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Editorial: Adult Learning, Adult Skills and Innovation

Richard Desjardins, Thomas Lans & Peer Ederer

A broader link between adult education and innovation has been highlighted by a number of scholars and analysts in recent years. Overall, a strong correlation can be observed at the country level between adult education activity as measured in the EU Adult Education Survey and innovation performance (CEDEFOP, 2012). Tellingly, this correlation is found to be stronger than that between the proportion of higher education graduates and innovation performance. One interpretation of these data is that tertiary education itself is not sufficient for innovation. That is, higher learning may need to be complemented with adult education, including training and workplace learning, in order for it to make a significant contribution to innovation. Moreover, innovation is not just something that highly-educated people do or something that happens only as a consequence of specialised researchers working in R&D departments. It involves workers across the skill spectrum.

The idea that continuous learning is part and parcel of innovation processes is intuitive. Yet, many policy makers, scholars, and practitioners, such as human resource managers fail to grasp the need to develop and nurture broad-based adult learning systems at the country, regional or organisational level. Is adult learning in all its forms strategically fostered to enable innovation? Can it be or should it be? It is easy to see that these questions have important implications for the EU agenda on innovation. Not least, innovation and entrepreneurship are considered to be key for the creation, development, growth and long-term survival of firms. European statistics are indicative here, as they show that 72% of the European companies have introduced at least one innovation in their company over the period 2012-2015. These innovations occur in a wide range of domains: new or significantly improved services (45%), goods (42%), organisational methods (38%), processes (32%) or marketing strategies (32%) (Innobarometer, 2015).

The topic of innovation and entrepreneurship is important because it is directly relevant for outcomes, such as a start-up or the introduction of a new product, process, practice or service. But scholars increasingly acknowledge that innovation is not just about outcomes, it involves processes of learning and communication. Yet, in practice, it continues to often be approached from a narrow perspective. Take, for instance, well-documented proxies for innovation, such as R&D investment and patent data. The notion behind these proxies is that innovation is a result of a linear process in which universities, research institutes and R&D departments are the core players. Knowledge is created by the research institutes and subsequently finds its way into new products and processes – the so-called Science, Technology and Innovation (STI) mode of innovation (Jensen *et al.*, 2007). Based on this view of innovation, one might conclude that the European food industry is not very innovative compared to other European manufacturing industries. However, this perspective neglects the fact that many innovative firms do not perform R&D and that a large proportion of innovations are not patented. The practice of patenting varies

widely according to sector, but this does not mean that innovation does not occur in sectors with fewer patents.

To illustrate the dynamics involved, recent research highlights the importance of interactions with suppliers, customers, stakeholders and other forms of multi-stakeholder processes and feedback from the market as key modes of innovation (Arundel *et al.*, 2007). This mode of innovation - the Doing, Using and Interacting (DUI) mode - is of particular importance in low and medium technology sectors (Arundel *et al.*, 2007) and in particular for Small and Medium-sized Enterprises (SMEs) (92% of all European enterprises have less than 10 employees). DUI emphasises the importance of learning and innovation for the whole workforce. It is not something that is exclusive for those active in R&D departments (Toner, 2011). Therefore, firms are increasingly looking for ways to encourage and foster innovative and entrepreneurial behaviour in their employees.

Several aspects related to innovation processes are thought to lead to success, including successful start-ups or the launch of new products (Reid & De Brentani, 2004). Some of these activities include problem finding, idea generation, information collection, joint problem-solving, idea screening and exploration (Ardichvili, Cardozo, & Ray, 2003). From a skill oriented perspective, these activities are closely connected to what is referred to as 21st century skills. It is not a coincidence that key competencies as identified in the European Reference Framework on Lifelong Learning include *sense of initiative and entrepreneurship* (EC, 2006).

As evidence mounts that such skills are subject to learning and development, it is easy to see that the level of commitment to learning that is espoused by organisations is likely to have consequences. Several researchers seem to agree that innovation and human capital are interdependent and reinforce each other (CEDEFOP, 2012; Lundvall & Lorentz, 2012). However, more in-depth interdisciplinary research is necessary, as this relationship seems to be more subtle than often claimed in research and policy reports (CEDEFOP, 2012; Toner, 2011). As Jones and Grimshaw (2012) stated, the conceptual interest in human capital in the innovation literature stays at a rather implicit, superficial level. To be sure, knowledge on learning for innovation and entrepreneurship remains highly fragmented. One reason for this is that it has been studied through different disciplinary and conceptual lenses (e.g. economics, management or psychology), as well as at different levels – individual, group, organisational, and even inter-organisational.

Disentangling the relationships between learning and innovation at different levels is not only relevant for those interested in adult learning, organisational learning, and human resource development, but also for those interested in formal education. For example, highly innovative companies indicate that the organised training of staff in innovation-related aspects such as sales and marketing would be the most important type of public support they could obtain (Innobarometer, 2015). Moreover, initial levels of formal education are increasingly expected to prepare students to self-direct their learning beyond formal education, including on their job. In all sorts of new configurations such as 'living labs', 'innovation labs' or 'hybrid learning configurations', new partnerships are emerging to address today's innovation challenges. These partnerships typically consist of knowledge producing centres, including (vocational) education institutions, businesses and other organisations that aim to develop innovative solutions. Thus, rather than being consumers of innovative knowledge at the end of the innovation cycle, students and teachers become active participants in the innovation process (Wals, Lans & Kupper, 2011).

This special issue has sought to broadly address the theme of adult learning, adult skills and innovation by collecting contributions which draw on analytical insights from a number of recent and ongoing cross-national research projects in Europe that revolve around this theme. These projects include the recent survey conducted under the auspices of the OECD, namely the Survey of Adult Skills (alternatively known as the Programme for the International Assessment of Adult Competencies – (PIAAC)), the EU-sponsored LLLightinEurope project, and the BRAIN (Barriers and drivers regarding adult education, skills acquisition and innovative activity) project sponsored by the Research Council of Norway.

In this Issue

Following the success of the Journal's inclusion of more personal reflection pieces (*thought pieces*) in Volume 50, which are written in a freer style and take whatever angle the author chooses in addressing an important but simple question, we have invited one short thought piece addressing the following question: *'what role, if any, does adult learning play in innovation?'* ***Stephan Vincent-Lancrin*** reflects on this question in a way that adds substantially to the issue by offering a broad overview of the relationship between adult learning and innovation. Importantly, he points out the 'reverse causality', namely that innovation itself necessitates adult learning in order to adjust to new ways of doing things or using new technologies.

The first article is by ***Edward Lorenz, Bengt-Aake Lundvall, Erika Kraemer-Mbula, and Palle Rasmussen*** who base their analysis on PIAAC data to address the relationship between forms of employee learning and work organisation, as well as the role of national systems of education and training. They emphasise the short-comings of a 'skill-deficit' type of thinking, which is still prominent in the policy debate. In highlighting the workplace as an important site for learning and developing expertise, their analysis points to some of the conditions under which national education and training systems can relate to a favourable environment for continuous learning and adaptation.

Moving towards the individual level, the article by ***Liv Anne Støren*** attempts to capture what it means to be innovative. Based on a selection of countries from the PIAAC database, she concludes that the likelihood of 'being an innovative strategic learner' at work is not just a matter of human capital in itself (e.g. education), but is also very much dependent on how work is organised, particularly in terms of flexibility and autonomy. Although from a different angle, namely that of entrepreneurial behaviour of employees, ***Yvette Baggen, Thomas Lans, Harm J. A. Biemans, Jarl Kampen, and Martin Mulder*** confirm the importance of innovative work behaviour at the individual level in their study of SMEs. In their analysis, they go one step further and illustrate that innovative work behaviour is in fact the most important predictor for translating ideas into new projects within companies.

Two other articles focus more on the question of how firms (can) actually foster learning that is connected to innovation. This brings the role of Human Resource Management (HRM) to the forefront. ***Dorothy Sutherland Olsen's*** study of large Norwegian firms illustrates the informal and unplanned nature of learning that is connected to innovation, but also the importance of learning from others within and outside the firm. ***Brandi and Iannone*** further structure the role of HRM by providing an overview of the literature and introducing a model in which they emphasise three aspects of learning strategies in high-performing enterprises.

These include skills development, learning systems and incentives, as well as work design and the organisation of work. They stress the importance of the latter in their analysis of the data they collected from a group of companies.

Finally, an important recurrent topic across all the articles which link learning, work (organisation) and innovation is complex problem-solving. The article by ***Peer Ederer, Alexander Patt, and Samuel Greiff*** delves deeper into the relevance of problem-solving for innovation and taps into a fundamental question: can complex problem-solving skills be developed?

Part II of this issue begins with an article by Jon Olaskoaga-Larrauri, Miren Barrenetxea-Ayesta, Antonio Cardona-Rodríguez, Juan José Mijangos-Del Campo and Marta Barandiaran-Galdós, Between Efficiency And Transformation: The Opinion Of Deans On The Meaning Of Quality In Higher Education.The literature on quality management at higher education institutions has for some time been working on the basis of two issues: a) the diversity of ideas as to what 'quality' means and b) the idea that this diversity is in some way a response to the different positions occupied by stakeholders in regard to the processes and institutions of the sector. It has been suggested that students, employers, administrations in charge of funding and academics may hold different positions concerning the purposes of universities and, therefore, concerning the criteria on which their quality should be assessed. However, those stakeholders have rarely been asked directly what concept of quality they defend. This article presents the results of a survey of deans of Spanish university faculties and schools in which this question was put to them. Their answers contrast with some of the commonplaces of current literature.

The second article, The road travelled in Europe towards the 2020 European objectives in Education. A Spanish perspective, by María Luz Martínez Seijo and Juan Carlos Torrego Seijo, analyses the facts and difficulties that influence the educational policy of the EU to reach agreements and the facts that define common work until the year 2020, mainly under the principle of subsidiarity or complementarity. It also discusses the way to work in the different administrative political systems of the EU countries. Another objective is to discuss the role that National Agencies have in the development of European programmes in the different administrative political systems.

The third article, International Influences on Post-Soviet Armenian Education by Shelley Terzian, constructs an analysis of the most recent international influences on Armenian education, illustrating how international standards are driving post-Soviet reform in the Armenian Secondary Schools.

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Innovation, Skills, and Adult Learning: two or three things we know about them

Stéphan Vincent-Lancrin

Innovation systems rely on a well-educated and well-trained workforce. Beyond the codification of knowledge that reflects innovation such as in patents, scientific journals or their embodiment in products and processes, the knowledge and know-how that spark innovation are embodied in people and in the ability of innovation systems to make their knowledge circulate and grow. Innovation surveys have consistently revealed that the lack of qualified personnel was one of the top three obstacles to innovation, closely following a lack of access to finance. Not surprisingly, innovation policies are nearly always found to emphasise the importance of human resources (OECD, 2015).

Public policies face three major skills-related questions: does the labour force have the adequate skills to fuel their current capacities to innovate, do firms and other organisations use available skills in an appropriate way, and do these entities foster the development of skills to fuel their next-generation innovation system?

What does this have to do with adult learning? While most people complete formal education in adolescence or early adulthood, learning continues as a lifelong process and is enhanced through formal training, non-formal learning as well as informal learning through experience. Skills evolve over people's lifetime as a consequence of learning and experience, thus a large share of innovation-related skills are developed beyond initial formal education.

Initial formal education plays an important role in developing skills for innovation (Scott & Vincent-Lancrin, 2014) – a role that is often overlooked as people often assume that innovation skills require exceptional talent or can only be achieved once a certain level of educational attainment is reached. However, we know that initial education is a good predictor of how much continued learning both in formal and non-formal contexts one can expect to get (OECD, 2013).

Policy makers who are specialised in innovation policy typically consider the following: 1) the quantity and quality of available scientists and engineers, including the lifelong learning policies to develop their capacity; 2) the quantity and quality of available entrepreneurs, and notably innovative entrepreneurs; and, 3) the quantity and quality of specialized researchers, since they contribute to R&D intensive innovation. Additionally, they consider some of the practices that lead to capacity development such as: international mobility, which is a key factor for scientists, researchers and other people to learn what is going on elsewhere, for example, to adopt or adapt foreign practices to their local contexts; inter-sectoral mobility such as between the private and public sector, or simply between different industrial sectors, for the same reasons, and often at a more moderate cost; and sometimes the fostering of gender, ethnic or national diversity as well as diverse disciplinary approaches, precisely to allow for more ideas to flow, or just to tap into untapped talent from neglected or discriminated "minorities" or other under-represented groups.

Such ideas and inclinations are appropriate even if they are not always easy to implement in practice. However, in this piece, I would like to recall the importance of having a broad approach to the fostering of learning and skill development in relation to innovation. While entrepreneurs, scientists, and highly-educated people matter for innovation, a much broader range of people are involved in the innovation process than we tend to acknowledge, and their opportunities for learning matter for innovation.

Innovation and Educational Attainment

In terms of qualifications, it is not just tertiary education graduates who contribute to innovation. There is substantial variation in the educational attainment, skills and occupation of workers engaged in innovation. This reflects the variety of activities and processes that firms across industries undertake when they innovate. Tertiary education graduates undoubtedly play a central role. More radical innovation requires high-level subject-based skills commonly associated with tertiary graduates. But people with vocational skills, like craft and testing also contribute to the innovation process, especially in the incremental changes that dominate innovation in practice. Non-university education such as vocational education and training helps to provide these essential capabilities (Toner, 2011).

But incremental innovation and development rely on a foundation of broadly distributed human resources and qualification levels. In particular, a large proportion of the generation, adaptation and diffusion of technical and organisational change involves important contributions from technicians and support staff. For example, trade and technical workforces underpin the generation, design, installation, commissioning, adaptation, maintenance and diffusion of new and existing technologies (Toner *et al.*, 2004). In this way, innovation in practice most often builds upon an organisation's current capabilities through tacit knowledge gained through 'learning by doing' or 'learning by using' across the range of the workforce.

Innovation and Field of Study

One way to assess the contribution of tertiary graduates from different fields to innovation lies in the likelihood that they have a highly innovative job five years after graduation. With my colleagues Avvisati and Jacotin, we analysed the international REFLEX and HEGESCO surveys, which cover 19 European countries and Japan. Tertiary education graduates were asked 5 years after graduation whether they worked in an organisation that innovates and if they participated in the introduction of these innovations: we define those answering the two questions positively as belonging to the 'highly innovative workforce' (Avvisati, Jacotin & Vincent-Lancrin, 2013; OECD, 2014).

A significant proportion of professionals with tertiary education degrees from all fields hold highly innovative jobs (Figure 1). Over 45% of tertiary graduates from any field participate in at least one type of innovation. This points to a more 'democratic' view of innovation, even when one focuses on tertiary education graduates.

Science and engineering graduates are more likely to participate in some form of innovation (over 60% of them do), but a significant percentage from other fields also have a highly innovative job – 55% for a tertiary education graduate on average and about 58% for arts and agriculture graduates. This contribution varies across

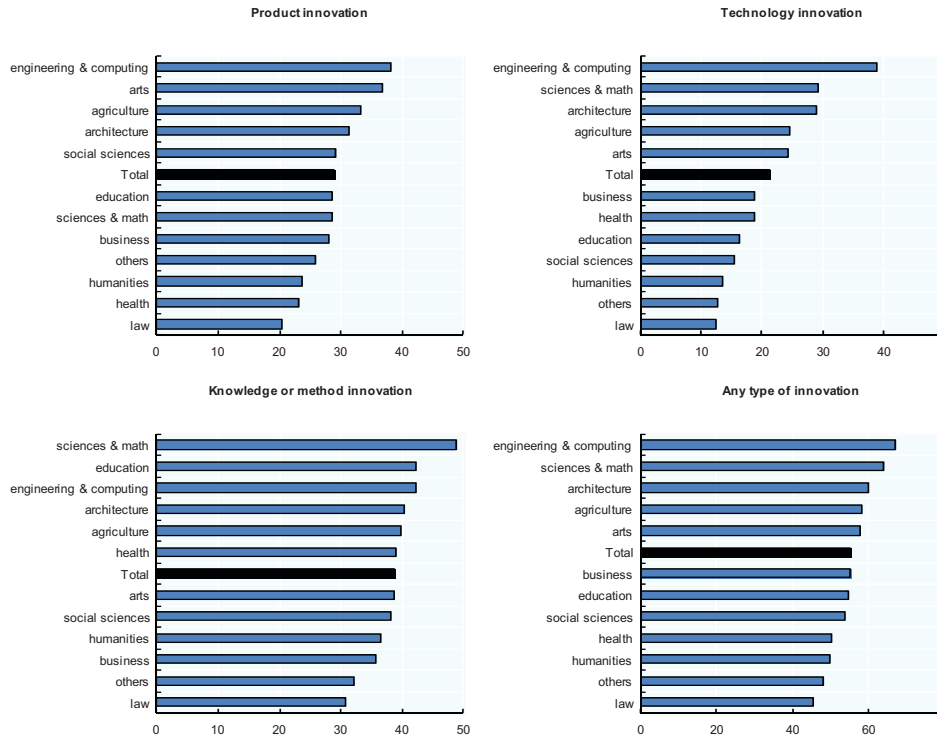

FIGURE 1. Percentage of tertiary graduates from specific fields having a highly innovative job
Source: Avvisati, Jacotin & Vincent-Lancrin (2013)

types of innovation: graduates in arts and in engineering have the same likelihood of participating in product innovation. In knowledge or method innovation, the differences across fields are relatively small, whereas they are much greater for technology innovation, in which engineers are significantly more likely to have a highly innovative job.

In terms of field of study, innovation policy makers often emphasise the importance of graduates in science, technology, engineering and mathematics (STEM) – and most innovation policies on skills development relate to encouraging STEM careers. While science and engineering fields are important, the contribution of different fields of study greatly depends on the type of innovation under consideration and on the sector of activity. The highly innovative workforce across different sectors comprises a varied mix of academic degrees.

Whereas Figure 1 told us who among graduates in a certain domain had ended up in an innovative job, Figures 2 and 3 look at those holding these innovative jobs and tell us about their field of study.

