problems play an increasingly important role in the working life (see, Tynjälä, 2013). Even in some cases technology diminish the need for problem solving; new problem solving needs may also emerge because of the technologies. According to Brand-Gruwel and Stadtler (2011), solving 21st century information-based non-routine problems requires multiple cognitive skills, from searching and evaluating to integrating information. As a result, an increasing amount of VET professions workers need to acquire innovative and transformative forms of learning and problem-solving (in addition to reproductive activities) in order to respond to these challenges (Tynjälä, 2013). Furthermore, while production processes are also speeding up, workers need to solve complex problems more and more rapidly. Therefore, professional expertise and abilities regarding problem-solving intuitively are becoming increasingly important. This means that in contrast to highly cognitive demanding and thus very conscious problem-solving activities, these intuitive problem-solving activities should be carried out in a more natural and spontaneous way, leading to more unconscious and very quick reactions in challenging situations (Harteis, Koch, & Morgenthaler, 2008). Moreover, this type of extraordinary performance based on intuitive problem-solving is also showing in rather complex knowledge construction activities (Harteis, Koch, & Morgenthaler, 2008; Harteis & Billett, 2013).

Recently Harteis and Billett (2013) argued that although intuitive problem solving in TRE is not recognised in the same ways in different professions, it is an important ability being utilised across all forms of work requiring instantaneous decision making (see also Harteis & Gruber, 2008). Despite the rapid proliferation of technologies at workplaces, research into the professional development and adults’ skills for solving problems in TRE is still in its infancy. Therefore, it is not yet clear what kind of proficiency adults with VET currently have with regard to problem-solving skills in TRE. At the same time the technological landscape influences workplaces and its necessities regarding VET adults’ skills. To guide future lifelong, life wide and workplace learning we need a better understanding of what kind of skills adults currently have and what kind of professional expertise regarding problem-solving in TRE will be needed in the future. The key challenge in investigating this association is determining how to obtain reliable information on individuals’ skills regarding future workplace needs. Previously, the problem has been that no accurate international large-scale data has been available with respect to adults’ key information-processing skills. The data from the Programme for the International Assessment of Adult Competencies (PIAAC) from the Organisation for Economic Co-operation and Development (OECD) comprise the most comprehensive source of information of adult skills ever undertaken. As a result, the PIAAC information is an extension of prior information sources on adults’ skills and competences and makes it possible to develop new ways to increase learning throughout adults’ working careers by predicting current and emerging needs of adults’ problem-solving skills in TRE. This presentation focuses on generating new knowledge on the problem-solving skills in TREs of adults with a VET background in European countries that participated in the PIAAC problem solving test. Namely, in this presentation we will:
Describe similarities and differences of adults’ problem-solving skills in TRE in Austria, Slovak Republic, Czech Republic, Denmark, Germany, Belgium, Finland, Ireland, Netherlands, Norway, and Poland.

Illuminate VET adults’ problem-solving skills in TRE in Finland in a more detailed level based on a Finnish PIAAC data.

RESEARCH METHODS AND RESULTS

This study builds on the PIAAC data to understand VET adults’ skills for solving problems in TRE. In short, PIAAC is a large-scale, continuing programme for monitoring performance in literacy, numeracy and technology-rich problem-solving among adults in 24 countries. In this presentation, we will focus on the assessments of problem-solving in eleven European countries (N=50,369) (for definitions of problem-solving see e.g. Brand-Gruwel & Stadtler, 2011; Levy, 2010) in TRE. In our analysis, we used all the countries of the Cedefop calculations (see, Eurydice Highlights 2012/2013) that participate in the PIAAC study (13 countries) and selected those countries that had data on problem-solving in TREs (Spain and France were excluded, as they did not participate in the PIAAC problem-solving test).

The main goal of the PIAAC was to determine whether adults’ basic problem-solving skills were at a level that made them ready to respond to the unpredictable needs of the future. In practice, PIAAC study involved two parts: (i) Participants answered questionnaires about their backgrounds (the aim of the background questionnaire was to let researchers to understand what kinds of skills participants used and how actively). (ii) A computer-based test was operated (the aim of the test was to capture the level of problem-solving skills, see OECD, 2013). During the PIAAC test problem-solving participants did not know the test tasks in advance and also intuitive problem-solving skills were needed. In PIAAC, problem-solving in technology-rich environments is defined as follows:

“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. The first PIAAC problem solving survey will focus 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”. (OECD, 2012b, p. 47).

