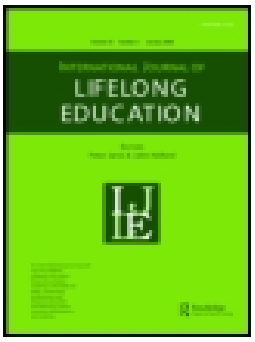

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ARTICLE

The developing field of workplace learning and the contribution of PIAAC

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ABSTRACT

There has been a prolific production of research papers on workplace learning (WPL) during the last two decades. Several reviews of the field discuss the development of themes, the use of foundational terms and some different models and frameworks have been developed. The purpose of this article is to analyse the recent development of the field of WPL, as presented in research literature, and to evaluate the potential of international survey data from the Programme for the International Assessment of Adult Competencies (PIAAC) to contribute to this development. Our study is organised in three stages. Firstly, we summarise the main topics and trends emerging from recent literature on WPL. Secondly, we analyse how peer-reviewed publications using data from the OECD PIAAC survey have contributed to WPL. Thirdly, we compare and discuss the different contributions and make some suggestions as to how PIAAC survey data might be used to further develop our understanding of WPL.

KEYWORDS
Workplace learning; PIAAC; skills; methodology

Introduction to workplace learning (WPL) as a field of research

The workplace is the locus of learning for many adults throughout their working career and thus WPL represents an integral and a substantive part of lifelong learning (LLL). An increasing amount of modern employment requires complex skills and mastery of new technologies, resulting in the need for a 'new emphasis on lifelong learning' (Edmonton & Saxberg, 2017). These skill-requirements are not static and, in a rapidly changing work environment, employers are having to find ways to develop their existing workforce, rather than rely on recruitment. In this context, a better understanding of WPL is becoming increasingly important.

Others outside academic research are also taking an interest in LLL and WPL, as can be seen in a recent report in The Economist on lifelong education (14.1.2017), which underlined the need to develop a new ecosystem of strong and continuous connections between education and employment, in new ways, throughout people's lives. 'The future of learning is not in the classroom. It's in the field – finding ways to do better while doing the work' (Edmonton & Saxberg, 2017). The OECD (2013a) has defined LLL as participation in a wide range of activities aimed at gaining a certificate, diploma, degree, etc., including distance and open education (formal learning) or on-the-job learning/training, seminars, workshops, private lessons, etc. as organised education or training (non-formal learning). Involving employees in formal and informal learning is now considered an important prerequisite for social inclusion as well as effective work performance

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(Cedefop, 2016). It is this convergence of interests between policy makers and researchers, which has inspired us to consider how we might develop knowledge and understanding on WPL by using available data in different ways. More specifically, we consider how data from the Programme for the International Assessment of Adult Competencies (PIAAC) survey might contribute to our understanding of WPL.

The purpose of this article is two-fold. Firstly we will map and analyse recent developments in the field of WPL, as presented in research literature. Secondly we will assess the potential of international survey data from the PIAAC by the OECD, to contribute to the development of WPL. PIAAC measures adults' proficiency in key information-processing skills – literacy, numeracy and problem solving in technology-rich environments and gathers information and data on how adults use their skills at work and beyond (www.oecd.org/skills/piaac/).

PIAAC, which collected data from 40 countries, is one of the largest studies, in depth and scope, of adult skills and competence and policy makers have high expectations for its use. For example, Jens Fischer-Kottenstede of the European Commission stated that

> First and foremost PIAAC shows that a lot, if not the most, lifelong learning takes place in the workplace by simply practicing and improving the skills. Thus, reasonably qualified jobs, in which people use their skills each and every day, are the best learning space. The best way of promoting skills development among adults is to provide and create these jobs. (Palmén, 2014)

In addition to the large volume of data, the method of gathering data in the homes of the interviewees makes it an interesting source of information on adult learning in general.

The article is structured into six sections. After the introduction, we describe the methodology for the two literature analyses. The third section describes the results from the analysis of trends in research on WPL. The PIAAC study is briefly introduced in the fourth section, highlighting the most relevant indicators for WPL. In the fifth section, we present findings relevant for WPL, based on the analysis of articles, which have used PIAAC data. The paper closes with a discussion on how research based on PIAAC data, has contributed to the field, and on the strengths and weaknesses, as well as on possible underutilised opportunities for advancement of the knowledge in the field.