For example, in manufacturing industries, over 50% of tertiary-educated employees involved in innovation have an engineering (42.9%) and science (7.8%) degree (Figure 1). This proportion shrinks in business activities (including computer-related activities, research and development, consultancy and advertisement), where engineering graduates represent 20.9% of tertiary-educated

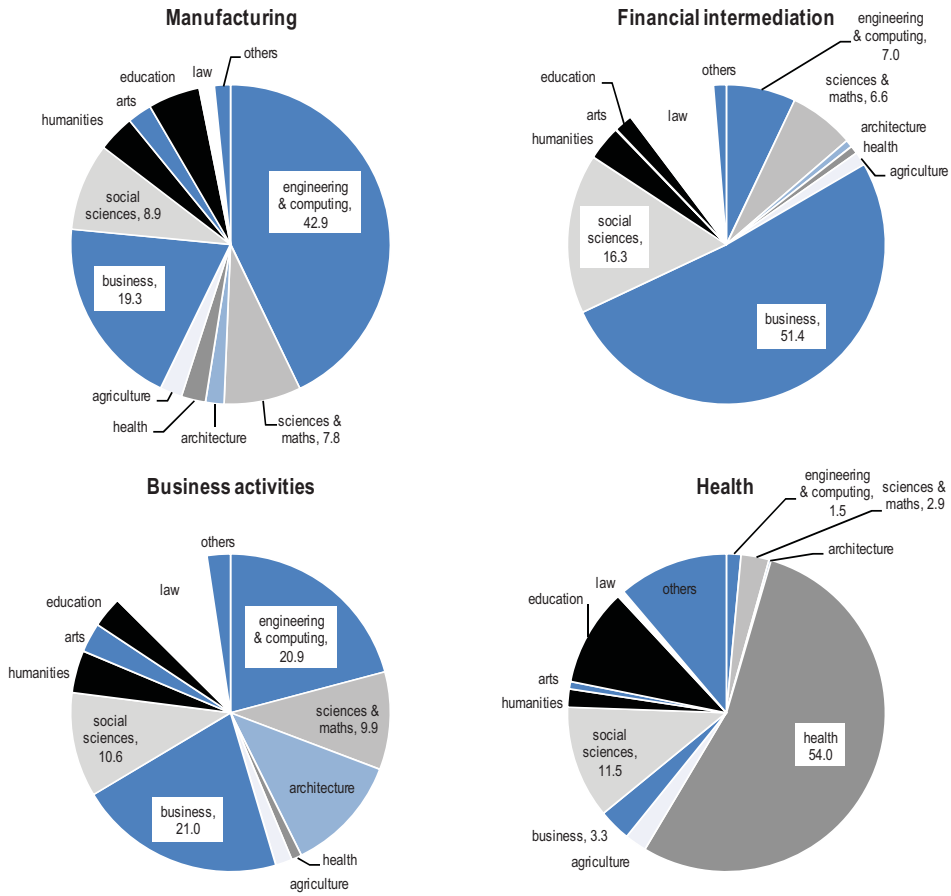

FIGURE 2. Field of study of the tertiary-educated innovative workforce, selected sectors of activity
Source: Avvisati, Jacotin & Vincent-Lancrin (2013)

employees involved in innovation and science graduates 9.9%; it is even smaller in finance, where the proportions are 7.0% and 6.6% respectively. In these service industries, the bulk of the highly innovative workforce is formed by business, social sciences, and law graduates.

The composition of the highly innovative workforce also varies by type of innovation (Figure 3). For example, engineering and computing graduates represent over a quarter (25.3%) of all graduates contributing to technology innovation (but only 13.5% of the total graduate workforce); they are also over-represented among graduates contributing to product innovation (18.3%), but only slightly over-represented among knowledge or methods innovators (14.9%). Science or maths graduates, who represent 6.7% of the graduate workforce, are over-represented among technology innovators (9.2%) and among knowledge innovators (8.4%), but not amongst product innovators (6.6%). This suggests that innovation often requires different disciplinary backgrounds (even though we do not really know with this study how the different disciplinary skills are used), and perhaps that

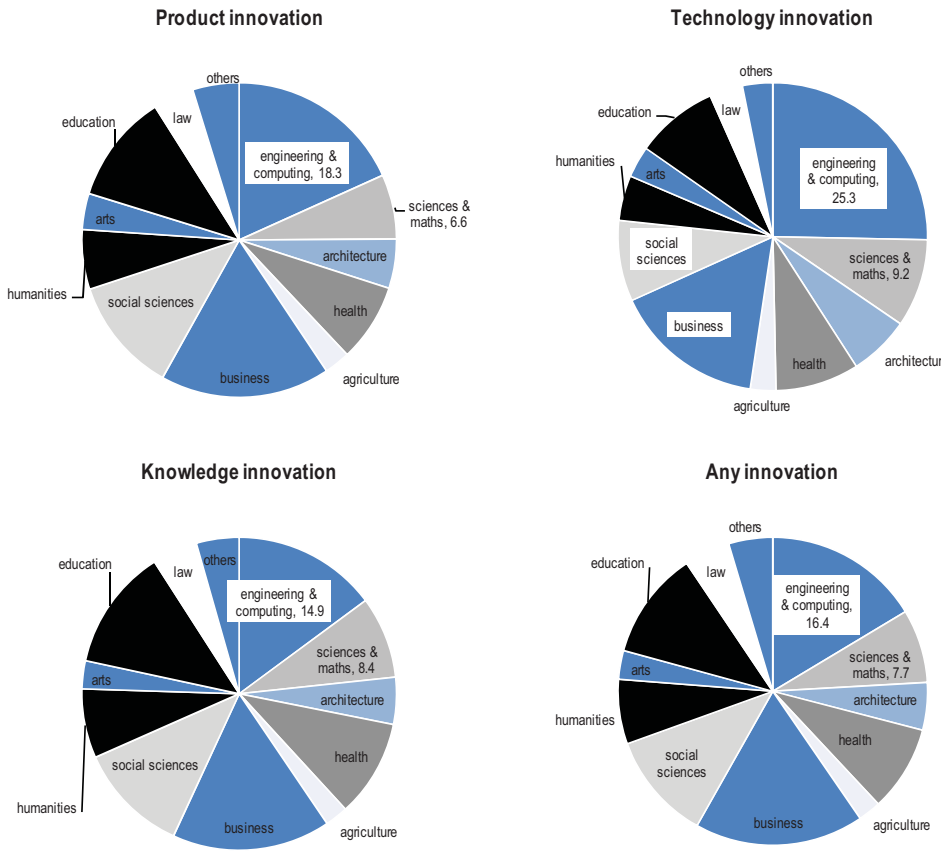

FIGURE 3. Field of study of the innovative workforce, by type of innovation
Tertiary-educated workers who contribute to their organisation's innovation activities face higher skill requirements than non-innovative graduates
Source: Avvisati, Jacotin & Vincent-Lancrin (2013)

innovation requires the interdisciplinary and diverse mix of skills that is often anecdotally highlighted in the innovation and managerial literature. Adult learning policies should in that respect not be restricted to personnel with any particular disciplinary background, but be expanded and accessible to a broader share of people. It is clearly not just those in formal 'innovation' positions (such as those working in an innovation or research and development unit) who should be trained or given the possibility to innovate.

Skills for Innovation

But what are the innovation-specific skills that people should learn and continue to develop to innovate? One way to identify these is to see which skills employees holding a 'highly innovative job' say they use as part of their job and compare with those who do not hold one. Figure 4 presents the odds that someone holding an innovative job reports a skill as very important in his-her job compared to someone in a 'non-innovative' job.

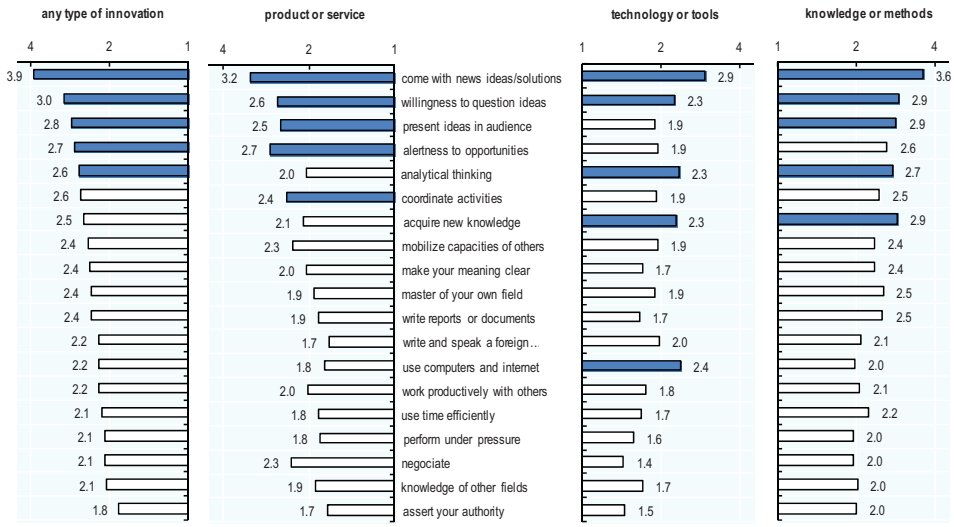

FIGURE 4. Critical skills for the most innovative jobs, by type of innovation
Source: Avvisati, Jacotin & Vincent-Lancrin (2013). Based on Reflex and Hegesco. Odds ratios correspond to the likelihood of mentioning the skill as required for workers in innovative jobs, compared to workers in non-innovative jobs. Generalised odds ratio are computed from logistic regressions controlling for country and sector of activity. The five most critical skills are highlighted in blue for each type of innovation.

The first interesting point is that people with an innovative job report that they use more of *all* types of skills in their jobs than their non-innovative counterparts. The 'critical' skills are also not the skills that people say are the most important in their job: for example, regardless of whether they hold an innovative job or not, they consider that 'using their time efficiently' is the most important skill in their job.

Now, to answer our initial question, amongst the results from the (self-reported) use of skills that distinguish innovative and non-innovative workers most are: creativity (coming up with new ideas and solutions), critical thinking (willingness to question ideas), communication (ability to present new ideas or products to an audience), opportunism (alertness to opportunities), analytical thinking, coordination, and learning (acquiring new knowledge) (Avvisati, Jacotin & Vincent-Lancrin, 2013).

This suggests that adults should learn but also have the space to use their creativity or their critical thinking if they are to contribute to the innovation process.

From Adult Learning to Innovation, and Vice-versa

An increasing literature shows the importance of adult learning for innovation, and in particular workplace learning. For example, Greenan and Lorenz demonstrate a strong association between the share of 'learning organisations' in a country and its innovation intensity (Greenan & Lorenz, 2010). One clear and plausible interpretation of this association is that there is a causal relation between learning organisations and innovation. Employees who have jobs organised according to the learning organisation model have more discretion, perform more complex tasks that are

non-routine and have more occasions to learn. It makes sense that they have more scope for innovation. Employees who have a job organised through a lean organisation model (high level of learning but routine), a taylorist model (not much learning and routine) or a simple model (not much learning but discretion) are much less involved in producing innovation, even though they may 'buy' their innovations from other organisations.

The research exploring the association between work organisation and innovation is important for several reasons. The first is that it emphasises that innovation is more pervasive than we often acknowledge, perhaps because we take manufacturing as our model sector for innovation.

The second reason is that it goes beyond the usual understanding of how innovation and adult learning are linked. Usually, the relationship between innovation and lifelong learning goes as follows: innovation implies "creative destruction" and when it happens to an activity, it will either require serious retraining or dismissals if the old ways of working/producing disappear. Innovation thus requires lifelong or adult learning so that one can adapt to the new technology or retrain to do another job. It is a way to adjust to the possibly negative effects of innovation. What the literature on learning organisations and innovation shows is different: adult learning is required for innovation to happen within a specific set of activities. This is a quite different story, with multiple implications. In sectors like education, where the employers are still largely a public authority, policy makers must provide opportunities for adult learning so that schools and teachers can innovate and improve education.

However, there is a third story that is generally overlooked: there is another direction to the causality. Another very plausible reason why innovation is associated with learning organisations is that it induces learning within organisations (and elsewhere). What happens when one introduces a new practice? Usually, people have to learn, to carry out their work in a less routine way, and to be provided with the space to do so. Innovation may also be a driver for learning organisations. After all, professional learning communities and communities of practice are often organised around an identified problem to solve. In education, this can be a new curriculum, the adoption of interactive whiteboards, etc. (Avvisati *et al.*, 2013). This relationship is also true for informal learning: whether formal training is available or not, there is usually at least a small amount of learning that follows innovation.

In that respect, in sectors such as education, where policy-makers often wonder how to incentivise teachers to have more professional development to improve their practices, especially when 'formal continuous training' is *de facto* a scarce resource, innovation should be seen as a possible driving factor of adult learning and professional development.

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DISCLAIMER

Stéphan Vincent-Lancrin is a Senior Analyst and Deputy Head of Division at the OECD Directorate for Education and Skills. The analyses given and the opinions expressed in this article are those of the author and do not necessarily reflect the views of the OECD and of its members.

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Work Organisation, Forms of Employee Learning and National Systems of Education and Training

Edward Lorenz, Bengt-Åke Lundvall, Erika Kraemer-Mbula
& Palle Rasmussen

Introduction

This article is situated at the crossroads of education studies and organisational theory, with an emphasis on knowledge-based approaches to the firm that focus on its capacity for learning and innovation. It establishes a link between the form of work organisation and style of employee learning at the work place on the one hand, and the characteristics of national education and training systems on the other. In particular, we show that forms of work organisation characterised by relatively high levels of employee discretion and learning are more likely to be adopted in nations with broad-based systems of education and training that recognise the value of both academic and vocational training and provide ample opportunities for adult education. Furthermore, we show that employees with low levels of formal education have better access to jobs offering organisational learning in countries with more developed adult education systems. The emphasis on workplace learning in this article reflects our dissatisfaction with the way knowledge and skills development are addressed in much of the policy literature on skills use in relation to national educational and training systems. While policy makers increasingly recognise that skills are acquired in a variety of settings beyond formal initial education, including at the workplace (Cedefop, 2015; OECD, 2013, European Commission, 2005 and 2010), there remains a strong static emphasis on identifying skills gaps and skills mismatches. Prescriptions derived from such static views tend to propose changes to the formal education and training systems to eliminate skills deficiencies. In EU education policy, this emphasis seems to have been reinforced by the recent economic crisis (Rasmussen, 2014). We see two important limitations to this.

First, it fails to give adequate recognition to the importance of tacit knowledge acquired through daily work experience and problem-solving as foundations for expertise. While expertise may depend on domain-specific knowledge acquired through formal education and training, as Lam and Lundvall (2006) have argued, the tacit knowledge underlying employees' capacity to solve problems on the job will be generated through interaction, experimentation and trial and error. This organic sort of knowledge is broad-based and varied, rather than confined to conventional academic specialisations (Winch, 2010) and it is acquired largely through work experience. The point was made some time ago by Penrose (1959) in her classic distinction between those firm's 'resources' that can be purchased on the market and the firm's 'productive services', the real inputs to production, that can only be developed on the basis of working experience and team-based learning at the workplace.[1] This argument implies an inevitable gap between the skills and knowledge that recently-graduated employees brings with them to the labour market and the core skills and competences that are central to the firm's competitive performance.

A second limitation of the mainstream policy discourse is closely related to the first. If daily work experience is central to the acquisition of tacit knowledge, then there is a need to consider how the organisation of work and the characteristics of jobs affect employee learning and skills development. Work activity that is organised hierarchically around detailed tasks will tend to generate narrow skills and a limited capacity for autonomous problem-solving. More decentralised and interactive forms of work organisation offering greater scope for exploring novel solutions to problems encountered will support the development and sharing of tacit knowledge as a basis for organisational competences. This is a central point made in a large literature of the knowledge-based firm and on 'learning organisations' (Jensen. *et al.*, 2007; Nielsen & Rasmussen, 2011; OECD, 2010 for an overview). It implies a need to go beyond static considerations of adapting formal education and training systems to the changing skills needs of firms to a dynamic focus on developing organisational designs with a capacity for continuous learning and adaptation.

In some of our previous work, we focused on the importance of work organisation and styles of employee learning for both enterprise and employee outcomes. In Jensen *et al.* (2007), on the basis of Danish data, we demonstrated that even in technological contexts where the acquisition of 'global' codified knowledge is central to competitive performance, firms that combine this form of learning with strong forms of organisational learning involving skills development on the basis of doing, using and interacting were significantly more innovative. In Arundel *et al.* (2007), we provided evidence that in nations where work is organised to support high levels of discretion in solving complex problems, firms tended to be more active in terms of innovations developed through their in-house creative efforts. In Lorenz, Lundvall and Valeyre (2004) and in the context of a larger project commissioned by the European Foundation for the Improvement of Living and Working Conditions (Valeyre *et al*, 2009), the issue of employee outcomes was addressed. This research provided evidence that employees experienced large benefits from being engaged in the discretionary leaning forms as opposed to forms of work organisation offering lower discretion and fewer learning opportunities. Forms of work organisation involving more discretionary learning were associated with more highly-perceived intrinsic rewards from work, better psychological working conditions related to HRM policies and social integration at work, as well as greater employee satisfaction with work conditions.

These results concerning enterprise and employee outcomes form the backdrop to this article which focuses on the diffusion of and employee access to different forms of work organisation. We use a multi-level framework to explore the way both individual employee characteristics and the characteristics of national education and training systems impact on the likelihood of employees having access to different forms of work organisation in 17 European nations. We draw on a unique internationally-harmonised data set resulting from the first wave of the Programme for International Assessment of Adult Competencies (PIAAC). The survey contains both measures of worker proficiency in numeracy and literacy based on formal assessments and measures of a number of generic features of the employees' tasks and job, including the amount of learning and problem-solving activity and the level of autonomy exercised in work. We use the generic work organisation measures to develop a three-way taxonomy of forms of work organisation and show how the frequency of the forms varies according to sector, occupation, establishment size and country. We then turn to the predictors of the form of work organisation at both the employee and country level. For country-level variables, we draw on the

harmonised aggregate measures available on Eurostat's website in order to capture differences in the characteristics of national education and training systems. Next we develop an interaction analysis in order to explore how these national differences interact with such employee characteristics as the level of initial formal education to affect the employee's access to forms of work organisation combining learning and discretion. We conclude with a discussion of the policy implications.

Mapping Forms of Work Organisation and Employee Learning across Europe

In order to map various forms of work organisation covering a number of European nations we draw on the results from the first wave of the Programme for International Assessment of Adult Competencies (PIAAC), an internationally-harmonised employee-level survey targeting the adult population in selected OECD and non-OECD countries. Our analysis focuses on the 17 European nations included in the first round.[2] The survey was designed to make direct assessments of adult skills in the domains of literacy, numeracy, and problem-solving in technologically-rich environments. It also included a Background Questionnaire (BQ) with a Job Requirements Approach (JRA) module designed to measure the 'generic skills' employees use in work, based on questions asking them about the characteristics of their jobs and the tasks they perform. We use the responses to develop a three-way taxonomy of forms of work organisation and employee learning.

The taxonomy draws on a methodology developed by Lorenz and Valeyre (2005) and is based on a factor and cluster analysis using 7 binary variables derived from employee responses to the BQ. The variables capture differences among workers across three main dimensions: the cognitive dimension of learning and problem-solving; the extent of autonomy or discretion exercised by employees in their daily work; and the extent of co-operation and knowledge exchange amongst employees within the organisation. Although the BQ is limited by the lack of questions measuring specific managerial practices such as quality circles or job rotation, the cognitive and interactive dimensions of work activity can be related to the differences in organisational design identified by such authors as Burns and Stalker (1961), Mintzberg (1979) and Lam (2000). The organisation design literature is a useful reference because it examines the relationship of work organisation to the enterprise's structure and in this way identifies the dominant forms of work organisation that an empirical analysis could hope to identify. In particular, it examines the relationship between the mechanisms used to coordinate the work divided in different ways horizontally and vertically and such features of work organisation as the degree of job specialisation, the amount of learning and adaptation needed, and employees' use of exercise discretion or autonomy in work.