This presentation includes two phases. Firstly, this presentation focuses on providing an insight into the problem-solving skills in TREs of adults with a VET background in eleven European countries (N=50,369); Austria, Slovak Republic, Czech Republic, Denmark, Germany, Belgium, Finland, Ireland, Netherlands, Norway, Poland (see, Hämäläinen, Cincinnato, Malin & De Wever, 2014). Secondly, the presentation develops better understanding on adults’ (n=4503) problem-solving skills in TRE in Finland (see, Hämäläinen, De Wever, Malin & Cincinnato, 2015).

Table 1 below summarizes how the data and data analysis was used to answer the research questions. In addition, the table concludes the main findings of our presentation.
Table 1: How the Data and Analysis Are Used to Answer the Research Aims

<table>
<thead>
<tr>
<th>Research questions</th>
<th>Data</th>
<th>Analysis</th>
<th>Main results and the conclusions</th>
</tr>
</thead>
</table>
| Aim 1: to understand what is the level and distribution of problem-solving skills in TREs for adults with VET in Austria, Slovak Republic, Czech Republic, Denmark, Germany, Belgium, Finland, Ireland, Netherlands, Norway, Poland? | >What is the level and distribution of problem-solving skills in TREs for adults with VET in Europe?  
>How is the level and distribution of problem-solving skills in TREs for adults with VET related to adults with other educational backgrounds? | A total of 66,322 16- to 65 year olds were involved (average weighted response rate of 60%, sample size of 113,744) in eleven European countries; 50,369 adults took part in the test of problem-solving skills in TREs:  
-The background questionnaire.  
-A computer-based test on problem-solving skills. | **Quantitative:** The results of problem-solving are represented on a 500-point scale >was divided into four different proficiency levels:  
- Level 1 = “weak performers”  
- Level 2 = “moderate performers”  
- Level 3 = “strong performers”  
- The participants who scored below Level 1 were defined as “at risk”  
Analysis involved three phases:  
1) Detecting the level of the problem-solving skills  
2) Investigating the differences in problem-solving skills between VET and other adults  
3) Examining the differences between the European countries applying school- or work-based approaches in VET | -VET adults have a tendency for a lack of or low problem-solving skills in all countries.  
- More than 11% of the VET adults are at-risk performers in all countries.  
- VET adults perform lower on average than adults with other educational background.  
- The difference (in average) between school-based and work-based VET is very small.  
- Variations between European countries hint towards influential differences between the countries. |
| Aim 2: To develop new understanding what factors explain the variation in problem-solving skills in TREs? | >How are the knowledge and skills of adults related to their lives, their personal life history and their real-life problems?  
> How do the differences in problem-solving skills in TRE between the four adult groups (VET versus other educational backgrounds, and ≥40 versus <40 years of age) vary before and after controlling for the background factors of our model(s)? | The Finnish PIAAC data, n=4503 adults:  
-The background questionnaire.  
-A computer-based test on problem-solving skills. | **Qualitative:** A thematic analysis of the PIAAC variables (see OECD, 2013, for the description of the 1600 variables).  
- **Quantitative:** Selecting the most important background factors associated with problem-solving skills.  
- Selecting statistically significant background factors.  
- Building statistical model(s) to explain problem-solving variation.  
- Controlling the effects of our model(s). | >Four models identifying factors explaining the variation in adults’ problem-solving skills based on theoretical assumptions and empirical support will be presented.  
> New understanding the factors that are statistically significant predictors of problem-solving abilities in TREs.  
> New knowledge for the factors that contribute to successful skills.  
> New prospects for supporting VET adults’ professional competences. |
In this presentation we will describe the level and distribution of problem-solving skills in TREs for adults with VET in Austria, Slovak Republic, Czech Republic, Denmark, Germany, Belgium, Finland, Ireland, Netherlands, Norway, and Poland: In our analysis we investigated the differences and similarities in the relationship between participants’ background (i.e. VET versus other educational backgrounds, and ≥40 versus <40 years of age) and the scores of the problem-solving test in eleven countries. When examining the similarities and differences in VET adults’ problem-solving skills in TREs across 11 European countries, our results show that there is only a minor average difference between school-based and work-based VET approaches. In addition, we will illuminate the following critical issues:

a) Only a minority of VET adults perform at a high level. 
b) VET adults have a tendency for a lack of or low problem-solving skills. 
c) VET adults perform lower on average than adults with other educational backgrounds.