Methodology

The study was carried out in three phases. Firstly, we analysed the main topics and trends emerging from the literature on WPL. We have reviewed publications in the field, the various types of contributions and the main research themes, which have emerged in recent years. The literature analysis was conducted as a meta-review, based on earlier reviews by other scholars, e.g. Fenwick (2006) and Tynjälä (2008), and three other collections of work on this theme by Malloch, Cairns, Evans, and O'Connor (2011), Rainbird, Fuller, and Munro (2004) and Billett (2002). Additionally, we carried out a search on the most read and most cited publications on WPL, and studied the themes published of major journals in this field, e.g. *Journal of Workplace Learning*. Analysis of this data resulted in a summary major themes, and some identifiable trends shaping this field.

In the second phase, we analysed the PIAAC papers on WPL. As the PIAAC data became available late 2013, related articles have been available starting from 2014. A literature search was carried out using 'PIAAC' as the search word, included in the title, abstract or as a key word. The search was carried out using the databases ISI Web of Science and EBSCO (several databases), resulting in 60 publications in peer-reviewed journals. Of these we selected those relevant to WPL, a total of seven peer-reviewed articles. The selection was based on reading and studying the abstracts.

In the third and final phase, we compared the identified topics and trends in WPL (phase 1) with the perspectives revealed by the analysis of studies based on the PIAAC data (phase 2). For this comparison, we developed in phase 1 a thematic framework based on the topics and trends in WPL identified.

We are aware of the limitations of using keyword searches and there may be academic publications based on PIAAC data which have not been revealed by our search methodology. However, we think that these articles provide interesting material with which to discuss the relevance of PIAAC data to our understanding of WPL.

Origins of the concept of WPL

Some of the early interest in learning in the workplace emerged around studies on work efficiency, which link learning-by-doing (or by doing repeatedly) to increased productivity (Arrow, 1962). This interest was further developed in the wake of discussions of the value of human capital (Boud & Garrick, 1999) and business managers became interested in the potential of investing in learning as a means of gaining competitive advantage. More recent studies have given prominence to informal learning and assume a relationship between learning and the way in which the workplace is organised. It has been suggested (Hager, 2011) that our understanding of WPL took a huge leap forward when theories of social learning were embraced, as seen in the work of Lave and Wenger (1991). This work raised interest in practice-based learning, learning-by-interacting in communities and ideas that learning can be shaped by the work being done and the way the workplace is organised.

As well as social learning, theories of emergence have been used to study WPL. Like social learning, the concept of emergence also assumes that learning is practice-based, but that knowledge or knowing is never stable and is continually changing. Sense is being made and remade, new identities are continually forming and changing and the balance of power is always shifting (Gherardi & Nicolini, 2006; Weick, 1995). This perspective has been used, among other things, to study the balance of power in the workplace and how this might affect opportunities of learning.

Developing our understanding of learning at work

All these different streams of research have resulted in a view of WPL as a combination of planned formal learning and informal learning occurring while working. This new understanding of WPL is summarised by O'Connor, Bronner, & Delaney (2007) as follows:

> This vocabulary [workplace learning] reflects the reality that we have shifted from being dispensers of basic skills and information to being educational experts and business partners whose work is to make sure that learners learn, and not just that training takes place… (p. x)…all about creating an environment where learning can flourish. (O'Connor, Bronner & Delaney, 2007, xii)

Some studies of WPL have resulted in new typologies or new models for understanding the phenomenon of WPL, such as Marsik and Watkins' (2001) model of informal learning, Illeris model for learning in working life (Illeris, 2004), Engeström's concept of expansive learning (Engeström, 2001) and a model for describing and analysing the learning environment at work (Ellström, Ekholm, & Ellström, 2008). In spite of all this productivity, there is not yet a consensus about the use of terminology (Fenwick, 2006).