The organic kind of organisation that Mintzberg (1979) refers to as an 'adhocracy' is characterised by the importance of employee involvement in the design of work activity, as well as by employees' responsibility for planning and carrying out their tasks. Three variables from PIAAC are used to capture these features of work organisation: (1) control over how the work is carried out; (2) control over the sequence of tasks; and (3) employee responsibility for planning work activities. Learning activities are described through three variables indicating whether or not employees learn from the task performed and whether they are involved in complex and simple problem-solving. Simple problem-solving is defined as problems that

TABLE I. Forms of Work Organisation

Variables	Percent of employees by work organisation cluster reporting each variable (weighted proportions)			
	Discretionary learning	**Constrained learning**	**Simple**	**Average**
Control over work methods	89.8	13.7	27.3	49.6
Control over pace of work	82.1	6.9	34.8	46.3
Planning your own activities	77.2	8.1	20.1	49.7
Learning from co-workers	52.7	52.7	22.6	44.5
Complex problem-solving activity	55.6	45.5	2.2	38.0
Simple problem-solving activity	88.7	93.5	15.5	70.3
Sharing information with co-workers	94.6	97.2	60.3	86.1
All sample	42.3	30.6	27.1	100.0

Source: Based on results of the first wave of PIAAC

require up to 5 minutes to think of a solution, whereas for complex problems at least 30 minutes are required. The extent and nature of learning activity can be linked to the degree of standardisation of work and skills and the amount of discretion employees exercise over their work. Hierarchical forms of work organisation based on the standardisation of tasks will provide less scope for learning and creative use of one's ideas. The degree of horizontal communication and interactive learning are captured by two variables: whether or not employees share information with co-workers; and whether or not they learn from co-workers. The sharing of information with co-workers can be seen as an indicator of the soft forms of coordination that Mintzberg (1979) refers to as 'mutual adjustment'.

The last column of Table I presents the frequencies of the 7 binary variables for the entire sample of 24,787 adult employees working in establishments with 10 or more employees in both the private sector manufacturing and service establishments in the 17 European nations. Columns 2, 3 and 4 present the results of the factor and cluster analysis identifying the three groups or classes of work organisation and employee learning.[3] We refer to these as the discretionary learning (DL), constrained learning and the simple or traditional forms of work organisation.

The DL class accounting for about 42% of the employees is characterised by the combination of high levels of discretion and learning and problem-solving. For example, the figures show that about 90% of the employees grouped in the discretionary learning forms exercise control over their work methods, a considerably higher percentage than for employees grouped in the other two forms of work organisation. Employees in this class typically plan their work activities. Information sharing is above average for the population as a whole, whilst cooperating with co-workers is at average levels. The forms of work organisation in this cluster correspond rather closely to those found in adhocracies and are due to the combined importance of work discretion, problem-solving and interactive learning.

Work organisation in the second class, which accounts for a little less than 31% of the population, shows similar levels of employee knowledge sharing and problem-solving. Problem-solving is also at a high level, with a bias towards relatively simple problem-solving. The greater difference between the two clusters concerns the degree of discretion exercised in work. It is relatively low in the second cluster. Only about 14% of employees exercise control over their work methods

TABLE II. Forms of work organisation by occupational category

%	Discretionary learning	Constrained learning	Simple	Total
Managers	72.18	21.2	6.62	100.0
Professionals	60.71	26.5	12.79	100.0
Technicians	55.42	31.82	12.75	100.0
Clerical Support Workers	44.15	32.09	23.77	100.0
Service and Sales Workers	32.83	34.69	32.48	100.0
Skilled Agriculture, Forestry and Fishery Workers	38.55	16.37	45.08	100.0
Craft and Related Trades	35.44	33.77	30.79	100.0
Plant and Machinery Operators	23.84	33.01	43.15	100.0
Elementary Trades	18.96	26.59	54.45	100.0
All sample	42.3	30.6	27.1	100.0

Source: Based on results of the first wave of PIAAC

and only about 8% are involved in planning their work activities. This points to a more structured or constrained form of learning and problem-solving embedded in a relatively hierarchical organisation of work activity with limited opportunities for using one's ideas or for exploring novel solutions to the problems encountered. In other research, we have argued that this this constrained form of learning tends to be characteristic of the 'lean' forms of work organisation, where team learning is embedded in a hierarchical organisational structure with work pace constrained by the use of quantitative production targets and learning objectives set by management (Arundel *et al.*, 2007).

In the third class, all the variables are under-represented compared to the population average. Cognitive demands are very low with only 2.2% of employees reporting that they engage in complex problem-solving. Discretion concerns only about a third of the employees. Information sharing is the lowest across the three classes. This class is likely to capture relatively informal or simple forms of work organisation found, for example, in personal services, restaurants and food services, or in small retail shops. It is referred to as the 'simple or traditional' form.

The figures in Table II show considerable variation in the frequencies of the three forms according to occupational category. As to be expected, the DL forms are over-represented amongst managers, professionals and technicians. They are slightly over-represented amongst clerical and support staff, but underrepresented amongst the remaining occupational groups. The constrained forms are relatively more characteristic of service and sales workers and the skilled and semi-skilled manual trades. The simple forms are relatively frequent amongst skilled agriculture, forestry and fishery workers, semi-skilled plant operators and especially the elementary trades.

The frequencies of the three forms of work organisation also vary considerably according to broad sector of activity. The DL forms range from about 58% in such knowledge-intensive business services as information and communication services and professional, scientific and technical services, to about 30% in transport and storage and in accommodation and food service. The constrained learning forms are somewhat over-represented in construction, transport and storage, and in finance and insurance at 34.3% and 35.8% respectively. The lowest frequencies of the DL forms occur in the water supply sector (20%) and in real estate

TABLE III. Forms of work organisation by nation

%	Discretionary learning	Constrained learning	Simple	Total
Sweden	59.92	23.01	17.07	100.0
Finland	59.75	16.46	23.78	100.0
Denmark	55.53	23.02	21.45	100.0
Norway	55.25	24.06	20.7	100.0
Czech Republic	53.35	23.52	23.13	100.0
Austria	52.60	21.32	26.09	100.0
Belgium	51.27	19.99	28.74	100.0
Estonia	45.84	27.18	26.98	100.0
Germany	45.45	28.2	26.35	100.0
Netherlands	42.24	25.81	31.95	100.0
Poland	41.88	23.01	35.11	100.0
UK	38.64	38.08	23.28	100.0
Spain	37.30	36.11	26.59	100.0
France	36.44	34.83	28.73	100.0
Italy	35.38	34.18	30.44	100.0
Ireland	32.44	43.76	23.8	100.0
Slovak Republic	28.24	45.53	26.23	100.0
Slovak Republic	28.24	45.53	26.23	100.0
All sample	42.3	30.6	27.1	100.0

Source: Based on results of the first wave of PIAAC

(21.8%).The frequencies of the simple forms range from 43.6% in agriculture, forestry and fishing to about 17% in both professional, scientific and technical services and in the mining and quarrying sector.

Concerning the size of the establishment, the frequency of the DL forms tends to increase with size, ranging from about 40% in small establishments with between 11 and 50 employees to about 49% in establishments with over 1000 employees. The opposite trend is true for the simple forms, which decrease in frequency from about 30% in the small establishment size category to about 20% in the over 1000 employee category. There is little variation in the frequency of the constrained learning forms according to the size of the establishment.

Table III shows important differences in the frequencies of the three forms across nations. As in our previous comparative work (Lorenz & Valeyre, 2005; Arundel *et al.*, 2007), the results show relatively high frequencies of the DL forms in the Nordic countries, with approximately 60% of employees grouped in the DL class in Sweden and Finland and about 55% in Denmark and Norway. The lowest frequencies of the DL forms are found in Southern Europe, Slovakia, Ireland and to a lesser extent the UK. Symmetrically, the constrained learning forms tend to be less frequent in the Nordic nations and relatively frequent in Spain, Italy, France, Ireland, the Slovak Republic and the UK. The simple forms also tend to be under-represented in the Nordic countries. They are over-represented in Poland, The Netherlands and to a lesser extent Italy.

Accounting for Access to Learning at the Workplace: the role of national systems

Much of the policy discussion around the relation of national education systems and skills development at the workplace is in terms of identifying skills shortages

and adapting education and training curriculum to respond to skills obsolescence and skills gaps (World Economic Forum, 2014; Edge Foundation, 2014). On this account, national systems impact on skills development at the workplace mainly by shaping the supply of skills which employees carry with them on the labour market. National systems, however, may vary in terms of the balance between formal academic education emphasising the acquisition of codified and scientific knowledge and vocational training designed to provide practical and intermediate level technical skills. Another dimension on which national systems differ is the degree of commitment to lifelong learning opportunities which may provide 'second chance' opportunities for employees penalised by relatively low levels of formal initial education or by weak foundation skills.

From a sociology of work perspective, it can be argued that the impact of these characteristics of national educational and training systems goes beyond the question of the supply of skills and has implications for the form of interaction and learning at the workplace. The classic study in this perspective is Maurice *et al.* (1986) who compared the interrelations between work organisation and national education systems in France and Germany. A central point was that the two systems promoted a different conception of professionalism and expertise, with a relatively high value placed on formal and codified knowledge in the French context compared to the German case where greater value was placed on practical knowledge and intermediate skills acquired in part on the job through the system of dual apprenticeship. These differences were reflected in more marked hierarchical divisions between the 'élite' holders of formal academic qualifications and the workers on the shop floor in France as compared to Germany, where the greater social recognition and value attributed to practical knowledge and skills contributed to a relatively decentralised form of work organisation, with skilled workers exercising considerable autonomy in carrying out daily tasks (for an earlier analysis along the same lines, see Lutz, 1976).

Differences in notions of professionalism and of the relative value attached to theoretical versus practical knowledge are difficult to capture through surveys. However, as Lam (2000) has argued, these differences in the formalisation of expertise tend to be associated with differences in the academic bias of the education and training system. Broadly speaking, national systems which place high value on formal academic knowledge and give little social status or recognition to the value of practical skills tend to have relatively weak systems of vocational training. This results in a lack of, or weak development of, intermediate skills and qualifications for most workers and tends to reinforce the use of more hierarchical forms of work organisation that are adapted to the uneven spread of skills and competences within the firm. In the econometric analysis that follows, we attempt to capture differences in this respect by comparing the importance of extended school-based initial vocational training systems. We focus on the number of students enrolled at the upper secondary level in vocational educational programmes as a share of all students enrolled in both general and vocational programmes at this level.

Although Lam's (2000) discussion focused on the characteristics of the initial education and training system, we would argue that having a well-developed system of lifelong learning is an equally integral part of a broad-based system of education and training. First, a large part of the education and training in which adults engage is sponsored by the employer and is vocational in nature. Hence, a strong commitment to lifelong learning reflects the value that a nation places on broad-based and

TABLE IV. Country-level Covariates

Nation	LLL	IVTSCND	TERT
Austria	14.1	70.2	20.7
Belgium	7.4	60.2	43.8
Czech Republic	13.3	73.8	22.6
Germany	7.9	47.5	26.1
Denmark	32.8	43.3	37.6
Estonia	13.5	34.4	38.2
Spain	10.8	33.5	40.3
Finland	25.8	70.1	39.2
France	5.8	43.0	42.7
Ireland	6.2	1.5	48.3
Italy	5.4	59.4	20.8
Netherlands	18.3	54.4	40.3
Norway	19.1	51.9	45.0
Poland	5.1	48.7	37.1
Sweden	23.8	46.9	42.3
Slovakia	4.3	68.1	24.0
UK	17.4	43.8	41.6

Source: Eurostat

practical skills and may be seen as complementary to an emphasis on extended school-based initial vocational training. While adult educational activities may be described as formal in the sense of being directed and purposeful, most take place outside the formal academic system that confers degrees that are recognised by the relevant national education authorities. Providers include employers, employers' associations, trade unions and equipment providers (European Commission/EACEA/Eurydice, 2015). These opportunities for adult learning are important in terms of acquiring and upgrading skills that are valued by employers and can contribute to the diversity of the enterprise's knowledge base. Secondly, lifelong learning systems have broader goals, including remedial training in literacy and numeracy for adults with weak foundation skills. In this respect, they are inclusive because they offer those with low levels of initial education a second chance for developing valued skills.

Country-level covariates

In order to assess the effects of differences between national education and training systems, we drew on three indicators that can be downloaded from Eurostat's electronic webpage. The indicator of lifelong learning (LLL) is calculated as the annual averages of quarterly EU Labour Force Survey data (EU-LFS) and refers to the share of adult employees between the ages of 25-64 who participate in some form of training or education during the 4 weeks prior to the survey. Lifelong learning encompasses all learning activities undertaken after the end of initial education to improve knowledge, skills and competences. The intention to learn is the critical point that distinguishes these activities from non-learning activities, such as cultural or sporting activities. The indicator includes 'formal' and 'non-formal' education and training. Formal education and training is taken to mean education that is institutionalised and planned through the public organisations and recognised private bodies that are primarily involved in conferring degrees and certificates for

TABLE V. Correlations and descriptive statistics

	mean	std dev	LLL	IVTSCND	TERT
LLL	13.59	8.33	1.00		
IVTSCND	50.04	17.57	.12	1.00	
TERT	35.92	9.19	.25	−.62	1.00

completion of initial education. Some vocational and adult education activities leading to degrees or certificates take place in the formal system. Non-formal education and training refers to activities outside the 'formal' education system, both within and outside educational institutions, and covers programmes that impart adult literacy, life-skills, work-skills, and general culture. Most adult participation in education activities occurs in the 'non-formal' system and, although often pursued to develop job-related skills, is not related to acquiring degrees or certificates recognised by the 'formal' system. Adult participation in lifelong learning, then, provides a broad measure of skills development in a nation, including, but going beyond, job-related skills and competences, whether recognised or not by the formal degree conferring system. The figures in Table IV show that the share of adult employees participating in LLL in 2011 ranges from 32.8% in Denmark to 4.3% in Slovakia.

The measure of extended school-based initial vocational education (IVTSCND) is derived from figures collected through the UNESCO/OECD/EUROSTAT data on educational statistics. Our measure is the vocational educational share of all pupils enrolled in upper secondary level education in both public and private institutions. The figures include combined school- and work-based programmes such as dual system apprenticeship. The figures in Table IV show that the vocational share in 2013 varies from 73.6% in the Czech Republic to 1.5% in Ireland.[4]

We also included a measure of the level of development of the tertiary education systems, measured as the percentage of 24-35 years age cohort in 2011 having completed some form of tertiary level education (TERT). Tertiary education systems have evolved considerably in Europe over the last two decades, not only in terms of rates of participation, but also of the development of professional tracks at both the undergraduate and master's levels combining academic course work with internships in private enterprises or public organisations (Enders, de Boer & Westerheijden, 2011). These changes have arguably reduced the traditional academic bias of tertiary education systems in many countries, but the data to assess the importance of this trend are unavailable for most European nations. Nonetheless, we include a measure of the level of commitment of nations to developing their tertiary education with the assumption that a strong emphasis on tertiary education which is not accompanied by a well-developed vocational education system would tend to reinforce the disparities in educational backgrounds and skills levels within the enterprises that encourage the use of more hierarchical forms of work organisation. As shown in Table IV, the percentage of the 24-35 age cohort having completed tertiary level education in 2011 ranges from 46.7% in Ireland to 20.7% in Austria. Table V shows the correlation coefficients between the three aggregate variables.

Individual level covariates

At the employee level, we included a number of covariates that could be expected to affect an employee's involvement in the different forms of work organisation in

addition to controls for the sector of activity, establishment size and occupation. For the regression analysis presented below, we regrouped the 1-digit ISOC categories into 4 broad occupational categories: managers, professionals and technicians; skilled and semi-skilled white collar workers; skilled and semi-skilled blue collar workers; and the elementary trades. We included the level of formal initial education (Ed) as a measure of the acquisition of formal academic and domain specific skills. We included measures of foundations skills in the areas of literacy and numeracy based on the formal assessments undertaken in PIAAC.[5] In order to provide a rough measure of the importance of experience-based tacit knowledge, we included the number of years of work experience (Yrs). For the importance of investments in job-related skills, we included a measure of whether or not the employees engaged in some form of training over the last year, either on or off-the-job (Train). We included the type of employment contract, whether permanent, temporary, agency or no contract (Contract). We also controlled for gender and for whether the employees exercised a supervisory role. Table VI provides descriptive statistics for the employee-level covariates.

Regression analysis

In order to gain insight into both the employee and national level contextual determinants of an individual's access or involvement in the different forms, we adopted a multi-level framework that analysed both employee-level determinants and national system effects. We used a logit model and started with a 'random intercepts model' in which the intercept is allowed to vary across nations. The estimated variance in the intercept provides an estimate of the variation in the average likelihood of the different forms of work organisation across nations after controlling for the explanatory variables.

The results presented in Table VII show that, for the DL forms, the log odds increase with the level of initial education. They increase in years of experience up to 24 years, they are positively related to having participated over the last year in some form of further training, in having a supervisory role, and in being male. Workers with permanent contracts are more likely to be involved in the DL forms than those with other types of contracts or no contract, and the higher levels of occupational hierarchy are more likely to be engaged in the DL forms relative to the elementary trades. The log odds of DL increase in the level of numerical proficiency, but not in literary proficiency.

For the constrained learning forms, there is no significant effect of the level of initial education. Men are more likely to be engaged in the constrained forms. Workers involved in some form of adult education or training are more likely to be engaged in the constrained forms, and literacy proficiency has a positive impact, whilst numerical proficiency does not. The effect of years of experience goes in the opposite direction from the DL forms with declining relative odds with increasing years, and relative to the elementary trades managers and both semi-skilled and skilled white and blue collar workers are less likely to be engaged in the constrained forms. The constrained forms of work organisation are more characteristic of larger establishments.