The factors that explain the variation in problem-solving skills in TRE: A detailed examination of the Finnish adults indicate that more than two thirds of VET adults have weak skills or lack the skills in solving problems in TRE. Furthermore, we will illustrate that the likelihood of having fragile problem-solving skills is six times higher for adults with VET than for adults with at least upper secondary qualification. Since the need for TRE problem-solving is likely to increase in the future, this study also identifies the indicators for problem-solving skills differences. In practice, we investigated problem-solving skills in TREs from the perspective of the socially situated nature of learning (i.e. how the knowledge and skills of adults are related to their lives, their personal life history and their real-life problems). Therefore, the models that aimed to identify factors explaining the variation in adults' problem-solving skills based on theoretical assumptions as well as empirical support were built (see detailed description in Hämäläinen, De Wever, Malin & Cincinnato, 2015). In this presentation, these models predicting problem-solving skills (based of theoretical assumptions and empirical support) are presented. Finally, we will illuminate that VET adults’ lower performance does not seem to be associated with the VET educational system itself, but is mostly due to age, education in years, occupation, and gender, as well as work-related and everyday life factors (see Figure 1).
DISCUSSION AND FUTURE DIRECTIONS

Due to the changing context of European workplace, it is important to get a better understanding of VET adults’ problem solving skills in TRE. PIAAC data provided new prospects for understanding what kind of problem-solving skills in TRE VET adults’ have at the European level. The aim of study was to generate new knowledge on the problem-solving skills in TREs of adults with a VET background (Hämäläinen, Cincinnato, Malin & De Wever, 2014). In addition, our aim was to develop better understanding on adults’ problem-solving skills in TRE in Finland (see, Hämäläinen, De Wever, Malin & Cincinnato, 2015). In light of PIAAC data, our results show the critical issue that adults with VET perform lower on average than adults with other educational backgrounds. As problem-solving in TRE is increasingly important in labour market, there seems to be a gap emerging between what kinds of skills VET adults currently have and what is beneficial in future workplaces. In addition, changes in the labour market are not alone in modifying VET workers’ jobs, since also workplace practices (e.g. forms of working, technological development etc.) are playing a significant role in this regard. This study provides insight that in addition to technical issues, VET workers may have difficulties in performing effective problem-solving processes in TRE settings. Hence, the question arises how to best support the development of VET adults’ problem solving processes and abilities in TRE. Due to the range of challenges for VET adults’ professional development, we propose the following recommendations for enhancing adult learners continuing professional development and work conditions.
First, it seems that VET adults need support and resources for developing their professional competencies, knowledge, and skills to better match future workplace needs. Currently, the ways of working are changing. At the future working life work tasks are increasingly based on collaboration with different professionals. As a direct result of this advancement, the ability to apply network skills is the foundation of future work (OECD 2012a). We emphasise the importance of group based working and learning approaches in supporting VET adults’ problem-solving in TRE. Our findings illuminated that all eleven European countries have the same trend of having very few VET adults performing at the highest level. For the future, one solution may be to pay more attention to collaboration between groups of adult learners. For example, communities of practices (Wenger 1998) may help VET adults to engage in the processes of collective learning in a shared domain.

Second, the challenge is that in workplaces, adult learners with VET background face concrete and rapid problem-solving situations in which knowledge is somehow implicit and directly integrated into practice. There is a critical issue that most decisions in current work places have to be made under time constraints or with restricted or incomplete information, requiring creative problem-solving under those conditions (Harteis & Billett, 2013). However, people with little prior experience regarding successful problem-solving experiences in TRE settings may not have developed adequate knowledge that guides them in problem-solving situations (Fischer, Kollar, Stegmann & Wecker, 2013). Thus, the rapid technological advancement regarding problem-solving in TRE challenges the development of VET adults’ knowledge structures during the development phases from novice to experts. Our findings give indications that everyday life learning and skills used outside the workplace appear to be clearly related to problem-solving skills in TRE. Currently, VET adults may not be ready to quickly take over new technologies and to solve problems in changing technological environments. This may be related to the notion that VET adults may not spontaneously engage in everyday life learning and using TRE problem-solving skills outside the workplace. Regarding Eraut (2004 a,b) everyday life and informal learning encounters are essential for experiencing, developing, refining, and sharpening what has been learnt previously and generating tacit knowledge and routines that are shaping professional development also in the workplace settings. In line with this, in addition to novel workplace learning approaches, VET adults’ professional development calls for novel ways to support non-formal and informal learning.

Third, new technological solutions can provide encouragements for solving problems at workplace contexts. For example, it has been argued that from the perspective of experiential learning approaches, mobile devices may support workplace learning (e.g. real-time information retrieval and rapid access for note- or photo-taking may be helpful for developing vocational skills and expertise, Lai, Yang, Chen, Ho, & Chan, 2007). In addition, according to Brookshire, Lybarger, and Keane (2011) new workplace learning technologies may support workers (i) flexibility and control over their learning experience, (ii) create new possibilities to take extra time with more challenging material, (iii) provide a safer environment with less pressure than traditional workplace learning approaches, (iv) offer more flexibility to learn anytime and anywhere; and finally (v) give more adaptability for a variety of adults learning styles and needs. Despite these optimistic notions of technologies, in the following
we will discuss the critical point that the usage of latest technological tools in itself it does not guarantee successful problem solving in TRE settings.