As well as enriching our theoretical understanding of adult learning, many of the studies of learning in the workplace describe and discuss different forms of learning such as e-learning, coaching, collaborative learning and learning based on problem-solving, among others. These studies are too numerous and diverse to try to summarise here. Suffice to say that many of these studies are descriptive case studies based on interviews or observations in various workplaces.

Although the emphasis of studies within this field has been on social- or practice-based learning, many studies have focused on the learning content or the skills being learned. The latter frequently address how employers can encourage the development of certain skills, for example information and communication technology (ICT), numeracy, problem-solving skills and leadership.

How does the workplace affect learning?

All the studies reviewed relate to learning in the workplace. There is a strong emphasis on understanding the relationship between the workplace and the learning, which is going on. While WPL can be individual and self-directed (Straka, 1990), much of learning at work happens collectively, in dialog and collaboration with colleagues (e.g. Tikkanen, 2002). Different working contexts give employees different opportunities to learn, and not all work is conducive to learning (Skule & Reichborn, 2002). Firm size, industrial sector, strategy and management decisions may all affect opportunities for learning. Many larger employers, or employers who have many different locations, are often focused on how to share know-how, often documenting knowledge or building arenas for communicating and sharing knowledge. Some attempts have been made to develop frameworks for characterising different kinds of workplaces and assessing how they might affect learning. One of these is the expansive-restrictive continuum (Lee et al., 2004). Based on their studies of apprentices, Fuller and Unwin found that workplaces, which took a broad view of learning, not limited to skills directly relevant to the current situation, provided better long-term learning and more adaptable employees (see Table 1).

Another feature of the workplace, which is driving learning and continuous competence development are the tools and materials of work, such as machinery and technology. These can stimulate and support learning as employees start using new tools/machinery or new materials, and learn to operate and interact with new technology. Literature on socio-materiality and on man-machine interactions has investigated the role of technology in the workplace (Orlikowski, 2002).

The contributions of WPL

As well improving our understanding of employee learning and development and the fulfilment of employment goals, WPL is also of interest to researchers in other fields. Studies of innovation build on the concepts of learning and innovating at work (Lundvall, 2008). Innovation can occur as a result of an individual learning or a change or transformation of the workplace. Different types of workplace, characterised in terms of their levels of learning and problem solving (discretionary learning, lean, Taylorist and traditional forms), have also been linked to differences in national measures of innovation (Arundel, Lorenz, Lundvall, & Valeyre, 2007).

Some policy makers have also taken an interest in research on WPL, indeed much of the work on vocational education draws upon studies of WPL (Billett, 2001). Making education relevant and preparing young people for the workplace requires a knowledge of the workplace and many scholars view the transition from education to the workplace as a continuous learning trajectory.

Table 1. Characteristics of learning environments (based on Lee et al., 2004).

Expansive learning environment	Restrictive learning environment
Participation in multiple social entities inside and outside the workplace	Restricted participation in social entities inside and outside the workplace
Planned time off work, including time for reflection	Virtually all on the job; limited opportunities for reflection
Organisational recognition of, and support for, employees as learners	Lack of organisational recognition of, and support for, employees as learners
Teamwork valued	Rigid specialist roles
Managers as facilitators or workforce and individual development	Managers as controllers of workforce and individual development
Bottom-up approaches to innovation	Top-down approaches to innovation

We see this in the many studies (e.g. Jensen, 2007; Tikkanen, 2002) of how new recruits, fresh from education continue their learning at work. Management studies frequently draw upon findings from WPL, this applies particularly within the areas of organisational learning (Elkjaer & Wahlgren, 2005).

How has WPL been studied?

Since the change in focus from training to learning (O'Connor et al., 2007), there has been a need to develop a better understanding of the context of learning, including its breadth and complexity. Researchers have sought to understand the kind of situations, where learning is occurring. Data have been gathered from informants, who are not necessarily aware that they are learning. There has been a rapid expansion in use of case studies, interviews, observations and ethnographic studies, but there are also examples of use of mixed methods, combining surveys and interviews, as well as quasi-experimental studies. Moraes and Borges-Andrade (2015) call for developing better definitions of the field of WPL, and suggest further use of quasi-experimental design.