In the case of the simple forms of work organisation, women are significantly more likely to work in these conditions and employees who receive training or who exercise a supervisory function are less likely. The log odds of the simple forms decrease with the level of initial education and with the number of years of working

TABLE VI. Definition of employee-level covariates and descriptive statistics

Variable name	Definition	Mean*	Std. dev	Min	Max
Sex	Binary variable equal to 1 if the employee's is male, 0 otherwise	.62	.49	0	1
Train	Binary variable equal to 1 if the employee's has received on or off-the-job training over the last year, 0 otherwise	.59	.49	0	1
Supervisory role	Binary variable equal to 1 if the employee's exercises a supervisory role, 0 otherwise	.34	.47	0	1
Foundation: numeracy	Continuous variable equal to the employee's score on the PIAAC numeracy assessment	282.4	47.0	24.8	444.1
Foundation: literacy	Continuous variable equal to the employee's score on the PIAAC assessment	280.0	42.9	91.8	415.6
Ed 1	Binary variable equal to 1 if the employee's level of initial education is less than upper-level secondary, 0 otherwise	.15	.36	0	1
Ed 2	Binary variable equal to 1 if the employee's level of initial education is upper-level secondary or post-secondary but not tertiary, 0 otherwise	.49	.50	0	1
Ed 3	Binary variable equal to 1 if the employee's level of initial education is tertiary, 0 otherwise	.36	.48	0	1
Yrs 1	Binary variable equal to 1 if the employee has less than 5 years of working experience, 0 otherwise	.07	.26	0	1
Yrs 2	Binary variable equal to 1 if the employee has 5 to 9 years of working experience, 0 otherwise	.14	.34	0	1
Yrs 3	Binary variable equal to 1 if the employee has 10 to 24 years of working experience, 0 otherwise	.43	.50	0	1
Yrs 4	Over 24 years of working experience, 0 otherwise	.36	.48	0	1
Contract 1	Binary variable equal to 1 if the employee has a permanent contract, 0 otherwise	.43	.50	0	1
Contract 2	Binary variable equal to 1 if the employee has a temporary contract, 0 otherwise	.22	.41	0	1
Contract 3	Binary variable equal to 1 if the employee has an agency contract, 0 otherwise	.27	.45	0	1
Contract 4	Binary variable equal to 1 if the employee has no contract, 0 otherwise	.08	.26	0	1
Occupation 1	Binary variable equal to 1 if the employee's occupational category is manager, professional or technician, 0 otherwise	.43	.50	0	1
Occupation 2	Binary variable equal to 1 if the employee's occupational category is skilled or semi-skilled white collar worker, 0 otherwise	.21	.41	0	1
Occupation 3	Binary variable equal to 1 if the employee's occupational category is skilled or semi-skilled blue collar worker, 0 otherwise	.27	.45	0	1
Occupation 4	Binary variable equal to 1 if the employee's occupational category is the elementary trades, 0 otherwise	.08	.27	0	1

*Denotes the share of employees with the variable characteristic or trait

TABLE VII. Multi-level logit model with random intercepts

Dependent Variable	Discretionary learning	Constrained learning	Simple forms
Employee level	Model 1	Model 2	Model 3
Constant	−1.766***	−1.970***	
Training	.274***	.173***	−.544***
Sex (male)	.183***	.094***	−.392***
Supervisory role	.801***	−.290***	−.946***
Foundation: numeracy	.002***	.001	−.004***
Foundation: literacy)	.001	.002**	−.004***
Education			
Ed 1 (Lower secondary or less)		Reference	
Ed 2 (Upper secondary and post-secondary but not tertiary)	.263***	.056	−.243***
Ed 3 (tertiary)	.362***	−.035	−.364***
Years' experience			
Yrs 1 (0-4 years)		Reference	
Yrs 2 (5-10 years)	.265***	−.165**	−.154**
Yrs 3 (10-24 years)	.349***	−.231***	−.212***
Yrs 4 (>24 years)	.343***	−.296***	−.093
Contract			
Contract 1 (permanent) C		Reference	
Contract 2 (temporary	−.116**	.108**	.017
Contract 3 (agency)	−.424***	.153	.153
Contract 4 (no contract)	−.285**	−.222*	.498**
Occupation			
Managers, professionals and technicians		Reference	
Skilled and semi-skilled white collar workers	−.443***	.350***	.343***
Skilled and semi-skilled blue collar workers	−.849***	.315***	.854**
Elementary trades	−1.089***	−.023	1.223***
Establishment size			
11-50 employees		Reference	
51-250	−.006	.003	−.011
251-1000	−.096**	.142***	−.068
> 1000	−.062	124**	−.117*
Sector			
Agriculture, forestry and fishing	−.022	−.139	.117
Mining and Quarrying	−.091	.166	−.122
Manufacturing		Reference	
Electricity and gas	−.093	.045	.089
Water supply	.227*	−.129	−.133
Construction	.125**	.120**	−.273***
Wholesale and retail	.071	.039	−.138**
Transport and storage	−.487***	.273***	.253***
Accommodation and food services	−.099	.036	.087
Information and communication	.202***	−.107	−.252***

Table VII. *Continued*

Dependent Variable	Discretionary learning	Constrained learning	Simple forms
Employee level	Model 1	Model 2	Model 3
Finance and Insurance	.009	.138**	−.303***
Real estate	.352**	−.296*	−.159
Professional, scientific and technical	−.092	.008	.130
Administrative and support	−.009	.015	−013
Arts and entertainment	−.149	−.004	.286**
Other services	.131	*−.202**	*.034*
Random effects			
Intercept variance	.143 (.051)	.189 (.066)	.051 (.019)
N	*24,787*	*24,787*	*24,787*
LR test vs logistic regression	*chibar2 (01) = 382.6 prob > chibar2 = 0.000*	*chibar2 (01) = 743.9 prob > chibar2 = 0.000*	*chibar2 (01) = 124.2 prob > chibar2 = 0.000*

experience. Employees with no contract are considerably more likely to be engaged in the simple forms.

Concerning the random part of the model, the estimated variance in the intercepts shows that the amount of unexplained variance in the likelihood of the forms of work organization across nations is greater for the DL and constrained learning forms than it is for the simple forms. The likelihood ratio tests reported at the bottom of each column compare how well the multilevel model fits the data compared to the single-level logistic regression without random intercepts. The test is statistically significant in each case, showing that the multi-level framework provides a better fit.

In summary, the regression results presented in Table VII show that both employee characteristics and such 'structural' features as the size of the establishment, the sector of activity and one's occupational category have a significant impact on the likelihood of an employee being involved in the different forms of work organisation. In particular, access to the DL forms tends to be associated with higher levels of initial education, more years of working experience, and being employed at a higher level in the occupational hierarchy. At the same time, the random part of the model shows that there is considerable variance in the likelihood of being involved in the DL forms across nations after controlling for these employee-level and structural characteristics. In Table VIII, we present the results of regression models that seek to account for some of this inter-country variation by including measures of the national education and training systems as country-level covariates. The quite strong negative correlation between measure of tertiary education attainment and the measure of extended school-based initial vocational education (see Table V) poses a potential problem of multi-collinearity and we therefore developed separate models. The regressions also control for the log of GDP per capita in 2011. We then extended the analysis to explore possible interaction effects between these aggregate measures and differences in the employees' level of initial education, their occupational category and whether or not a supervisory role was exercised.

TABLE VIII. Multi-level logit model with random intercepts and country-level effects

	Discretionary learning			Constrained learning			Simple forms		
Dependent Variable	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Employee level									
Constant	−2.289	−7.222**	−7.395**	−2.312	2.567	2.108	2.458	3.217	3.911*
Train	.272***	.272***	.274***	.175***	.173***	.174***	−.542***	−.543***	−.544***
Sex	.182***	.182***	.182***	.095***	.095***	.095***	−.392***	−.391***	−.392***
Supervisory role	.802***	.802***	.801***	−.291***	−.290***	−.290***	−.947***	−.945***	−.946***
Education									
Ed 1 (Lower secondary or less)					reference				
Ed 2 (Upper secondary or post-secondary but not tertiary)	.266***	.264***	.264***	.054	.05	.055	−.243***	−.244***	−.243***
Ed 3 (tertiary)	.363***	.364***	.363***	−.036	−.038	−.036	−.363***	−.363***	−.365***
Occupation									
Managers, professionals and technicians	1.089***	1.088***	1.088***	.023	.024	.023	−1.223***	−1.223***	−1.222***
Skilled and semi-skilled white collar workers	.666***	.664***	.665***	.372***	.374***	.373***	−.880***	−.880***	−.879***
Skilled and semi-skilled blue collar workers	.240***	.239***	.240***	.337***	.374***	.338***	−.368***	−.369***	−.368***
Elementary trades					reference				
Country-level									
LLL	.032***			−.029**			−.007		
IVTSCND		.010**			−.014***			.003	
TERT			−.007			.004			.004
GDPCAP	−.054	.428	.444	.031	−.446	−.401	.044	−.030	−.098
Random effects									

Table VIII. *Continued*

	Discretionary learning			Constrained learning			Simple forms		
Dependent Variable	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Intercept variance	.080 (.029	.104 (.037)	.131 (.046)	.134 (.047)	.123 (.043)	.179 (.063)	.048 (.018)	.047 (.018)	.049 (.019)
N	*24,787*	*24,787*	*24,787*	*24,878*	*24,878*	*24,878*	*24,787*	*24,878*	*24,878*
LR test vs logistic regression	Chibar2 (01) = 320.3 prob > chi2 = 0.000	Chibar2 (01) = 444.3 prob > chi2 = 0.000	Chibar2 (01) = 538.6prob > chi2 = 0.000	Chibar2 (01) = 525.4 prob > chi2 = 0.000	Chibar2 (01) = 504.3 prob > chi2 = 0.000	Chibar2 (01) = 690.3 prob > chi2 = 0.000	Chibar2 (01) = 109.7 prob > chi2 = 0.000	Chibar2 (01) = 114.5 prob > chi2 = 0.000	Chibar2 (01) = 119.3 prob > chi2 = 0.000

*** = sig at .01 level; ** = .05 level; * = .10 level. The regressions include controls for sector, establishment size, type of contract, years of experience, and foundation skills.

TABLE IX. Multi-level logit model with random intercepts, random coefficients and country-level effects

Dependent Variable	Discretionary learning		
	Model 13	Model 14	Model 15
Employee level			
Constant	−2.854***	−8.241***	−8.091**
Sex	.179***	.178***	.180***
Supervisory role	.798***	.780***	.800***
Education			
Ed 1 (Lower secondary or less)		Reference	
Ed 2 (Upper secondary or post-secondary but not tertiary)	.265***	.266***	.274***
Ed 3 (tertiary)	.382***	.381***	.394***
Occupation			
Managers, professionals and technicians	1.102***	1.098***	1.086***
Skilled and semi-skilled white collar workers	.678***	.670***	.660***
Skilled and semi-skilled blue collar workers	.242***	.242***	.233***
Elementary trades		Reference	
Country level			
LLL	.043***		
IVTSCND		.004	
TERT			.006
GDPCAP	−.043	.525*	.511
LLLx Ed2 (secondary)	−.001		
LLLx ED3 (tertiary)	−.013*		
LLLx Supervisory role	.003		
LLLx Mangers	−.005		
LLLx White collar	−.018**		
LLL x Blue collar	−.004		
IVTSCND x Ed2 (secondary)		.004	
IVTSCND x ED3 (tertiary)		.003	
IVTSCND x Supervisory role		−.000	
IVTSCND x Mangers		.005	
IVTSCND x White collar		.006	
IVTSCND x Blue collar		−.002	
TERT x Ed2 (secondary)			−.008
TERT x ED3 (tertiary)			−.011
TERT x Supervisory role			−.003
TERT x Mangers			−.006
TERT x White collar			−.014
TERT x Blue collar			−.003
Random effects			
Intercept variance	.075 (.029)	.102 (.038)	.132 (.049)
Coefficients			
Ed 2 (secondary)	.000 (.000)	.000 (.000)	.000 (.000)
Ed 3 (tertiary)	.011 (.001)	.022 (.014)	.020 (.013)
Supervisory role	.008 (.008)	.008 (.008)	.007 (.007)
Managers	.000 (.000)	.000 (.000)	.000 (.000)
White collar	.013 (.012)	.021 (.014)	.013 (.013)

Table IX. *Continued*

Dependent Variable	Discretionary learning		
	Model 13	Model 14	Model 15
Blue collar	.040 (.022)	.027 (.016)	.024 (.018)
N	*24,787*	*24,787*	*24,787*
LR test vs logistic regression	Chibar2 (07) = 354.1 prob > chi2 = 0.000	Chibar2 (07) = 466.8 prob > chi2 = 0.000	Chibar2 (07) = 549.3 prob > chi2 = 0.000

The regressions control for sector, establishment size, type of contract, years of experience and foundation skills.

The results for the country level effects shown in Table VIII provide support for the view that broad systems of education and training, systems that balance the importance attached to academic qualifications with well-developed systems of vocational education training and which provide opportunities for lifelong learning, are supportive of autonomous learning at the work place. Translating the estimates of the log odds into odds, the results imply that a 10% increase in the percentage of adult employees participating in some form of adult education is associated with approximately a 32% increase in the odds being involved in the DL forms for employees on average. Furthermore, the inclusion of LLL in the model predicting the log odds of the DL forms accounts for 40% of the unexplained cross-country variance in the likelihood of the DL that was estimated in the model 1 regression without country-level covariates (see Table VII). The results also imply that a 10% increase in the share of students participating in extended school-based vocational education at the upper secondary level can be associated with an approximately 10% increase in the odds of being engaged in the DL forms for employees on average. As regards the constrained learning forms, the results show that the development of broad-based systems of education and training tends to reduce the likelihood of an employee being involved in these forms of work organisation in roughly the same proportions as they increase the likelihood of being involved in the DL forms. Increases in the share of the 24-35 years age cohort with tertiary level education, however, have no statistically significant impact on the likelihood of the different forms of work organisation.

Interaction analysis

The analysis above focussed on the impact of national education and training systems on employees in general and it has shown that well-developed broad-based systems of education and training tends to increase the share of the population of employees who are engaged in jobs characterised by discretionary learning. The analysis assumed that the coefficients on the employee-level covariates were fixed, implying that the impact of differences in individual employee characteristics - such as the level of initial education or the occupational category - were uniform across nations. But if broad systems of education and training with well-developed provision of lifelong learning are associated with greater value being attached to practical and vocational skills, then it could be expected that, in nations with such systems, the penalties of not having completed initial secondary level education for access to the DL forms would be reduced. This could be because lifelong learning systems offer adult employees a 'second chance' to

acquire job-related skills and competences that support autonomous learning at the workplace. Furthermore, insofar as such educational systems foster a more even distribution of competences at the workplace and support the adoption of more decentralised forms of work organisation, one could expect a more even pattern of access to the DL forms across occupational groups within the organisation and a lesser divide between those with and those without a supervisory role. In highly taylorised work settings, it is mainly the upper level managerial categories or those with a supervisory function that enjoy the benefits of autonomy in work, whilst most workers labour under the constraints of a high degree of job formalisation and specialisation.

In order to test these hypotheses, we allowed for the possibility that the value of the coefficients on the employee-level covariates may vary across nations. We then conducted an interaction analysis in order to see if the variance in the coefficients across nations was related systematically to the level of the aggregate education and training measures. We focused on the way increases in the three aggregate measures of the education and training system interacted with the categorical variables measuring the level of initial education, the employee's broad occupational category, and whether a supervisory role was exercised. In the case of formal educational attainment, the reference category was employees with lower secondary education or less which corresponds to the drop-out rate in a country. We focused on the sign of the interaction effect between the level of the three aggregate variables, LLL, IVTSCND and TERT, and the dichotomous variables measuring whether the level of initial education was at the tertiary level, or at the upper secondary or post-secondary but not tertiary level. A negative interaction effect indicates that the relative advantages of having attained these higher level of initial education for access to the DL forms was reduced. Similarly, we took the lowest level of skill in the occupation hierarchy, the elementary trades, and not having a supervisory role as the reference categories for the variables measuring these employee characteristics. Negative interaction effects between the national system variables and the binary variables indicating that the employee was at a higher level in the occupational hierarchy or has a supervisory role would point to a more even distribution of access to discretionary learning within the workplace.

The results for model 13 provide some evidence in support of the view that broad-based system of education and training have an equalising impact in terms of relative access to the DL forms at the workplace. Whilst there are no significant interaction effects with respect to having a supervisory role, there is evidence that in nations with more developed systems of lifelong learning the odds of participating in autonomous learning at the workplace for employees who have not completed upper secondary level education is greater than those with tertiary level education. Moreover, such systems would appear to lessen the organisational divide between skilled and semi-skilled white collar workers on the one hand, and the elementary trades on the other.

Conclusions

We began this article by arguing that skills policies needed to go beyond static considerations of adapting formal education and training systems to the changing skills needs of firms to a dynamic focus on developing organisational designs with a capacity for continuous learning and adaptation. Such policies may operate at many levels. The Nordic nations, for example, have a long and rich experience with

policy programmes designed to directly support organisational change and innovation at the workplace level. These programmes typically operate by providing competitive funding for the implementation of change within individual firms or within networks of organisations, with management and staff actively working alongside outside local researchers or experts. Examples include the Value Creation (VC) programme in Norway, the TEKES programme in Finland, and the workplace innovation programmes administered though VINNOVA in Sweden (Alasoini *et al.*, 2005; Alasoini, 2009 for overviews).

We focused on the way the macro framework conditions at the level of national education and training systems could support the adoption of different forms of work organisation. Our results show that broad-based systems of education and training that recognise the value of both academic and vocational training and that provide ample opportunities for adult education can create a favourable environment for the adoption of organisational designs with a capacity for continuous learning and adaptation. Such systems may be highly complementary to policy frameworks focusing on the micro and workplace-level of the sort that have been developed extensively in the Nordic nations.

Given these conclusions, we would argue that there are reasons to be concerned by current trends in the development of Europe's education and training systems. Two cornerstones of the EU's 2020 education and training policy are increasing tertiary education attainment rates and the rate of adult participation in education and training. The figures for EU member countries that can be downloaded from Eurostat's electronic webpage show that, whilst considerable progress has been made in terms of increasing tertiary-level attainment rates over the last decade, participation in lifelong learning has stagnated. For the EU-28, tertiary-level attainment rates for adults increased from 22.5% in 2005 to 29.3% in 2014 and each of the 17 nations covered in this study increased their tertiary level attainment rates. During the same period, for the EU-28, participation in lifelong learning only increased marginally, from 9.6% in 2005 to 10.7% in 2014. The increases registered in Sweden, Finland, Denmark, Estonia, Italy and the Czech Republic were to a large extent compensated by declines in the UK, Ireland, Slovakia, Poland, and Belgium.

Our results imply the need for a more balanced commitment of actual resources to these two pillars of the EU's education and training policy. This will require an increased commitment of resources at both the EU and national levels to develop broad and inclusive systems of lifelong learning and it will require mobilising employers and a broader set of stakeholders. In our view, such an effort will be central to the ability of Europe to compete in an increasingly global economy characterised by rapid changes in technology and skills needs.

A more balanced strategy would also contribute to a more egalitarian and democratic society through two different mechanisms. First, it would offer employees with low levels of formal education easier access to jobs offering organisational learning. Second, it would lead to more equal access to organisational learning at the workplace. This is important in a situation where there is growing concerns regarding increasing inequality in Europe.