Harteis and Billett (2013) claimed that experts recognise patterns in complex arrangements that enable them to better respond spontaneously in ways that novices would not be able to do during intuitive problem-solving situations. The crucial question is how VET adults with low problem-solving skills in TRE develop complex arrangements that enable them to respond quickly to problem-solving situations in their working life. Therefore, our fourth propose is that it is pivotal to create support for VET adults to respond to future problem-solving challenges. Previous research in educational contexts has focused on individual (Schank & Abelson, 1977) and collaboration (Kobbe, Weinberger, Dillenbourg, Harrer, Hämäläinen, Häkkinen, & Fischer, 2007; Fischer et. al., 2013) scripts as a successful instructional approach to support problem solving in TRE (Fischer, Kollar, Stegmann & Wecker, 2013; De Wever, Hämäläinen, Voet & Gielen, 2015; Hämäläinen & De Wever, 2013; Hämäläinen & Cattaneo, 2015). In short, scripts refer to culturally shared knowledge about the world that provides information, for example, about conditions and processes of problem-solving situations (Schank & Abelson, 1977). According to Kollar and colleagues (2006), scripts provide individuals with information about appropriate actions for given situations and help them better understand the situations in which they are involved. This aims to result in enhanced information processing and problem solving. In practice, scripts operate by sequencing activities and assigning roles to learners in order to enhance effective problem-solving processes in TREs, related to the thoughtful use of available resources and/or task division (for a detailed description of scripts, see a recent review by Fischer et. al., 2013). Despite these optimistic notions of scripting problem solving in TREs (e.g. Kollar, et. al., 2014; Gielen & De Wever, 2015), previous systematic, empirical research has dealt with workplace learning contexts to a much lesser extent than with other learning contexts. Therefore, we will propose that we need empirical research in scripting to the area of workplace learning.

The findings further highlight the needs for future studies. We found empirical evidence that there seems to be variations between 11 European countries. Therefore, future studies should address in more detail why there are differences between the countries (e.g. with a more qualitative approach). Furthermore, VET adults are a heterogeneous group and the needs can vary among professionals. We need several novel ways to support VET adults’ professional development. We have workers that will change occupations and complete different training programmes for different professions (see Bresnahan, Brynjolfsson, & Hitt, 2002; Crafts, 2004). Thus, empowered continuing education is needed. In addition, we will have to develop new ways of workplace learning for the workers who will stay at the same workplace, but their job descriptions change (Maclean & Wilson, 2009; Tuomi-Gröhn & Engeström, 2003). And finally, VET adults that can be identified as “at-risk” or “weak” performers may be in danger of exclusion from the labour market due insufficient skills and abilities they have. As previous studies have indicated that low levels of education and working experience are associated with an increased risk of labour market exclusion (Rosholm, 2001), special attention needs to be paid for developing new prospects VET adults’ lifelong, life wide and workplace learning.
An important implication of this study is that our results bring out new prospects about needs for lifelong, life wide and workplace learning. In particular, we found out that age, education in years, occupation, gender, as well as work-related and everyday life factors explain the variation in problem-solving skills. Our study shows that, at their best, accurate international large-scale data may be helpful for identifying starting points for future studies. Our findings (see, Hämäläinen, De Wever, Malin & Cincinnato, 2015) are in line with the notion that learning taking place at work, through work and for work (Tynjälä, 2013) may enhance problem-solving skills in TRE. Thus, the increasing popularity of technology-enhanced learning (TEL) at work calls for evidence-based practices that can guide future efforts in designing 'good' workplace learning approaches (Gegenfurtner, Quesada-Pallarès & Knogler, 2014). Previously, the beneficial effects of various workplace learning approaches have been discussed (i.e. computer-supported collaborative learning (CSCL) at work (e.g. Goggins & Jahnke, 2013; Krange, Moen, & Ludvigsen, 2012). Despite the researchers’ optimistic notions of TEL at work, in reality, successful workplace learning is rather hard to predict and identify. Our recent review article of TEL in the work context (Tynjälä, Häkkinen & Hämäläinen, 2014) indicates that there is a need for empirical evidence regarding how to enhance workers’ problem-solving skills in TREs. Currently, the emerging research challenges involve the future development of workplaces regarding technological and pedagogical development. In addition, future studies are needed to get insight into the challenges and opportunities that VET adults face in their work (e.g. how VET adults describe their current work and what kinds of the relationship emerge between their work and their professional identity).

ACKNOWLEDGEMENTS

This work was supported by the Academy of Finland under Grant number 292466 [the Multidisciplinary Research on Learning and Teaching profile of JYU].

REFERENCES