> Finally, from a methodological standpoint, this study showed the possibility of measuring workplace learning and the use of a longitudinal quasi-experimental design. Following what has been suggested by several authors, it has shown options for more comprehensive studies that may better define the phenomenon of workplace learning and identify its relationships with other variables. (ibid: 107)

During the last 10 years, some reviews of WPL have concluded that most studies are explorative, with the main focus on case studies and perhaps an overreliance on qualitative methods (Hetzner, Gartmeier, Heid, & Gruber, 2009). Other authors argue that learning related to work can only be truly understood if it is also studied by means of quantitative methods in addition to qualitative (Clarke, 2004; Marsick & Watkins, 2003).

Summary and future directions in WPL

Several reviews on WPL have been carried out, including meta-reviews. One of the studies is by Fenwick (2006), who finds that most empirical papers are case study based. There are few attempts at theory building (except within the cultural-historical activity theory). There is also limited dialogue between the different disciplines working on this theme (Tikkanen, 2005). However, Fenwick identifies similarities in research questions: understanding learning processes, knowledge generation, knowledge sharing, inhibitors and facilitation of these processes. She points out that most studies are still based on individual learning, in spite of the fact that work is normally a collaborative activity. Fenwick calls for a more critical approach in case studies with analysis of power in relation to WPL, since there is evidence of it in the many rich descriptions provided. Fenwick also identified a need for more interdisciplinary work, as well as more rigorous use of concept of learning. Table 2 summarises the main themes arising from the authors' review of the field.

Table 2. A summary of the main themes of studies on WPL (based on the authors' review).

Theme	Description
Developing our understanding of learning at work	(a) Developing learning theory: social learning, emergence, LLL (b) Studies of different forms of learning: e-learning, coaching, teamwork, LLL, problem-solving etc.
How does the workplace affect learning?	Descriptive studies on different aspects of the organisation or work processes. Development of frameworks of characteristics.
Empirical studies of learning in the workplace	(a) Qualitative methods and descriptive studies (b) Mixed methods
Contributions to:	
Policy	Knowledge economy, VET, social inclusion
Management studies	Organisational learning, human capital
Innovation studies	Studies relating working conditions or tasks to improve innovative performance

Some attempts have been made to predict future directions of WPL, such as the need to research the effects of the lack of permanence, workplaces changing ownership, being absorbed by larger firms, or closing down (Malloch et al., 2011). Technological change is predicted to contribute to deskilling of the existing workforce (Warhurst, Grugulis, & Keep 2004; Lee et al., 2004) as computers take over repetitive tasks and the need for new skills to work with these new technologies. Globalisation is expected to reduce the impact of national cultures on our workplaces. There are also expectations that employees should be mobile and able to function independently of the workplace context (Méda, 2016).

We will now look at the PIAAC survey and discuss its potential to improve our understanding of WPL.

PIAAC

The PIAAC surveys seek to provide valid and reliable estimates of the competency of the adult population in key information-processing skills (OECD, 2016a), by answering policy questions on (i) skills distribution, (ii) importance of skills and (iii) factors related to skills acquisition and decline (OECD, 2011). The PIAAC survey consists of three main elements: the background questionnaire, a module on skills use and a direct assessment of key information-processing skills in three fundamental domains, and reading components. A detailed description of the PIAAC background questionnaire and of the skills assessment is available in the report The Survey of Adult Skills – Reader's Companion (OECD, 2016a; – also, 2010).

The PIAAC survey has been carried out in three rounds. The first wave of data-collection took place in 2011–2012 in 24 countries in Europe, the Americas and Asia and the results were available at the end of 2013 (OECD, 2012). The second was carried out 2014–2015 in nine countries, while the third is expected to be completed in 2019. In total, around a quarter of million adults aged 16–65, have been surveyed, representing 815 million adults in the age group. The surveys were carried out in the official language(s) of the countries (OECD, 2017).

In the following, we shall briefly describe the key areas in both PIAAC components with relevance to WPL. This description aims to introduce the potential of PIAAC data to advance knowledge in the area of WPL.