Finally, we see our contribution as a step towards developing a more systemic approach to skill formation. Whilst some skills may be fostered in initial and adult education and training – i.e. in contexts where the explicit objective is to upgrade skills – other skills originate from learning at the work-place as an unintended side-effect. Finally, some skills are fostered in a mixed category where management –

sometimes in collaboration with employees and trade union representatives – design organisations in order to enhance the learning effect from employees' ordinary activities. In this article, we analysed how the first category related to the other two. A more ambitious approach would be to study the *national learning system* as encompassing all three elements. Such an analysis would need to include a wider set of institutions, including labour market institutions and industrial relations.

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NOTES

1. As Penrose (1959, p.46) eloquently put it, 'The managerial team is more than a collection of individuals; it is a collection of individuals who have experience in working together. This means that existing managerial personnel provide services that cannot be provided by personnel newly hired on the market. This is because the experience gained from working within the firm and with each other enables managerial personnel to provide services that are uniquely valuable for the operations of the particular group with which they are associated'.
2. The European countries are: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Poland, Slovak Republic, Spain, Sweden, and the UK. In most countries, the sampling frame was the national population registry. In some cases, two-stage sampling was applied with frames of communities or municipalities in the first state and population registries at these levels in the second stage. See: http://www.oecd.org/site/piaac/Technical%20Report_Part%204.pdf
3. The type of factor analysis used is multiple correspondence analysis (MCA). A hierarchical cluster analysis was undertaken using the first 3 factors from the MCA which account for 60.5% of the total variance in the data set.
4. Figures on student enrolments are only available on Eurostat's webpage for 2013 and 2014. Values for The Netherlands are missing and the vocational share was imputed on the basis of values for TERT and LLL using Stata's impute procedure
5. In PIAAC, the full set of items for the numeracy and literacy assessments is organised into different, but linked, assessment booklets; each individual receives only one booklet so as to reduce response load. Thus, the survey solicits relatively few responses from each respondent and based on multiple imputation 10 plausible values for the full set of items are estimated for each respondent. The measures of literacy and numeracy proficiency described in Table VI and used in the econometric analysis are based on the average of the 10 imputations for each employee respondent. For details on the multiple

imputation method, see the Technical Report of the Survey of Adult Skills (PIAAC), OECD, 2013.[1]

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Factors That Promote Innovativeness and Being An Innovative Learner At Work – Results From PIAAC

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Introduction

This article considers what is broadly thought to be essential for being innovative at work. Added focus is given to the role of learning practices and learning environments in fostering innovation. The existing evidence and discourse on innovation are considered in the light of broader conceptualisations of innovativeness and what it means to be innovative. Innovation refers to creating something new, be it a product, process, service, marketing or organisational method (OECD & Eurostat, 2005). Innovativeness is thus to be able to actively contribute to this. Central to the definition of innovativeness used in the analysis here is that the worker actively seeks new knowledge and i uses it for work-related tasks. This is based on the previous research emphasising learning-by-doing, using new knowledge and learning organisations. When examining innovativeness, the respondents' learning activities and strategies are examined to identify those who are *innovative strategic learners at work*. Alternative measures of innovativeness and the occurrence of what can be called 'being an innovative strategic learner at work' are considered. The aim is to examine the extent to which this phenomenon varies between a selected group of countries and between workers within these countries, and which factors seem to determine this variation. The key questions are: what promotes innovative*ness* and how does this capability vary? Data from the OECD Survey of Adult Skills (PIAAC) (OECD, 2013a; b) are examined to decipher key factors involved in promoting innovative behaviours and practices at work. The focus is on Denmark, Finland, The Netherlands and Norway. The Nordic countries and The Netherlands are in many ways similar. All are welfare states with a highly-educated workforce. They all obtained high scores in adult skills in PIAAC and have high participation rates in adult and lifelong learning.

Background

An important motivation for the study was what can be called 'the Norwegian puzzle' (OECD, 2007; Wilhelmsen, 2012). Norway scores high on several economic indicators but low on innovation indicators. Relatively few Norwegian companies report innovation activities (Wilhelmsen, 2011; Statistics Norway, 2012), according to the Community Innovation Survey (CIS). Furthermore, according to the Innovation Union Scoreboard (IUS) (EU, 2014), Norway scores far below The Netherlands, Finland and Denmark. The latter two are referred to as innovation 'leaders', The Netherlands as an innovation 'follower' (the second best category), while Norway is amongst the 'moderate innovators' (the second poorest category).

The Norwegian results of the Innovation Union Scoreboard are often questioned, for example by pointing to the fact that many of the indicators refer to the percentage of GDP, where Norway's high GDP[1] makes it particularly difficult for it

to achieve a high score. Another criticism is that the Scoreboard does not measure the innovative capabilities of the workforce (employee-driven innovation), which could be decisive for the overall innovative activity in the workforce. Critics and questions concerning the validity of CIS have also been presented. In 2013, Statistics Norway conducted an independent innovation survey (similar to the CIS survey), in which the results differed widely from those reported for Norway in the 2012 CIS survey. Wilhelmsen (2014) argues that one of the reasons behind the low scores for Norway in CIS is that, unlike many other countries, it has integrated the R&D and Innovation surveys into a single combined survey, while most countries have separate R&D and Innovation surveys. The new survey (2013) was not a combined survey.

Other types of studies have also presented international comparisons of innovation activity. When comparing the situation among graduates in 13 European countries five years after graduation, Paul (2011) found that Finland was at the top concerning the share of graduates working in organisations that are at the *forefront of innovation*. It was also found that Finland had the highest frequency of graduates *introducing* innovations at work (Bjørnåli & Støren, 2012).

For Norway, low scores in innovation indicators are challenging. The OECD Action Report (OECD 2014b), which draws upon the OECD Skills Strategy Diagnostic Report for Norway (OECD, 2014a), highlights the underuse of skills for entrepreneurship and innovation and states that, within the context of a declining oil production, Norway should adjust for a boost in its non-oil economy. After the decline in oil prices after the autumn 2014 (followed by a notable increase in the unemployment level, which has generally been lower in Norway than elsewhere in Europe),[2] this challenge is accentuated and perceived as becoming even greater. The terms 'need for renewals, restructuring and innovation' are heard more and more frequently in Norwegian public debate. Requests for restructuring also have other political reasons called the need for a "green shift", referring to the fact that the threat of climate change means that Norway must invest in other industries than the oil sector. This backdrop makes it interesting to compare Norway with similar countries when it comes to questions about the innovativeness of the workforce.

Key Factors Involved in Innovation

Previous research has identified several factors as being central for introducing innovations and innovative activity at work. They are: participation in training, skills and education levels, roles at work, and discretionary work forms.

Participation in training and learning at work

OECD (2010a) highlighted the importance of learning at work by suggesting that learning organisations were positively associated with innovation in the workplace. The study suggested that learning and interaction within an organisation, as well as learning through interaction with external agents, was essential for innovation. Similarly, OECD (2010b) suggested that one of the key policy principles for innovation was to empower people to innovate through education and training systems that equip them with the foundations to learn and the flexibility to upgrade skills. OECD (2011) also suggested that there was a need to better identify relationships between innovation and work organisation and explore the strength and direction

of these relationships, as well as the relationship between skills, competence and training and innovation.

Overall, the literature seems to suggest a reciprocal relationship between training and innovation, a 'good circle' where innovative activity provides incentives for work-related training which in turn promotes innovation. Workplace learning and employee innovation are mutually reinforcing (Ellström, 2010; De Spiegelaere *et al.*, 2012). Involvement in innovation brings about learning and workplace learning gives workers the capacity and opportunity for innovation.

As suggested by Lorenz and Lundvall (2011), a broad competence-based system of education and training is essential regarding the extent to which the nation's workforce is a 'creative workforce'. The four countries which are the focus of this article have this system. According to the Adult Education Survey (AES) 2011 the percentage of adults aged 25 to 64 participating in education and training in the 12 months prior to the survey was 60% in Norway, 59%0 in The Netherlands and Denmark, and 56% in Finland, compared to 40.3% in the EU-27 (Eurostat, 2013). The high participation rates are interesting in view of the emphasis placed in the innovation literature on lifelong learning in general and workplace learning in particular. In previous studies, it was found that training rates were positively correlated with investment in R&D and innovation (Bassanini *et al.*, 2005; Cedefop, 2012; Næss, Støren, & Kaloudis, 2009; OECD, 2011).

As mentioned, there could be a reciprocal relationship between participating in courses and innovative activity. This is in accordance with Ellström's theoretical work on practice-based learning (2010) where practice-based innovation is regarded as a cyclical process of learning. In a Danish study, Rasmussen (2009) reports that most workers, irrespective of background, did *not* regard continuing education as important for their ability to engage in innovative thinking or as a source of creative and innovative competence. These findings may challenge the ruling view that there is a strong relationship between work-related training and innovation, at least that the relationship found at the aggregate level may depend on a variety of background factors. The relationship may be strong in a few cases and weak in most other cases. As mentioned above, about 60% of the adult population in the four countries studied here participated in training in the 12 months preceding the interview according to AES. Probably, most do not experience that this participation in itself leads to innovations in the workplace. However, Rasmussen (2009) and Cedefop (2012) stress the importance of continuing vocational training for innovation.

Education levels and skills

Many of the composite indicators for the Innovation Scoreboard reflect that a high level of human capital is generally regarded as one of the key factors for innovation. The relationship between human capital and innovation can be understood in different but complementary ways. One perspective is that those who are highly-educated are more creative (innovative). Rasmussen (2009, 2012) refers to surveys showing that highly-educated people are more creative and innovative than those with lower levels of education and that a higher proportion of the highly-educated report that they have learned to develop new ideas through education or extended education.

Another perspective refers to high skills being necessary to *use* new technologies for innovation. Leiponen (2005) suggested that firms benefited less from innovation if the employees did not possess sufficient skills, because they would not have the absorptive capacity. Toner (2011) points to the need for skilled workers in order to

be able to introduce new technologies at the workplace. High levels of skills are necessary for the *absorptive capacity* and for adaptation. He argues that the capacity to engage in innovation has been shown to depend critically on the technological 'absorptive capacity' of the workforce, broadly conceived as the ability to adopt, adapt and disseminate new or improved products, production processes and organisational innovation.

OECD (2011) suggested that human capital *by itself* was not sufficient to enhance the propensity to engage in product innovation, because of the potential correlation of human capital with other variables. Among others, this is based on Schneider *et al.* (2010). Different studies have pointed to scientific skills, engineering skills, information technology skills, general business and marketing skills, depending on the type of industry (OECD, 2011). Leiponen (2005) uses data from a panel of Finnish manufacturing firms and finds, amongst other things, that human capital and high technical skills can be seen as enabling factors in profitable innovation.

Learning by doing

A number of economists (Arrow, 1962; Dasgupta & Stiglitz, 1988; Stiglitz & Greenwald, 2014) are occupied with the economic returns to *learning-by-doing*, the importance of learning on the job and the close relationship to innovation, as well as how society/workplace promote learning. Another central concept in the innovation literature is the 'Doing, Using and Interacting' (DUI) mode of innovation. According to Asheim and Pirralli (2012), the learning work organisation is the micro foundation of the DUI mode of innovation that is described amongst others by Jensen *et al.* (2006). (The other form is the STI-mode, 'Science, Technology and Innovation', based on the production and use of codified scientific and technical knowledge, see Jensen *et al.*, 2006, p. 680).The importance of learning-by-doing and the learning environments brings us to another central concept in the literature, namely the concept of discretionary workplace learning and what may be called innovation-friendly work forms which are frequently considered as promoting learning and innovative activity.

Work forms promoting innovation

OECD (2010a) has suggested that a learning organisation could support innovation through employee autonomy and discretion promoted by learning and training opportunities. Asheim and Pirralli (2012) also emphasise the importance of the 'learning organisation'. *Discretionary learning forms of work organisation* refer to autonomy, i.e. discretion in fixing work methods and work pace, learning new things at work, problem-solving activities and complexity of work tasks (OECD, 2010a; Lorenz & Lundvall, 2011). 'High levels of discretion in work provide scope to explore new knowledge'. It is further argued that adhocracies (referring to flexible, adaptable, and informal organisational structures) 'tend to show a superior capacity for radical innovation' (OECD, 2010a, p. 33). OECD (2010a) suggested that in nations where work is organised to support high levels of employee discretion in solving complex problems, the evidence showed that firms tended to be more active in terms of innovations. This conclusion is based on the relationship between organisational learning and innovation explored at the *aggregate* level and refers to *correlations* between findings in two different surveys, CIS and EWS (European Working Conditions Survey). A positive correlation was found at the national

level between discretionary learning and innovation. Cedefop (2012) finds corresponding results. It found a correlation between innovation performance of countries and the learning intensity of work organisations and workplace learning in addition to other, more formal modes of learning.

OECD (2010a), like other research based on the EWCS (Arundel *et al.*, 2007; Lorenz & Lundvall, 2011), found that the Nordic countries and The Netherlands were in the forefront when it came to innovation-friendly and creative work forms. Furthermore, they found that these work forms could be correlated with a number of characteristics of the education system and the labour market. The relationships found by Arundel *et al.* (2007) are reported as correlational. Their main finding is that, in countries where work is organised to support high levels of discretion in solving complex problems, firms tend to be 'more active in terms of innovations developed by their own in-house creative efforts'. Norway was not included in the analyses.

Certain *working roles and competency profiles* can also be related to innovative behaviour. An innovative role involves high levels of professional and creative competencies, as well as communicative and championing competencies (Bjørnåli & Støren, 2012). The same applies to the role of a technical innovator (demanding a high degree of specialised knowledge and recognising opportunities), and the *knowledge broker,* who links information and knowledge from outside organisations or between different units in an organization (Zahra, Nielsen & Bogner, 1999; Hargadon, 2002; Bjørnåli & Støren, 2012).

The PIAAC Data

PIAAC data enable further analysis of some of these factors. Many questions in the PIAAC survey cover learning strategies and activities, and work profiles as discussed above (OECD, 2013b). These data do not provide information on the concrete output in terms of introducing or producing innovations. Hence, in our analyses, we use proxies for what we consider as innovativeness based on many questions in the survey.

Defining the Innovative Learner

In defining innovative workers, emphasis is placed on their learning strategies, combined with information on what they do at work. The purpose is not to achieve an absolute measure of how many persons can be characterised as performing innovatively at work. This proportion will vary according to how many criteria are used and their strictness. The purpose here is to reach a meaningful definition that can be used for comparisons between groups of workers and countries. Based on the literature above, and referring to certain questions in the PIAAC survey, we consider that workers have an innovative work profile if the respondents' job

A. to a large extent involves keeping up to date with new products or services, *and*
B. to a large extent involves learning-by-doing from the tasks they perform; *and* if the respondents
C. to a large extent like to get to the bottom of difficult things, *and*
D. relate it to what they already know when coming across something new, or,

E. like to figure out how different ideas fit together, *and*
F. are quite frequently confronted with complex problems at work.

The mean proportion with high values on these variables as well as and for combinations are shown in Table I.

TABLE I. Percentage of workers engaging in innovative behaviours and being an innovative and/or strategic learner at work

	Denmark	Finland	Netherlands	Norway	Total. the four countries	The 18 other countries
A: Keeping Up to Date	43.0	49.5	38.6	36.4	41.7	39.9
B: Learning By Doing	52.2	63.8	51.7	64.9	58.1	56.9
Learning strategies						
C: I like to get to the bottom of difficult things	69.6	76.8	38.1	73.4	64.4	54.8
D: When I come across something new, I try to relate it to what I already know	71.9	86.3	64.7	73.7	74.0	57.8
E: I like to figure out how different ideas fit together	60.9	60.7	33.8	50.2	51.2	50.2
F: Solving complex problems	58.4	60.2	52.8	59.5	57.7	57.7
Constructed variables						
G: A + B Innovative learning	29.5	37.0	26.7	28.6	30.3	31.1
H: High C + D or High C + E (strategic learner)	62.3	72.6	33.4	63.7	57.8	49.1
I: G + H: Innovative strategic learner	21.3	28.8	12.2	20.4	20.5	19.6
J: I + F: Innovative strategic (and problem-solving) learner	16.5	20.7	9.1	15.5	15.4	14.8

Row G refers to a construct merging rows A and B; row H refers to a construct merging rows C – E, and rows G and H are merged in row I. In row J, I is merged with row F, referring to 'solving complex problems at work'. When including the last condition the percentage being an innovative strategic learner is reduced from 20.5% in row I to 15% in row J. All estimates refer to employed persons. The variable in row **J** is the main dependent variable in the following analyses. Those who fit all the criteria in row J *keep themselves updated, are curious, are able to learn something new from the work they do, use previous knowledge strategically, like to get to the bottom of difficult things, and in addition, quite frequently solve complex problems at work*. We find it reasonable to label a person who scores high in such aspects as an 'innovative strategic learner'.

Except for some of the learning strategies, the mean share for the four-country group does not differ much from the mean of the (rest) 18-country group participating in PIAAC. Additional analyses show that there is a broad variation between the countries within the latter group. The largest country (US) pulls up the average,

together with another large country like Canada. Concerning row J, we find US at the top (23%), the UK and Canada (20% and 18% respectively). Sweden scores at the same level as its neighbouring country Norway, with 15.5%

Comparisons with other measures of innovation

When comparing the results of the Innovation Union Scoreboard (2014) for the four countries, the best convergence is found for Finland. Denmark and Finland are among the highest performing countries according to the Innovation scoreboard, but the correspondence is lower for Denmark. The rankings coincide only to a limited extent for Norway which is average on 'innovative strategic learner', and *below* average on the Innovation Union Scoreboard. (The score for Norway is 0.480 on the IUS compared to 0.544 for the EU.) The rankings differ markedly for The Netherlands. Netherlands scores very high on the IUS 2014 (0.629), but particularly low on 'innovative, strategic learner'.

The measures are based on entirely different types of data and methods. The innovation scoreboard is based on indicators at national level. Many are based on data from Eurostat/CIS, which could also have measurements problems, as mentioned in the introduction. It could also be mentioned that many of the ratios are based on the percentage of GDP, where Norway has a particularly high GDP per capita. Being an 'innovative, strategic learner' is based on individuals' subjective self-evaluation, though it is a quite strict measure based on several indicators, but it does not necessarily imply that innovation actually or necessarily has taken place.

Other comparisons also show a divergence between the ranking of the innovation scoreboard and the national workforces in terms of innovation. Paul (2011) compared the proportion of graduates in 13 European countries working in organisations at *the forefront of innovation* in the private sector five years after graduation (the REFLEX survey) with the ranking of countries according to the European Innovation Scoreboard 2006 (EIS). Finland was no. 2 on EIS, and no. 1 on REFLEX, and Netherlands no. 10 and 9 respectively (good correspondence for both countries). The rankings in the innovation scoreboards varied for The Netherlands, and was lower in 2006 than in 2014, thus there was a good correspondence between the REFLEX ranking and the EIS ranking (2006) (relatively low on both). The Netherlands was ranked clearly below Norway in the REFLEX study. The results confirm that, regardless of the type of measurement, Finland ranks very high. Furthermore, Norway ranks higher in both the surveys (PIAAC and REFLEX) than in the innovation scoreboards. The Netherlands scores relatively low both in the REFLEX survey and according to the measure based on PIAAC data. For countries like Germany and Belgium the results are quite similar to those for The Netherlands.