PIAAC skills assessment

The three key information-processing skills assessed are literacy, numeracy and problem solving in technology-rich environments, representing 'cross-cutting cognitive skills that provide a foundation for effective and successful participation in the social and economic life of advanced economies' (OECD, 2012, 10). The background for development of these measures is the changing demand for skills in the workplace, especially related to development of ICT, as well as changes in the structure of employment.

In the area of literacy and numeracy PIAAC represents the third round of skills assessment by the OECD (the two previous were the International Adults Literacy Survey of 1994–1998 (IALS) and the Adult Literacy and Life Skills Survey of 2003–2006 (ALL)). Thus, it provides evidence on the current level and distribution of skills, but also on the change in the skills profiles over time. In the third area of skills relevant to the digital age – problem solving directly linked to the technology-rich environments, which characterise jobs with a high information-processing content – PIAAC provided the first assessment of its kind. The survey is carried out as a computer-based assessment, the background questionnaire being administered by an interviewer. Skills are measured on a 500-point scale, divided into six proficiency levels (OECD, 2012.)

PIAAC background questionnaire

While the measures of adults' proficiency in literacy, numeracy and problem solving in technology-rich environments provide information on the supply of these skills, the background questionnaire provides more contextual information and information on 'how skills are being used in modern workplaces and how the demand for different types of skills is evolving' (OECD, 2016a, 39). Besides general information and basic demographic characteristics of respondents, the background questionnaire covers a range of themes related to learning, skills and work: educational attainment and participation (incidence of formal training and various kinds of informal learning contributing to skill acquisition); labour force status, work history and employment; social outcomes; the use of literacy, numeracy and ICT skills at work and in everyday life; the use of a range of other skills (e.g. generic skills) at work, as well as the match between the respondents' skills and qualifications with their work requirements, and autonomy over key aspects of their work (OECD, 2011, 2016a).

When it comes to ICT, PIAAC data can be used to investigate the proficiency of the adult population using ICT for defined cognitive goals, such as extracting, interpreting, evaluating and analysing information, but also the incidence, frequency and type of use of ICT (OECD, 2016a).

PIAAC is not only about measuring skills, but also how these skills are used at work, a theme which has largely been ignored by earlier surveys, as well as skills maintenance and development. The participating countries were requested to adapt the questions to reflect national circumstances (OECD, 2016a), such as nationally specific institutional structures and national protocols for collecting data. We now provide more detailed information on the indicators used in PIAAC, which provide information relevant to WPL.

Information was gathered on tasks and activities at work related to technology (ICT skills), interaction (co-operation, influencing), learning (learning from others; learning-by-doing; keeping up to date with new products or services), organisation and planning (planning own activities; planning activities of others; organising own time), and physical requirements (working physically for long periods; use of fine motor skills) (OECD, 2016a, 40). When it comes to indicators of the use of skills at work, PIAAC asked questions about a range of generic skills, besides information-processing skills. The following is a list of skills and learning, with examples of relevant questions from the questionnaire:

- Task discretion skills (choosing or changing sequence of job tasks, the speed of work, working hours; choosing how to do the job). E.g. 'To what extent can you choose or change .. the sequence of your tasks? .. how you do your work? (not at all, very little, to some extent, to a very high extent)'.
- Learning at work (learning new things from supervisors or co-workers; learning-by-doing; keeping up to date with new products or services). E.g. 'In your own job, how often do you learn new work-related things from co-workers or supervisors? (Never, less than once a month, less than once a week but at least once a month, at least once a week but not every day, every day)'.
- Influencing skills (instructing, teaching or training people; making speeches or presentations; selling products or services; advising people; planning others' activities; persuading or influencing others; negotiating),
- Co-operative skills (with co-workers)
- Self-organising skills (organising time). E.g. 'How often does/did your job/last job usually involve ..planning your own activities? ..organising your own time? (Never, less than once a month, less than once a week but at least once a month, at least once a week but not every day, every day)'.
- physical skills (working physically for a long period),
- dexterity (using skill or accuracy with hands or fingers) (OECD, 2010, 2016a; 41).

Findings from PIAAC-based articles on WPL

In this section, we present our main observations from the analysis of PIAAC studies on WPL, and discuss the contributions of these papers to the field. Surprisingly, we found just a handful of studies with relevance to WPL: out of a total of 60 publications in peer-reviewed journals, based on PIAAC data, only 7 was related to WPL. The publications spread over a range of different peer-reviewed journals across countries: Cultura y Educación/Culture and Education, European Journal of Education, International Journal of Lifelong Education, International Journal of Comparative Sociology, Computers & Education and Numeracy at Work. The corresponding authors were based in Spain, Norway, Finland, Italy and Germany. Table 3 shows an overview of the seven peer-reviewed journal publications using PIAAC data. How the contributions of these publications have advanced our understanding of the field of WPL, will be explored in relation to the themes identified in our WPL review, to the extent they were relevant. To simplify the presentation, we have identified each article with an alphabetical character, as shown in table 3.

Developing our understanding of learning at work

The results of the analysis showed that the seven PIAAC-based publications provide only a limited contribution to our general understanding of learning at work. However, there are exceptions, paper B provides us with some interesting information on the extent of informal learning occurring the workplace and on conclusions about which workplace practices provide the best opportunities for informal learning. There are contributions to our understanding of LLL from papers A and D. The former is concentrated specifically on learning and using ICT, while the latter studies participation in job-related learning. Other PIAAC studies provided information about skills learned at work, such as numeracy, ICT and problem-solving.

How do different workplaces affect learning?

There are items in the PIAAC survey, which can be used to increase our understanding of various aspects of the workplace and its relationship with learning. Paper B used responses to questions on interacting with colleagues, such as sharing information and giving advice, to analyse the opportunities for informal learning at work. Informal learning was then related to the kind of work an employee has, such as management, and to other factors, such as business sector. Paper F on vocational education and training (VET) also provided new knowledge of learning in technology-rich workplaces, and how these workplaces might affect the development of problem-solving skills. Paper E on gender provided knowledge on who the learners in the workplace are, and investigated gender issues in relation to different national contexts. Paper D provided information

Table 3. Peer-reviewed journal publications using PIAAC survey data, June 2017.

ID	Author	Year	Title
A	Fernandez-de-Álava et al.	2016	Use of ICTs at work: an intergenerational analysis in Spain
B	Pineda-Herrero et al.	2017	PIAAC results on opportunities for informal learning in the workplace in Spain
C	Støren	2016	Factors that promote innovativeness and being an innovative learner at work – Results from PIAAC (comparison Norway, Sweden, Finland and the Netherlands)
D	Tikkanen and Nissinen	2016	Participation in job-related lifelong learning among well-educated employees in the Nordic countries
E	Damrich et al.	2015	Gender and job-related non-formal training: A comparison of 20 countries
F	Hämäläinen	2015	Education and working life: VET adults' problem-solving skills in technology-rich environments
G	Straesser	2015	'Numeracy at work': a discussion of terms and results from empirical studies (based on a review of earlier studies)

on the specific group of well-educated employees, and on how, among others, various job-related factors influence their participation in work-related LLL. Paper G on numeracy studies explored how numeracy skills are used and developed in the workplaces within different industrial sectors, whereas paper A analysed the different ways in which ICT is used in different workplaces. These two studies on practice-based learning could have linked the different practices with learning opportunities, but they did not explore this link. Papers C, D, E, F and G all made international comparisons and discussed how cross-national differences in working cultures or labour policies influenced learning at work.

Contributions of PIAAC

PIAAC data provides a great potential to explore the outcomes WPL in terms of information-processing skills, but also generic skills, and skills use at work. As PIAAC is a cross-sectional study, it is not possible to investigate skills development as a function of various work and work place-related factors. However, as mentioned earlier in this paper, in the areas of literacy and numeracy the OECD has carried out two earlier large surveys, IALS (1994–1998) and ALL (2003–2006), before PIAAC. This data makes it possible to explore change in the skills profiles over time (with different compositions of the population). Among the seven publications on studies on WPL in our data, none have used data from all the three surveys, nor exploited the possibility to explore change over time.