Below, we examine the factors that can contribute to the variation between the four countries when it comes to innovativeness as measured by the PIAAC data.

Results

Table II shows the results per country of regressing a number of work-related factors on being an innovative learner using binomial regressions. The analyses are adjusted for many variables (industry, fields of study, skills etc.). The results for key variables are shown here. The last row in Table II indicates the additional variables that are taken into account. (Full results are available from the author on request).

TABLE II. Being an innovative strategic learner. Results of binomial regressions in each of the four countries

	Denmark		Finland		Netherlands		Norway	
	B	S.E.	B	S.E	B	S.E	B	S.E
Female (ref. male)	−0.148	0.114	**0.300**	0.114	***−0.281***	0.157	−0.014	0.117
Education and occupational level (ref. edcat 1 + 2, elementary occupations)								
Edcat 3 and 4	**0.523**	0.215	−0.028	0.241	−0.009	0.300	***0.359***	0.190
Edcat 5 and 6	**0.685**	0.243	−0.174	0.284	−0.158	0.355	0.159	0.224
Edcat 7 (master, higher)	**1.009**	0.265	−0.239	0.313	0.161	0.381	***0.451***	0.238
Skilled occupations	**1.392**	0.411	**1.002**	0.312	**1.669**	0.763	**1.962**	0.719
Semi-skilled white collar occupations	**1.198**	0.411	**0.764**	0.301	***1.313***	0.767	**1.421**	0.717
Semi-skilled blue collar occupations	***0.819***	0.424	**0.765**	0.319	***1.495***	0.785	**1.604**	0.730
Training (ref. no training)								
Obligatory training	0.421	0.264	−0.045	0.198	−0.045	0.319	−0.173	0.259
Own interest training	**0.483**	0.231	0.129	0.165	0.222	0.246	**0.342**	0.198
1-2 days training	−0.224	0.269	−0.245	0.201	−0.093	0.306	−0.194	0.241
3 – 7 days training	−0.323	0.257	−0.043	0.194	0.068	0.296	−0.066	0.227
8 – 20 days training	−0.100	0.259	0.276	0.197	0.307	0.292	0.109	0.229
More than 20 days training	−0.025	0.279	0.056	0.231	***0.525***	0.300	**0.568**	0.253
Working roles and flexibility/autonomy (ref. low values)								
Brokering, middle	0.231	0.142	**0.532**	0.226	**−0.048**	0.197	0.007	0.146
Brokering, high	**0.553**	0.139	**0.951**	0.218	**0.370**	0.186	**0.400**	0.146
Championing, middle	**0.771**	0.200	0.204	0.154	0.174	0.205	0.287	0.189
Championing, high	**1.017**	0.203	**0.687**	0.162	**0.625**	0.211	**0.938**	0.194
Information exchange, middle	−0.036	0.189	0.195	0.158	**0.675**	0.239	−0.086	0.209
Information exchange, high	**0.348**	0.163	**0.531**	0.148	**0651**	0.216	**0.374**	0.187
Independent, middle	**0.428**	0.216	0.027	0.157	−0.179	0.285	0.176	0.165
Independent, high	**0.706**	0.191	**0.365**	0.143	**0.422**	0.224	**0.491**	0.150
Autonomy/flexibility, middle	**−0.287**	0.160	***0.283***	0.151	**0.714**	0.185	**0.371**	0.155
Autonomy/flexibility, high	0.023	0.162	**0.500**	0.154	**0.673**	0.200	**0.669**	0.166
Constant	**−4.166**	0.716	**−4.519**	0.658	**−5.817**	1.091	**−4.037**	0.896
Nagelkerke R Square	0.210		0.163		0.196		0.199	

Table II. *Continued*

	Denmark		Finland		Netherlands		Norway	
	B	S.E.	B	S.E	B	S.E	B	S.E
No. observations (un-weighted)	5030		3737		3692		3507	
No. observations (weighted)	3535		3488		3641		3569	

Also included: Controls for age, work hours, numeracy and literacy skills (combined), and dummies for different levels of problem-solving skills, unknown occupation level; fields of study, and industrial sector.

**Coefficients in bold types are significant at level $p<0.05$. Coefficients in bold types and italics are significant at level $p<0.1$.

The key work-related variables are as follows. 'Championing' refers to influencing and advising people. 'Brokering' refers to negotiating with people either inside or outside the organisation. 'Independent' refers to organising one's time and planning one's activities. 'Information exchange' refers to the response concerning how often the respondent shares work-related information with co-workers. Flexibility and autonomy (indicators of work environment) refer to the response to questions concerning the extent to which the employed persons could choose or change the sequence of work tasks, how they do their work, the speed or rate of work, and working hours.

In addition to the analyses in Table II, pooled analyses of the four countries were conducted (not reported here because of space limitation but available from the author on request).[3] Here, different dependent variables measuring different aspects of being an innovative learner (Table I) are used. With a few exceptions, the central explanatory variables have significant similar effects on all the dependent variables that constitute being an innovative learner. For example, has work-related training of own interest and/or of long duration a positive impact on all the dependent variables. The same applies to increasing education level and work profiles such as 'championing', 'brokering', 'information exchange' and 'independent'. In brief, the results of the analyses suggest that people who work in organisations with great flexibility and autonomy, who participate in work-related training of own interest – and particularly when it is of long duration, who score high on being brokering, independent and championing and on information exchange, are very likely to be innovative and/or strategic learners at work. Furthermore, the results indicated that Norway scored lower than The Netherlands on 'keeping up-to-date' when including controls for a number of independent variables, but Norway together with Finland scored highest on variable 'learning-by-doing'. Concerning learning strategies, The Netherlands scored very much lower than the other three countries, also when a number of control variables were employed. In total, The Netherlands scored much lower than the other three countries, and Finland stood out when controlling for a number of independent variables.

Table II shows that the effects of the independent variables indicate many similarities in the four countries, but also many differences concerning which have the largest impacts. Below, the findings concerning the effects of some of the explanatory variables (per country) are outlined and illustrated.

The effects of the variables measuring the different work profiles have strong impacts in all four countries. The item 'autonomy/flexibility' has a particularly large positive effect in The Netherlands and Norway, but has no significant effect in Denmark. Elsewhere, we find that overall, high values on 'championing' have the greatest positive effects and impact in all countries, but more particularly in Norway and Denmark, and 'information exchange' is particularly important in The Netherlands, followed by Finland. *Educational level* has the greatest impact in Denmark (Table II), but no significant effect in Finland (when controls for all other variables are applied). It should be mentioned that additional analyses show that the effects of educational levels are much greater when controls for work profiles are not included, which correlates to a certain extent with education level.

The effects of some of the explanatory variables are illustrated in Figure 1. The estimates refer to those with average values (average for the four countries in aggregate) on *all* other variables than the variables in question. The estimates are based on the *effects for each country* respectively. *Occupational* level (skills level in the job)

has a strong impact in all countries. Those in skilled occupations are most likely to be innovative learners. The effect of occupation level for the four countries is illustrated in the upper part of Figure 1, referring to those with medium education level and different occupational levels, and average values on all other variables, including amongst others, fields of study and the industrial sector. Finland scores highest irrespective of occupational level, Denmark is next, followed by Norway.

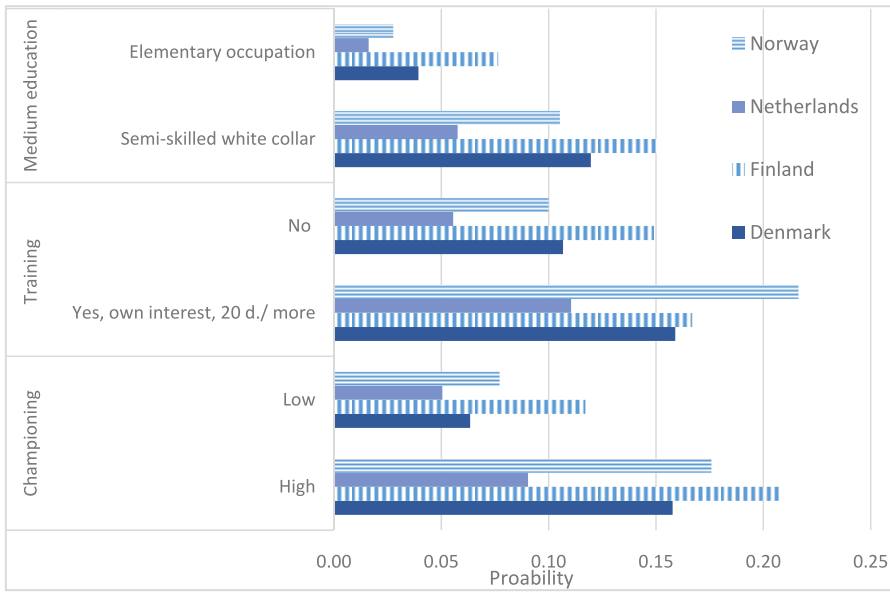

FIGURE 1. Estimated probability of being an innovative, strategic learner at work, for different groups of workers, by country

Concerning the effects of *work-related training*, Finland differs from the other countries, with weak or non-existing effects (Table II). The effects of training seems to have greater effects in the other countries. In Denmark, the effect of work-related training of own interest is positive and significant, in The Netherlands it is the effect of long duration of training that has the largest effect, in Norway both these variables have positive effects. The large (combined) effect for Norway is clearly shown in Figure 1. It should be mentioned that additional analyses show that the effects of work-related training in all countries are higher when controls for work profiles etc. are not included. This indicates that the positive effect of work-related training found in many studies can hide the fact that this effect is mediated by the type of work the worker exerts.

The lower part of Figure 1 illustrates the effects of being championing. As for the other estimates, the estimates are based on average values on all other variables than the variables in question For example, the estimates for those scoring low and respectively high in 'championing' refer to those with average values on all other variables, amongst them 'independent' and 'brokering' and 'autonomy/flexibility'. When having high values on 'championing' the estimated probability of being an innovative strategic learner is very high in Finland. However, when also having *low* values in this item, the estimated probability for the Finish sample is higher than for the Dutch respondents when the latter score high in 'championing'.

Elsewhere, we see from Table II that gender has a significant effect only in The Netherlands and Finland; negative for women in The Netherlands, and positive in Finland. Additional analyses show that the negative effect of being female in The Netherland is much greater if controls for work hours are not included. Increasing work hours has a positive impact in all countries, particularly in The Netherlands (and next in Denmark). These results are particularly interesting for The Netherlands, where the weekly work hours are fewer than in the other countries. Additional analyses show that this in particular applies to the Dutch female workers.

Discussion

About 15% of the workers in the four countries meet our criteria for being innovative strategic learners at work. This varies from 9% in The Netherlands to 21% in Finland. Country differences in the likelihood of being an innovative strategic learner at work are quite robust when controlling for a number of independent variables. Figure 1 illustrates the existence of country differences when constant distribution of the independent variables and country-dependent varying effects of the independent variables are taken into account. It is also illustrated here that the differences between countries are to some extent affected by the varying effects of certain variables, such as work-related training and work profiles.

The definition of an 'innovative strategic learner at work' depends on many dimensions. When Finland ranks highest of the four countries, this is because it ranks high on *all* the individual variables that are merged and constitute this construct. When The Netherlands ranks lowest, this is because it ranks lowest or second lowest on *all* the individual variables that constitute being an 'innovative strategic learner at work'. The results for The Netherlands are surprising, particularly when comparing these with the IUS ranking, where it is ranked as an 'innovation follower'. According to IUS, it performs above the EU average on most indicators. The Netherlands scores particularly high on IUS indicators such as international scientific co-publications and most cited scientific publications, indicators where Norway's score is also quite high. What differs between Norway and The Netherlands on IUS is mainly the indicators referring to the percentage of GDP or to the Community Innovation Survey.

The little likelihood of being an innovative strategic learner at work is also found in The Netherland's neighbouring countries Belgium and Germany. In the light of this, one could ask whether the results refer to socio-cultural differences. These can be of two kinds. The first is that the results refer to differences in the way work tasks are organised in the workplace, i.e. *real* differences. The second is that there are country differences in the response pattern. Still, as far as we can see, there is no evidence from the response pattern in other parts of PIAAC material that the Dutch sample has a 'particular' response pattern which distinguishes it from other nationalities.

It is also interesting to note that there is a negative effect for women in The Netherlands and a positive effect in Finland. It should be mentioned that Finland has the highest proportion of women with higher education and the longest work hours, and The Netherlands the lowest on both parameters. In the literature on innovation activity, gender is not a central issue, yet, in the literature on entrepreneurship, gender is a recurrent issue (Berglann *et al.*, 2011; Kelly *et al.*, 2011;

Xavier *et al.*, 2013). Being innovative is much broader than starting a new business, and it is not obvious that females are less innovative at work than men.

The variables indicating that people have different roles at work, i.e. variables that cover the extent to which the worker can be characterised as being *brokering*, *championing*, *independent* and/or exchanging information, have a great impact on the likelihood of being an innovative strategic learner at work and seem more decisive than education levels and skills. We may conclude that the (isolated) effects of education levels found here are quite small compared to the strong emphasis on human capital that is generally found in the literature on innovative activities and capabilities. However, it appears that the control for work profiles has a strong impact on the effects of education levels. This is in line with arguments in some previous studies mentioned in the introduction that human capital in itself is not sufficient to increase the likelihood of engaging in innovation since it may correlate with other variables. Here, we have established that these other variables concern the role of the person at work. In addition, the type of job, i.e. the classification of jobs according to skills level (here labelled as occupational level) has very great impact. In some countries (particularly Norway and Denmark), varying educational levels within a certain occupational level also seem to be of great importance.

The work environment measured by flexibility and autonomy – frequently referred to in the literature as discretionary work forms – also has strong impact. High values of flexibility and autonomy increase the likelihood of being an innovative strategic learner, which is consistent with the emphasis placed on 'discretionary work forms' in the literature about what promotes innovation.

It is natural that a statistical effect of training on innovation activity is found in many studies, because those with a high education level and/or with high scores in variables covering work profiles frequently request training, i.e. people whom we can assume as having a more innovative orientation. Moreover, the *availability* of training in an organisation may be of great importance and may explain the relationship between training and innovation at the aggregate level that is found in many studies. Here, we found that work-related training increased the probability of being an innovative strategic learner, also when controlling for work profiles and education level, etc., though the effects of training are small for some of the countries when including controls for the mentioned variables. A large part of the 'real' effect of training found in many studies on innovative activity is thus probably largely caused by the persons' work profile. However, this does not mean that training does not matter. Also when controlling for work profiles and education level, the findings indicate that it has a particular impact in Norway, followed by The Netherlands (if it has a long duration) and Denmark.

Policy Implications

With regard to the Norwegian puzzle mentioned in the introduction, it is of interest to look at the special challenges that may be found, based on the findings in the article.

- One challenge is that the Norwegian workforce scores quite low on the item 'keeping up to date with new products and services'.
- Increased efforts as regards work-related training will probably have particularly positive effects in the Norwegian workforce.

- Increased scores in the work environment variable 'autonomy and flexibility' and in the variable 'independent' increase the likelihood of being an innovative strategic learner at work in Norway. Additional analyses show that the Norwegian sample scores lower than Denmark and Finland in these variables. The results indicate that more emphasis could be put on autonomy, independence and flexibility in the Norwegian working life. High values in the work profile 'championing' also have a particularly positive impact in the Norwegian sample.

When focusing on Norway, this does not mean that these points are not equally (or more) important in The Netherlands, where better scores in e.g. the variable 'autonomy and flexibility' probably would greatly increase the innovativeness of the workforce. Moreover, in The Netherlands, particular challenges are found regarding the role of women in the workforce, the low share of workers exerting active learning strategies, and having work that involves learning-by-doing.

The findings raise questions for further research:

- Future research should examine the extent to which innovation activity is a gender issue. Not least, the results for Finland suggest that women's education and labour market behaviour have a special impact.
- The robust and large effects of the different work profiles on the probability of being an innovative learner should be examined further, e.g. *which factors act as barriers or drivers for workers in exerting such roles at work?*.
- Finally, a further question relates to the need for more comprehensive data which would combine individual data on workers' training and education, their work profiles and work environment, and information on corporate innovation investment and output/turnover.

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NOTES

1. GDP per capita in Norway is extremely high compared to most other countries, mainly because of the oil sector (OECD, 2015).
2. In 2011, i.e. the time of the PIAAC survey, the unemployment rate in the EU was 9.6%, while in Norway it was only 3.2%. The corresponding figures for 2014 were 10.2% and 3.5% (Eurostat, 2015).
3. The mean sample values of independent variables per country is also available from the author on request.

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Fostering Entrepreneurial Learning On-the-Job: evidence from innovative small and medium-sized companies in Europe

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Introduction

The interest of EU policymakers in ways to promote entrepreneurial learning has been growing in the last few decades. This interest has grown, on the one hand, because of the large number of independent entrepreneurs: the Global Entrepreneurship Monitor (GEM) indicates that almost one out of ten European citizens is thinking about starting or is taking initial steps to start their own business (Amorós & Bosma, 2014). On the other hand, there is an increasing group of employees that is taking the lead in Entrepreneurial Employee Activities (EEA) in existing firms: 'Employees developing new activities for their main employer, such as developing or launching new goods or services, or setting up a new business unit, a new establishment or subsidiary' (Bosma *et al.*, 2013, p. 7). Figures from the GEM in 2011 suggest that the group of entrepreneurial employees concerns almost 5% of the European adults (Bosma *et al.*, 2013) and this number is increasing as economies become more innovation-driven. As such, it is no coincidence that one of the key competencies as identified in the European Reference Framework on Lifelong Learning is a sense of initiative and entrepreneurship (European Parliament and the Council of the European Union, 2006), emphasising that entrepreneurship is more than venture creation.

Despite the growing interest in entrepreneurial learning, research on this topic is still in its infancy, starting as from the 1990s. Although significant advancement has been made, there are still many research issues in this field that warrant attention. Firstly, research on entrepreneurial learning is rather fragmented. Secondly, studies on entrepreneurial learning have been criticised for focusing solely on the entrepreneurial individual, neglecting that entrepreneurial learning is very often socially-mediated and situated learning (Dimov, 2007a). Thirdly, the field has mostly benefitted from conceptual work. Empirical work is scarcer, especially with regard to a focus on (promoting) entrepreneurial learning within the context of existing organisations, such as entrepreneurial learning of employees (De Jong, 2013).

Recently, the EU stated in its 'Europe 2020'-strategy that adult learning was an important way to promote entrepreneurship amongst employees. Hereby, (social) innovation and creativity are stimulated, and it is an important answer to (youth) unemployment and social exclusion (Council of the European Union, 2011). Furthermore, most firms are small and medium-sized (SMEs) (Muller *et al.*, 2014), with often no or hardly any human resource structures in place to systematically stimulate entrepreneurial learning amongst their employees. As most research focuses on large companies, it remains unclear which factors stimulate entrepreneurial learning in SMEs (Politis, 2005). Therefore, more insight into these factors

is needed and will help policymakers in addressing (some of) the overarching European challenges with regard to stimulating entrepreneurial learning in an SME context.