As expected, the PIAAC-based studies frequently examine skills. Specific analyses of the three basic skills and participation in job-related learning turned out to be rather common topics. Examples of these include country-specific and cross-country comparative studies. A country-specific study by Hämäläinen, De Wever, Malin, and Cincinnato (2015) in Finland, explored problem-solving skills in technology-rich environments among adults with VET. The study by Straesser (2015), which was not a country-specific one, explored the numeracy and its relationship to work, analysing specific forms and constrains of workplace-related numeracy. Three case studies were analysed, complemented by an analysis of the PIAAC survey. The three information-processing skills in PIAAC are all central skills in the modern workplace, but the literature on WPL so far did not dwell on skills types in the same way. In spite of the focus on skills, all the papers reviewed here, relate the development of these skills to various conditions in the local workplace or a broader national or international context. It is this connection between skills and the workplace, which makes these papers interesting contributions to WPL.

Contribution to policy

The studies on VET,gender or LLL all provide potential contributions to policy. Paper F on VET policies and paper D on LLL makes a potential contribution to social policy or to policies, designed to include or involve lager numbers of citizens in active employment. All the papers considering cross-national differences are potentially of interest to policy makers. For example, paper E by Dämmrich, Kosyakova, and Blossfeld (2015) on gender differences in participation in job-related non-formal training, comparing the situation in 20 countries, found that country-specific institutional settings, primarily family policies supporting women's employment, seemed to reduce gender differences in participation. The authors of these papers discussed the findings in relation to employment policies and national differences in employee protection and related this to the participation of women in the workforce. Paper C on innovation, suggested some changes, which might improve national levels of innovation.

Contribution to management studies

The studies on gender in paper E and ICT in paper A contribute to our knowledge on management. The study on gender by Dämmrich et al. (2015), which looked at factors influencing women's unequal economic treatment in jobs and employment, found that learning participation is gendered: compared to men women are less likely to participate in job-related, employer-financed training, but more likely to participate in non-employer sponsored (non-work-related or work-related) training. This kind of information can be useful to managers, who wish to improve skills development through learning participation or to find the appropriate forms of training for their employees. Paper B contributed to the awareness of informal learning in the workplace and made recommendations on how managers can increase opportunities for informal learning.

Contribution to innovation studies

Only one study, paper C used PIAAC data to explore innovation and factors that promote it in the context of workplace. This study built on some key concepts in this area, such as innovative workplaces and learning-by-doing, and used a number of factors to develop a concept of the innovative learner. Furthermore, the study contributed to the discussion on the relationship between the individual employee and the workplace, and comparing it across a selection of countries. Table 4 provides an summary of findings from PIAAC papers in relation to WPL themes. These few papers have provided data on most of the themes identified in Table 2. The contributions to our understanding of learning at work are largely related to different forms of learning, such as LLL and informal learning. Only one paper combines qualitative and quantitative methods, while all the others are quantitative. There are some important aspects of the PIAAC papers, which did not arise in our review of WPL, such as international comparisons, intergenerational comparisons and gender comparisons.

Discussion

The purpose of this study was to analyse the development of WPL as a field of research, and in particular, how the availability of the international PIAAC survey data by the OECD since the end of 2013 has stimulated this development through new studies. The PIAAC survey covers a range of questions relevant for WPL and skills development and skills use at work. We implemented the study in three phases, and summarise the main findings in the following accordingly.

In the first phase, we explored main trends emerging from the literature on WPL. The exploration of the abundance of publications in this field, several of them reviews, was structured into a number of themes: how to understand of learning at work, the effect of workplace variety on this learning, different methodology applied in these studies and how they have contributed to related research areas (management and innovation), as well as to policy development. Under all the themes, we identified a wide range of topics and perspectives, albeit less so with regard to

Table 4. Summary of findings from PIAAC papers in relation to WPL themes.

Theme	Description	Paper based on PIAAC data
Developing our understanding of learning at work	(a) Developing learning theory: social learning, emergence, LLL (b) Studies of different forms of learning: e-learning, coaching, teamwork, LLL, problem-solving etc.	B, A, D
The effect of the workplace on learning	Descriptive studies on different aspects of the organisation or work processes. Development of frameworks of characteristics.	B, F, D, E, F
Empirical studies of learning in the workplace	(a) Qualitative methods and descriptive studies (b) Mixed methods	G
Contributions to:		
Policy	Knowledge economy, VET, social inclusion	F,D,E,C
Management studies	Organisational learning, human capital	E, A
Innovation studies	Studies relating working conditions or tasks to improve innovative performance	C

research methodologies . Such a variety does not allow a simple overview, but we summarised the main themes and topics into a presentation in Table 2.