This article begins by unfolding the conceptual boundaries of entrepreneurial learning, by elaborating upon what and how entrepreneurs learn. Then, relevant antecedents and outcomes of entrepreneurial learning in the workplace are described and discussed. Next, the antecedents of entrepreneurial learning are further illustrated by an empirical study among more than 200 employees in 12 SMEs, covering individual aspects, as well as aspects related to the level of the organisation and work environment.

The Role of Education and Learning in the Entrepreneurial Process

With growing attention given to promoting entrepreneurship in the policy realm, research on entrepreneurship education and entrepreneurial learning is becoming more and more relevant. As Minniti and Bygrave (2001, p. 7) state: 'entrepreneurship is a process of learning, and a theory of entrepreneurship requires a theory of learning'. Therefore, in order to understand the entrepreneurial process, it is important to grasp *what* and *how* entrepreneurs learn (Wang & Chugh, 2014).

In defining what entrepreneurs should learn, research has shown that a great variety of competencies plays a role in the entrepreneurial process, such as strategic, relational, organisational and analytical competencies (Lans, Verstegen, & Mulder, 2011; Man, Lau, & Chan, 2002). In the context of entrepreneurial learning, authors particularly refer to the ability to identify entrepreneurial opportunities (Politis, 2005). The concept of entrepreneurial opportunities was popularised by the article of Shane and Venkataraman in 2000 to provide the research field of entrepreneurship its own intellectual identity (Venkataraman *et al.*, 2012). Despite its importance, scholars tend to disagree on what entrepreneurial opportunities comprise. Some argue that opportunities are objective entities, waiting to be discovered in the economic environment. From this point of view, entrepreneurs are *sensing learners*: practical thinkers who search for opportunities, set goals, scan the environment, analyse competition, and make strategic plans (DeTienne & Chandler, 2004; Wang & Chugh, 2014). Others argue that opportunities are socially constructed entities, created by entrepreneurs in interaction with their environment (Companys & McMullen, 2007). From this more subjective point of view, entrepreneurs are *intuitive learners*: abstract thinkers who act upon their environment, create market conditions, collaborate, and negotiate with others (DeTienne & Chandler, 2004; Wang & Chugh, 2014; Wood & McKinley, 2010).

Recently, scholars have tended to reconcile these two perspectives and acknowledged that opportunities could both be discovered and constructed: '(. . .) opportunities may be of several different kinds – some obvious and easily recognized, others more subtle and not so easily discovered, and yet others non-existent until people set out to make them from unexpected ingredients' (Venkataraman *et al.*, 2012, p. 24). Hence, both sensing and intuitive learning play a role in the entrepreneurial process. The attention given to entrepreneurial opportunities in the literature and the debate on this topic show the desire to understand how entrepreneurial opportunities are identified and acted upon, as well as the complexity of the learning process behind it (Politis, 2005).

Concerning the question of *how* entrepreneurs learn, Wang and Chugh (2014) summarise in their study that entrepreneurs learn by doing, experience, trial-and-error, participation, and the experience of others. Learning and working are difficult to separate in entrepreneurial learning, since learning is often unstructured, unintentional and not always recognised as such, being a concurrent process to working (Eraut, 2004). What seems to be clear from recent entrepreneurial learning literature is that learning-related activities associated with the ongoing entrepreneurial process are neither exclusively individual, nor exclusively social, but a combination of both (Cope, 2005; Dimov, 2007a, 2007b; Dutta & Crossan, 2005). Also, critical incidents or episodes seem to be important triggers for entrepreneurial learning (Cope, 2005; Cope & Watts, 2000; Lans *et al.*, 2008). Examples include financial problems, exit of key staff, acquiring new customers or innovating new products.

The fact that entrepreneurial learning is often unstructured, informal and unintentional does not mean that there is nothing to 'organize' in terms of entrepreneurial learning. Literature on entrepreneurship education, which centres around the effectiveness of entrepreneurship education programmes, is helpful here. Although the field is rather young and it is still difficult to tell whether entrepreneurship education is effective, the first, general impression is that it does work (Rideout & Gray, 2013). In a recent exercise carried out by the European Commission, in which 91 studies on entrepreneurship education in 23 countries were analysed, it was concluded that there was a positive impact of entrepreneurship education on all sorts of outcomes, such as the development of specific motivations (e.g. future engagement in entrepreneurship), knowledge, skills and attitudes, and employability and career ambitions (European Commission, 2015). Scientific studies on entrepreneurship education mainly focus on factors that influence the development of entrepreneurial intentions as predictors for entrepreneurial behaviour (Krueger, Reilly, & Carsrud, 2000). Recent meta-analyses in this field show overall small but positive effects of entrepreneurship education on entrepreneurial intentions (Bae *et al.*, 2014; Martin, McNally, & Kay, 2013). Also, entrepreneurial competencies, such as opportunity identification, can be improved by offering educational activities. For instance, DeTienne and Chandler (2004) showed that training could enhance the number and innovativeness of ideas identified by students. Comparable effects of entrepreneurship education on students' opportunity identification competence were reported by Karimi *et al.* (2014).

3-P model: factors influencing entrepreneurial learning of employees

The need for employees with an entrepreneurial orientation within existing organisations has been stressed in the work on corporate entrepreneurship or intrapreneurship (Guth & Ginsberg, 1990; Lumpkin & Lichtenstein, 2005). Sharma and Chrisman (1999, p. 21) define corporate entrepreneurship as 'the process whereby an individual or a group of individuals, in association with an existing organization, create a new organization or instigate renewal or innovation within that organization'. They state that it does not exclusively focuses on innovation, but also includes (1) the birth of new firms within or adjacent to the existing organisation and (2) strategic renewal, for example, changing the key ideas on which the organisation is built (Sharma & Chrisman, 1999).

As stated in the introduction, a large group of entrepreneurial learners hardly profits from organised learning activities. Specifically, for employees working in SMEs it is often difficult to organise such learning activities, given the size of the

company. However, their work environment is an important and powerful site for learning, and also for developing entrepreneurial competence. Several scholars tried to explain how an entrepreneurial work environment could be created and fostered, and what employees in all kinds of functions and roles needed in order to become entrepreneurial employees (Bosma *et al.*, 2013; Holman *et al.*, 2012; Wang, Ellinger, & Wu, 2013). In this regard, a helpful model to structure learning factors is the 3-P (presage-process-product) model, originally introduced by Biggs (1993). Although it was originally developed to map the complexity of learning in a school context, Tynjälä (2013) slightly adjusted and used it in the context of workplace learning. Following Tynjälä (2013), presage factors are seen as learner and work environment factors, process factors as work activities that foster learning, and product factors as learning outcomes.

To start with *product*, opportunity identification is a crucial outcome of entrepreneurial learning and is at the heart of the entrepreneurship literature (Shane & Venkataraman, 2000). Therefore, the ability of employees to identify entrepreneurial opportunities, referred to as opportunity identification competence (OIC), is the learning outcome of interest in this article. OIC is defined as 'the ability of individuals to identify ideas for new products, processes, practices or services in response to a particular pain, problem, or new market need' (Baggen *et al.*, 2015, p. 417). In this definition, opportunities are seen as ideas, which Davidsson (2015) referred to as *new venture ideas* (i.e. 'imagined future ventures', p. 7). OIC refers to being able to generate new business ideas or, in other words, to think of *potential* opportunities whose exploitation could lead to value creation.

From a *presage* point of view, prior experience in entrepreneurship is considered important, as scholars seem to agree that entrepreneurs mainly learn from experience (Harrison & Leitch, 2005; Politis, 2005). Studies from entrepreneurship education show that several learner factors, such as self-efficacy, influence the development of entrepreneurial intentions as predictors for entrepreneurial behaviour (Krueger *et al.*, 2000; Rideout & Gray, 2013). In a business context, employees' creative self-efficacy is considered crucial to realise innovations (Tierney & Farmer, 2011). Also, the study by Wang *et al.* (2013) showed that self-efficacy was one of the most important predictors of entrepreneurial opportunity recognition in the work context. Furthermore, they confirmed that social networks influenced (research and development) employees' opportunity recognition. Interpersonal, social networks help to receive diverse and accurate information on opportunities, thus contributing to the successful identification of opportunities (Wang *et al.*, 2013).

At the work environment (company) level, several studies focus on the importance of job design and openness to interaction with the external environment (Hornsby, Kuratko, & Zahra, 2002; Jones & Macpherson, 2006; Lans *et al.*, 2008). With regard to job design, Holman *et al.* (2012) studied the influence of job control and problem demand on employees' innovativeness in manufacturing firms. Job control was analysed as the extent to which employees had discretion over how they would prefer to do their job. It contributes to employees' intrinsic motivation and enables them to independently select the most appropriate solution for a given problem situation (Holman *et al.*, 2012; Hornsby *et al.*, 2009). Problem demand was seen as the frequency and difficulty of task problems. It prevents employees from solely focusing on effective task performance and challenges them to solve problems in new ways. Holman *et al.* (2012) found that both factors had an indirect

association with idea generation through work-based learning strategies. Concerning the importance of the external environment, Wang *et al.* (2013) found that the employees' perception of environmental opportunities was the most important predictor of opportunity identification, compared to four other antecedents related to the individual (such as self-efficacy). How employees perceive the companies' industrial environment, recognise threats and opportunities, and experience change and uncertainty in their environment seems to be relevant for exploiting the learning potential of the work environment (Hornsby *et al.*, 2009; Wang *et al.*, 2013).

For the *process* part of the model, Tynjälä (2013) refers to the work activities that foster learning processes, such as learning by doing. Several studies in the field of workplace learning emphasise the importance of work activities as vehicles for all sorts of work-related learning outcomes, including task performance, role performance, team work, awareness, understanding, decision making and problem solving (Eraut, 2004). Similarly, studies on entrepreneurial learning stress the importance of learning by doing (Cope, 2005). In 2011, the GEM investigated Entrepreneurial Employee Activity (EEA) worldwide to get a better grip on corporate entrepreneurship (Bosma *et al.*, 2013). As the GEM results show, employees actively involved in innovation-related activities are far more likely to identify potential opportunities.

According to Eraut (2004), important work-related activities can be grouped as 1) team work and working alongside others, 2) working with significant external stakeholders (e.g. clients), and 3) dealing with challenging tasks. In order to explore new ideas, to construct language and meaning in the organisation of potential new business ideas, new ideas must be shared with others. In the jargon: the potential business opportunity needs to be 'objectified' (Dutta & Crossan, 2005; Wood & McKinley, 2010). Although the entrepreneurship literature has long emphasized the 'heroic individual', there is an increasing amount of empirical evidence that supports the notion of significant peers, especially in the early stages of entrepreneurship. For instance, it is estimated that over 84% of the innovative projects use multifunctional teams (Griffin, 1997). Moreover, there is a direct link between team work and entrepreneurial performance (e.g. innovation), be it independent start-ups or corporate entrepreneurship projects (Vyakarnam & Handelberg, 2005). Besides learning internally about the new idea, business opportunities often grow and need to be validated in interaction with the external environment (Wood & McKinley, 2010). Work activities that include engagement in networks of external relationships, immersion within the industry (e.g. attending conferences, business visits) are all recorded as powerful learning-related work activities in small firms (Billett, 2011; Fenwick, 2003; Mulder *et al.*, 2007; Rae, 2006). In the continuing process of opportunity enactment, the support of external stakeholders becomes even more prominent. It requires activities such as setting up small experiments, prototyping and observation. This will inevitably lead to the challenging of earlier assumptions around the idea and to solving existing and emerging problems in the trajectory to realising the business idea.

To sum up, earlier work carried out in the field of entrepreneurial learning and education provides clear evidence of the importance of entrepreneurial learning in an SME context for different learning outcomes, such as entrepreneurial intentions and competencies. To further illustrate this, we explored how entrepreneurial employees learned and what specific factors contributed to an exemplary learning outcome of entrepreneurial learning, namely OIC. In short, we aimed to answer the following question: *What are antecedents of individual opportunity identification competence (as outcome of entrepreneurial learning) in a small and medium-sized business context?*

Methods

Participants

In total, 234 employees from 12 SMEs participated in this study. The companies were mainly active in the agricultural, food, and fibre industry and all the companies had an affinity with innovation, as the only requirement was that they had introduced at least one new product or service in the last three years. One company was from a different manufacturing industry, the metal industry. Although this is a different sector, it was included because it was comparable with the other organisations in terms of organization and innovation structure, size, and educational level. The same holds for the German company (the other 11 companies were Dutch). To gain insight into the innovative and learning capacity of each organisation as a whole, employees in all kinds of functions and roles were invited to participate in the study: members of the management team, employees from marketing, human resources, support, and employees working in the factory or at the shop floor level. It was recommended to invite a mix of employees in terms of age, gender, educational level, and function. Only participants with at least three years' working experience were included in the analysis to ensure that they were able to participate adequately. Of the total of 234 participants, 218 had at least three years' working experience. Their mean age was 42 (SD=9) and 76.1% were male. Their educational level ranged from primary or lower vocational education to PhD. Table I shows an overview of the companies that participated.

TABLE I. Overview of the participating companies in terms of main product, country, number of employees, and number of participants (with at least three years' working experience)

Company number	Main product	Country	Number of employees	Number of participants
1	Paper	The Netherlands	185	16
2	Paper	The Netherlands	40	8
3	Seeds	The Netherlands	220	25
4	Chrysanthemum	The Netherlands	100	28
5	Union seeds	The Netherlands	62	28
6	Trade & distribution vegetables and fruits	The Netherlands	38	15
7	Orchids	The Netherlands	70	26
8	Substrates	Germany	370	21
9	Trade & distribution vegetables and fruits	The Netherlands	43	11
10	Champignons	The Netherlands	100	15
11	Trade & distribution vegetables and fruits	The Netherlands	450	13
12	Metal	The Netherlands	70	12

Procedure

The data were collected at the participating companies by the first author. At the time of the data collection, the participants first received information on the procedure. Secondly, they signed a declaration of consent, stating (1) that all data would be processed confidentially and (2) they gave permission for the use of their results for scientific purposes. They then worked on the questionnaire. After completing

all the questions, the data were analysed and the first author returned to the company two weeks later in order to evaluate the data collection and discuss the results.

Measures

All the variables were measured using a questionnaire as the data collection tool. Most items were answered on a five-point ordinal scale. Items corresponding to a given concept (e.g. 'self-perceived creative self-efficacy') were combined in a summated rating scale which was used as an index in subsequent analyses. Noted advantages of summated rating scales include good reliability and validity (i.e. psychometric properties), ease in development, and ease to complete (Spector, 1992). Strictly speaking, parametric statistics may not be applied for such scales (Kampen & Swyngedouw, 2000), unless (as we do) we invoke the 'pragmatic sanction' that 'in numerous instances it leads to fruitful results' (Knapp, 1990, p.123).

Opportunity identification competence

To obtain insight into the outcome variable OIC, as valued in the business context, respondents were asked 'How many new ideas from you (or your team) have been adopted by the management (resulting in a concrete project) either in whole or in part, during the last three years?' Only the responses of the participants who had at least three years' working experience were included in the analysis. If they were ambiguous in their answers (e.g. indicating multiple numbers), the result was coded as a missing value. This way, wrong interpretation of answers was avoided.

Learner factors

Four learner-related factors were included in the questionnaire, namely self-perceived social networks, self-perceived creative self-efficacy, entrepreneurial intentions and entrepreneurial experience. To measure self-perceived social networks, a scale of three items was adopted from Wang *et al.* (2013). The questions focused on social networks considered important in a business context, such as contact or discussion with customers, suppliers, distributers, social, and professional contacts. Self-perceived creative self-efficacy was measured according to a three-item scale of Tierney and Farmer (2011) and included 'I have confidence in my ability to solve problems creatively'. The participants' entrepreneurial intentions were measured according to four items adopted from DeTienne and Chandler (2004), asking if participants would be involved in a new venture in the next 12 months, five years, ten years, or sometime in their lifetime. Finally, to investigate prior experience in entrepreneurship, they were asked whether they had a company at the moment of testing, and whether they had had an entrepreneurial venture in the past. These two questions were combined, so that 0 = no prior experience in entrepreneurship, and 1 = running an entrepreneurial venture now or in the past.

Work environment

Three work environment factors were measured in the questionnaire, namely problem demand, job control and self-perceived industrial environment. To measure problem demand, the participants were asked 'How often do you

usually face relatively more complex problems that take at least 30 minutes to find a good solution?' The answers were formulated as 'never', 'less than once a month', 'less than once a week', 'at least once a week', and 'every day'. Job control was measured with the question 'Considering the majority of your daily tasks at work, how precise are the instructions that you get from your supervisor regarding the process according to which they should be performed?' and could be answered with 'the instructions I receive determine every step of how I should perform my tasks, with no freedom at all', 'I receive relatively precise instructions and have limited freedom', 'I receive clear instructions but I can still be flexible', 'I receive general instructions and mostly have to decide the details on my own', or 'I have to decide on my own how to perform my tasks'. The three questions on the self-perceived industrial environment were adopted from Wang *et al.* (2013) and asked the participants whether they perceived many opportunities for new product innovation, technological innovation, and whether there were opportunities for growth in the industry.

Process: Entrepreneurial Employee Activity

EEA was measured according to six items concerning how often the participants were involved in innovation-related activities which included task-related, internal as well as external work-related learning activities, such as acquiring new groups of customers, optimising the organisation of work, or producing ideas to improve work practices (De Jong & Den Hartog, 2010).

Analysis

The internal consistency of the scales was determined by principal components analysis. Measurement properties of all used summated rating scales showed sufficient psychometric properties, except for EEA. Here, three items showed relatively low factor loadings and were removed. All other loadings ranged between .69 and .92, which provided no evidence that items measured more than a single dimension. An indication of the scale's reliability was given by Cronbach's alfa, which ranged between .69 and .89. To gain detailed insight into the relationships between the learner factors, work environment, EEA, and OIC, the analyses consisted of two steps. First, the relationships between OIC and each block of antecedents were investigated separately in three multiple regression analyses (i.e. learner factors, work environment, and EEA), in order to reach a specific understanding of the influence of each block of antecedents on OIC. Second, in order to find the strongest predictors of OIC, a backward regression analysis was conducted in which all learner factors, work environment factors and EEA were entered. Possible dependencies of responses due to the fact that respondents clustered in organisations were checked by including organisation as a fixed factor in an ANCOVA of OIC and its antecedents. The results showed that organisation did not have a significant effect and it was therefore not needed to control for organisation in further analyses. Significance level for all tests were set at a relatively conservative alpha level of .01 in order to control for capitalisation on chance.