Secondly, we analysed peer-reviewed journal articles (available since 2014), in which the PIAAC data were used to investigate WPL and explored how PIAAC may have contributed to research on WPL. Rather surprisingly, out of a total of 60 articles found only 7 had could be related to WPL. The topics of these studies covered use of ICT, opportunities to informal learning, innovation and learning, participation in learning at work, problem-solving skills in technology-rich environments in relation to VET and numeracy at work. In the third phase, we compared the topics on WPL, identified in phase 1, with those revealed by analysing PIAAC-studies in phase 2. Some topics were naturally overlapping, as PIAAC includes a range of items related to learning and work. There are limitations to what we can conclude about how PIAAC has contributed to the field of WPL, because there are so few publications. However, we have identified two main contributions. The first is new knowledge on the relationship between the development of information-processing skills, in particular problem-solving, and technology-rich environments. Secondly, the availability of PIAAC data seems to have strengthened the international, comparative research perspective of WPL. Of the seven studies, four included data from several countries and comparisons across them.

The analysis of WPL revealed many overlapping themes with related research areas in PIAAC (e.g. human resources development, human resources management and innovation). This suggests, on the one hand, that research and theory on WPL is still fragmented (Tikkanen, 2005), and, on the other hand, that the independence of WPL as a distinct field of research is still uncertain.

In comparison to the review of studies on WPL, it seems that the PIAAC-based studies explore particular aspects of learning in the workplace in greater depth. They are more focused on the learner profiles and the contents of learning than on how learning occurs, particularly apparent in papers A, F and G. This suggests that new knowledge generated on the basis of PIAAC data, has a potential to advance our understanding of WPL by complementing the knowledge from studies using qualitative research methods. One advantage of the PIAAC data is that it makes it possible to explore the origins of different phenomena in relation to different institutional, socio-economical settings and welfare regimes. Indeed, most articles using PIAAC data make cross-national comparisons. This was also true to those seven on WPL. At best, international comparative knowledge, pinpointing similarities and differences in various aspects on WPL, between some countries but not necessarily others, can advance development of the field, by helping to understand the larger mechanisms in play behind policies and practice, locally and nationally, as evidenced by four of the seven articles (B, C, D and E).

The analysis carried out provides little evidence that researchers of WPL have been making use of the rich data provided by PIAAC since 2013. There is no systematic knowledge available and different factors may contribute to this situation. One factor could be the existence of different camps of researchers (Al-Gharbi, 2017) who adhere to either qualitative and quantitative research methods. There might also be more practical obstacles to the increased use of PIAAC data to study WPL. One may be the lack of funding of studies, which make it possible for researchers to dedicate time to analyse PIAAC data. To our knowledge, only the Research Council of Norway has provided a specific research grant, under the program *Research and Innovation in the Educational Sector* (FINNUT), particularly encouraging researchers to incorporate PIAAC data in their research proposals. Additionally, the Federal Ministry of Education and Research of Germany has provided funds for a concomitant study on LLL to German PIAAC survey. Another obstacle may be the limitations in methodological skills of researchers in education and social sciences in analysing large quantitative data. Making the most of the rich potential that the data provides to advance our knowledge of LLL and skills development, requires a very good command in quantitative methods from a researcher. Qualitative research has been mainstream in social and behavioural sciences for decades, albeit more so in Europe than in North-America, with the consequence that researchers' skills in quantitative research have eroded. This is very unfortunate, even paradoxical, as the amount of freely available large databases has been increasing in parallel.

We conclude that research on WPL would largely benefit from more methodological variety. In particular, researchers of WPL should consider the use of international survey data, such as PIAAC, as a supplement to more descriptive studies. By combining different methodological approaches, researchers would become better equipped to demonstrate that knowledge on WPL can be of real value to employers and employees, that it is relevant for policy makers and contributes to society outside the workplace.

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