Results

The participants had little entrepreneurial experience (M=.21) and entrepreneurial intentions (M=2.41). Job control scored very high (M=4.17), indicating that the participants experienced relatively high degrees of freedom in how they performed their tasks. Problem demand scored average (M=2.93), suggesting that the participants faced complex problems (that take at least 30 minutes to find a good solution) less than once a week, but at least once a month. The participants' scores were comparable for the questions on the frequency with which they engaged in entrepreneurial work-related activities (M=3.20). Furthermore, on average, they had had 3.83 business ideas adopted by the management over the last three years. The standard deviation was relatively high (SD=4.20), suggesting that some participants were more successful here than others. Moderately high correlations were found between self-perceived self-efficacy and self-perceived social networks (r=.40), EEA and problem demand (r=.41), and EEA and the number of ideas adopted by the management (r=.44). Entrepreneurial experience did not correlate to any of the other variables. An overview of the descriptive statistics and correlations of the different variables from the model are given in Table II.

TABLE II. Means, standard deviations, and correlations for all the variables

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. Self-perceived social networks	3.84	.61	–								
2. Self-perceived creative self-efficacy	3.79	.61	.40**	–							
3. Entrepreneurial experience	.21	.40	−.06	.13	–						
4. Entrepreneurial intentions	2.41	.94	.26**	.27**	.13	–					
5. Problem demand	2.93	.98	.21**	.18**	−.00	.27**	–				
6. Job control	4.17	.78	.12	.09	.04	.10	.30**				
7. Self-perceived industrial environment	3.82	.69	.30**	.17**	.03	.10	.04	−.00	–		
8. Entrepreneurial Employee Activity	3.20	.82	.28**	.39**	.17	.18**	.41**	.28**	.19**	–	
9. Number of ideas adopted by the management	3.83	4.20	.22**	.28**	.10	.27**	.26**	.23**	.17	.44**	–

The three separate multiple regression analyses successively including the learner factors, work environment factors, and EEA suggested that EEA played the most important role in explaining OIC (i.c. the number of ideas adopted by the management). The F-values in the footnote denote the usual omnibus test for significance of the variables included in the analysis. The significant F-values suggest that all models significantly explained variance of the number of ideas adopted by the management as a whole. In the backward regression model, only two predictors remained: self-perceived creative self-efficacy and EEA. This model explained 24% variance of the number of adopted ideas by the management. The results of the multiple regression analysis per block and the backward regression analysis are shown in Table III.

TABLE III. Three separate multiple regression analyses per block predicting the number of ideas adopted by the management, and a backward regression analysis, including all blocks

	Analysis per block (enter)			All blocks (backward)[d]		
	B	*t*	*p*	*B*	*t*	*p*
Block 1: Learner factors and OIC [a]						
Constant	−6.19	−2.58	.011	−6.68	−3.34	.001
Learner factors						
Self-perceived social networks	.77	1.37	.174			
Self-perceived creative self-efficacy	1.57	2.48	.014	1.00	1.80	.074
Entrepreneurial experience	.66	.82	.416			
Entrepreneurial intentions	.39	1.01	.317			
Block 2: Work environment and OIC [b]						
Constant	−6.43	−2.59	.010			
Work environment factors						
Problem demand	.82	2.39	.018			
Job control	.95	2.14	.034			
Self-perceived industrial environment	1.02	2.39	.018			
Block 3: EEA and OIC[c]						
Constant	−3.89	−3.05	.003			
Entrepreneurial Employee Activity	2.39	6.23	<.001	2.07	5.12	<.001

Note. [a]R^2=.13, N= 144, F=4.99, df =4, 139, p<.01
[b]R^2=.12 N=158, F=7.06, df=3, 154 p<.01
[c]R^2=.20 N=160, F=38.75, df=1, 158, p<.01
[d]R^2=.24, N=143, F=22.39, df=2, 140, p <.01

Discussion

Because of the increasing interest in entrepreneurship education and entrepreneurial learning in general, and the shortage of studies on entrepreneurial learning of employees in existing businesses (Council of the European Union, 2011), this study focused on the factors that influence entrepreneurial learning in an SME context. More specifically, the influence of learner factors, work environment factors, and EEA on individual OIC was investigated. The number of ideas of a participant adopted by the management in the last three years was used as a business-specific measure of his or her OIC. Employees from all levels of the organisations were included to obtain insight into entrepreneurship in companies in its broadest sense.

A first result of this study was that in the multiple regression analysis, in terms of learner factors, the largest contribution came from self-perceived creative self-efficacy. This is similar to earlier work that had been carried out in the field of independent entrepreneurship. For instance, meta-analysis showed that entrepreneurial self-efficacy was one of the strongest individual characteristics that explained entrepreneurial success in terms of growth and financial performance (Rauch & Frese, 2007). Stimulating and developing entrepreneurial self-efficacy has become of major interest in entrepreneurship education programmes, starting already in initial education. Intervention studies suggest positive effects of organised learning activities on entrepreneurial self-efficacy (Fayolle, Gailly, & Lassas-Clerc, 2006), although

experiments are scarce and need further validation (Martin *et al.*, 2013; Rideout & Gray, 2013). In sum, the results of this study suggest that specific forms of entrepreneurial self-efficacy are important, not only for independent entrepreneurship, but also in the early stages of the entrepreneurial process in existing companies.

A second result was that work environment factors (job control, problem demand, and the perceived industrial environment) had a positive association with OIC. These effects disappeared in the backward regression analysis including learner factors and EEA. This is in accordance with the study by Holman *et al.* (2012) who found an indirect relation between job control, problem demand, and idea generation. The results provide mild evidence that work environment factors such as work design, organisation of work, and decision power not only yield more effective learning systems (Brandi & Ionnane, 2015), but may also indirectly foster the (necessary) flow of new business ideas from employees to the management.

A third important finding was that in the backward regression analysis, EEA had the largest impact on OIC. This confirms the results of the GEM, in which Bosma *et al.* (2013) found that employees involved in EEA were more likely to identify business opportunities of good quality. Furthermore, it underlines the complex and dynamic nature of entrepreneurial learning, as learning and work are difficult to separate in an entrepreneurial context (Eraut, 2004; Wang & Chugh, 2014). Learning by doing is not only crucial for independent entrepreneurs, but also for employees in a business context, especially in SMEs.

Limitations and the future research agenda

In this study, we attempted to measure the number of ideas adopted by the management as an indicator for OIC in a business context. Our results suggest that mainly EEA explains how many ideas of an employee are adopted by the management. Future research should reveal how and to what extent EEA serves as a moderator or mediator between the other independent variables (i.e. learner factors and work environment) and OIC, for which a larger sample is needed. Such research could include additional work environment factors where previous research showed that it played a significant role in corporate entrepreneurship, for instance innovation culture (De Castro *et al.*, 2013). We recommend asking about the type of ideas adopted by the management. By scoring the ideas in terms of their innovativeness, it could be investigated more specifically whether and how work environment factors relate to OIC. For example, DeTienne and Chandler (2004) scored generated business ideas on innovativeness based on a 6-point Likert scale.

In this study, employees fulfilling all kind of functions were invited to participate. The data did not allow us to make a distinction in entrepreneurial learning over functions. For future research, we therefore recommend collecting data among a larger sample in order to compare employees in different functions. Some studies already focused on a single group of employees (Wang *et al.*, 2013, who focused on research and development employees). A comparison between several functions in one dataset would be interesting to investigate more specifically how entrepreneurial learning in businesses emerged and who was involved in it.

Entrepreneurial learning is very often a social or group activity (Dutta & Crossan, 2005). Therefore, it would be interesting to investigate the collaborative entrepreneurial learning of groups of employees. Next to the individual competence

to identify opportunities, group competence to evaluate and exploit opportunities into a concrete plan for a new product, service, or process, could be tested.

Conclusion and Policy Implications

In sum, our results suggest that self-perceived creative self-efficacy, work environment factors and being actively engaged in entrepreneurial activities foster employees' success in having business ideas adopted by the management of the organisation. Although entrepreneurial learning is often informal in SMEs, and, as such, a by-product of work, the results also point to important areas to further strengthen entrepreneurial learning.

Firstly, the results emphasise the importance of soft skills, and more specifically belief in one's ability to execute entrepreneurial tasks, such as generating business ideas. As Brandi and Ionnane (2015) conclude, soft-skills are highly valued by employers and employees. Nevertheless, investment should mainly come from the individual employee, as in most SMEs there is a limited budget for developing such skills through training programmes. Companies invest primarily in harder skills that directly contribute to new business development and financial performance. As such, soft-skill development, like creative self-efficacy, depends on more informal learning mechanisms, such as mastery and vicarious learning. For early career professionals, this highlights the importance of fostering entrepreneurial self-efficacy in tertiary education. For more senior colleagues, this could be stimulated as a by-product in business-related programmes. Small companies could invest in combinations of business-related training programmes which simultaneously stimulate the development of softer entrepreneurial skills such as divergent thinking to enhance entrepreneurial self-efficacy.

Secondly, based on our results, we suggest that job control, problem demand, and the perceived opportunities in the environment indirectly contribute to entrepreneurial learning. Policy makers could play a role in designing jobs in which job complexity and autonomy are fostered at the shop floor level, and could facilitate collaboration between companies. As our results point towards a more complex interplay between the work environment and OIC, more research in this area is desirable.

The most important predictor of OIC was involvement in entrepreneurial activities, which confirms the importance of learning by doing. Learning by doing could be stimulated by involving employees in entrepreneurial work-related activities, investing in learning programmes with a focus on the shop floor level, and creating cooperation across boundaries within the organisation.

However, not all entrepreneurial learning is simply a matter of learning by doing. It would be a mistake to believe that entrepreneurial learning in the workplace often approaches its potential. As already indicated, individual (e.g. belief in one's skill) and work environment factors (e.g. room to manoeuvre) need to be in place to afford these type of entrepreneurial, work-related activities. Moreover, evidence from the literature suggests that small-firm owner-managers value and exploit the learning potential of the work environment very differently (Lans *et al.*, 2008). Hence, as owner-managers of SMEs have so much decision power, they must be educated and supported for this role. Nonetheless - as experienced in the data collection process among the various enterprises - the competence of managers in the field of entrepreneurial learning does not seem to be a priority in management development programmes. As the small-firm owner-managers play a crucial

role in recognising, affording and reflecting on this type of behaviour, policy programmes should target this group and make the recognising, fostering and capitalising of entrepreneurial learning an integral part of management development programmes. In sum, close collaboration between policy makers, employers and entrepreneurial learning professionals is called for in efforts to effectively combine and realise entrepreneurial learning, human capital, EEA, and eventually innovation in the SME context.

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Adult Learning in Innovative Organisations

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Introduction

Research on innovation has frequently suggested a strong link between human capital and the ability to innovate[1] (Cohen & Levinthal, 1990). Human capital has also been central to many studies of innovation carried out by the OECD and CEDEFOP which have demonstrated that organisations with a more highly-educated workforce were more innovative (OECD, 2011, Cedefop, 2012). Innovation is frequently defined as a learning processes (Lundvall, 1992, Edquist, 2001). 'Product and process innovations are the results of learning processes such as R&D, learning-by-doing, learning-by-using and learning-by-interacting' (Edquist, 2001, p. 16). Innovation is described as a gradual process whereby people, firms and nations learn from their joint attempts to solve problems and develop knowledge. It has been suggested that the decisive characteristic of an innovative firm was its ability to adapt to change (Barton, 2000). These innovative firms have also been described as learning organisations. This is supported by empirical studies, which have demonstrated that certain forms of flexible organisation make it easier for informal groups or communities to develop and that it was often these informal groups which provide appropriate environments for learning and creativity resulting in new products and services (Amin & Cohendet, 2004; Nonaka *et al.*, 1999). The results of European surveys, such as the Community Innovation Survey (CIS) and the European Working Conditions Survey (EWCS), have been studied by Arundal *et al.* (2007), who found a correlation between the way in which tasks were organised in the workplace and the innovativeness of the firm. Thus, we have innovation literature which places learning at the centre of the innovation process, both inside and outside firms. We have some research suggesting that certain kinds of organisation and certain ways of working are associated with more innovative firms and we also have research suggesting a connection between intellectual capital and innovation. However, we know little about whether firms are aware of any links between learning and innovation and, if so, what they are doing about it? This is the starting point for this article, which attempts to develop new insights into innovation by studying attitudes to learning and how learning and competence development are practised in innovative firms. This article draws upon concepts from workplace learning (Eraut, 2004) and concepts of learning used in innovation studies (Lorenz & Lundvall, 2011) to study learning in innovative firms. The main questions are:

> Are innovative firms aware of a relationship between learning and innovation?
> and
> What activities in the innovative firm contribute to interactive learning?

In order to answer these questions we examined the learning strategies of the various innovative firms and their activities designed to promote learning. We supplemented this with experiences of employees working on the development of new products and services.

What Do We Know about Learning in Innovative Firms?

Theories of innovation have frequently referred to the importance of learning in innovation. (Schumpeter, 1947; Lundvall & Johnson, 1994; Grønning & Fostenløkken, 2014). Schumpeter studied innovation as a process of destruction of old ideas and ways of thinking and their replacement with new ones, suggesting that all learning is simply the recombination of facts. Many of the early studies of innovation are based on the assumption that innovation is something which happens in the Research and Development (R&D) department (Kline & Rosenberg, 1986). Studying innovation by looking at R&D has proved a valuable way of understanding knowledge production in relation to the development of new technologies. More recently, there has been increasing interest in innovations in organisations which do not have R&D departments and do not necessarily have close links with research environments at universities, as is often the case within the service sector. This line of research has identified learning processes taking place while interacting with others (Lundvall & Johnson, 1994). These learners may be colleagues in the same firm, but can also be participants in large networks of (Powall & Grodal, 2005) which could include universities, as well as suppliers and distributors. This process of communication and exchange of information while new products and services are being developed was defined by Lundvall *et al.* (1992) as interactive learning. Jensen *et al.* (2007) developed this theme by differentiating between the kind of learning that one could expect to result from research collaborations and the kind the learning that one could expect as the result of shared practice. This differentiation was conceptualised in terms of science, technology & innovation (STI) and doing, using & interacting (DUI). STI is based on purposeful, research-based studies directed at developing new understanding, while DUI is based on practice. The latter often occurs as a direct result of ordinary work activities, rather than as the outcome of a carefully planned R&D project. Much of the literature on innovation builds upon the idea that learning is one of the central drivers of the innovation process.

Lorenz (2012) attempts to understand some of the activities within innovative firms and introduces us to different organisational characteristics which contribute to innovation. He suggests that some innovative firms are characterised by a predominance of highly-educated employees who have considerable freedom in deciding how their work should be organised and how tasks should be carried out. Not only do they have this autonomy, but they also have a high degree of security of tenure, something which Lorenz suggests makes them more willing to experiment. He also recognises another characteristic of innovative firms, i.e. the ease with which employees can build relations. This is particularly important in environments where decision-making is traditionally based on consensus. He defines the activities of employees engaged in innovation in terms of Florida's (2002) creative class, i.e. people who:

- Engage in complex problem solving
- Think on their own
- Take decisions
- Have a high level of discretion over their choice of methods and organisation of tasks

If we summarise some of the ideas of learning as expressed in the innovation literature, then the innovative firm should ideally consist of groups of highly-educated

employees who have access to further education, as needed, and who have freedom to plan their work and take their own decisions. We would also expect working tasks to include a great deal of problem solving. If we supplement this with some more detailed definitions of learning in the workplace, then our concept can include more criteria which might make a work situation conducive to learning and innovation.

One of the recurring themes of workplace learning is the relationship between formal and informal learning. Eraut (2000) describes learning as a continuum with formal learning at one end and informal learning at the other. Formal learning leads to formal qualifications, typically obtained in educational establishments. Informal learning is 'a combination of learning from other people and learning from personal experience, often both together'(Eraut, 2004, p. 248). This definition matches quite well with Lundvall's and Johnson's definition of interactive learning. Some of the research on informal learning has resulted in the following taxonomy:

Time of focus	Implicit learning	Reactive learning	Deliberative learning
Past episode(s)	Implicit linkage of past memories with current experience	Brief near-spontaneous *reflection* on past episodes, events, incidents, experiences	*Discussion* and *review* of past actions, communications, events, experiences
Current experience	A selection from experience enters episodic memory	*Noting* facts, ideas, opinions, impressions; *asking* questions; *observing* effects of actions	*Engagement* in decision making, problem solving, planned informal learning
Future behaviour	Unconscious expectations	*Recognition of* possible future learning opportunities	*Planning* learning opportunities; *rehearsing* for future events

FIGURE 1. Eraut's taxonomy of informal learning (Eraut, 2004, p. 250)

Eraut differentiates between forms of learning, based on whether it is intentional or not. The learner is not normally aware of implicit learning and it is not intentional, reactive learning can be opportunistic and near-spontaneous and thus may also be unintentional, while deliberative learning can be planned or designed. The implicit learning column explains what is happening to the individual, while the other columns include interactions, such as discussion, engagement and asking questions i.e. interaction. Like Lorenz and Lundvall, Eraut includes problem solving and involvement in the decision-making process as part of learning at work. However, if we add Eraut's definitions to those of Lundvall and Lorenz, we can extend our expectations of the innovative firm to include workplaces which provide opportunities for discussion and questions and a broad enough range of tasks which enables employees to compare an array of past episodes and experiences with current ones. We would also expect innovative firms to provide the opportunity to plan future learning opportunities. Eraut's differentiation between intentional and unintentional raises some interesting challenges for the study of innovation. In order to understand how learning could be contributing to innovation, we should look at both intentional and unintentional learning. We can assume that many R&D activities are intentional, but the other main actor steering intentional learning in firms is

Human Resource Management (HRM) (Olsen, 2015). In the following case studies we have included interviews with HRM departments and have studied their strategies for learning. In this way, we can better understand their intentions. In order to understand both intentional and unintentional learning, we talked to R&D managers and employees working on R&D projects and product development.

Research Design - Method and Data

Many of the earlier studies of innovation are based on surveys, while many of the studies of workplace learning use interviews and observations. Since we want to gain a better understanding of interactive learning and include both informal and unintentional learning, it was decided that a qualitative approach would be most appropriate. In the selection process, we used the definitions of innovation in international surveys such as the European communities innovation survey (CIS). They define an innovative firm in terms of the amount of income a firm derives from new products. We did not ask HR managers about the proportion of their income derived from new products or services, but used references in the national media and in the firms' published descriptions of their innovative activity. Four potential cases were identified in different business sectors (Telecom, Engineering, Defence & Banking).

In order to cover both intentional and unintentional learning, it was decided to include the opinions of employees working in environments that focus on innovation and in environments which focus on learning and competence development and to try to gather examples of learning which they believed to be important contributions to the firm. Thus it was decided that interviews supplemented by documentation would be the best method. We interviewed HR managers, managers or project managers in R&D or product development and employees working in product development or R&D in each firm. 20 interviews were carried out in Norway.

Data sources	HR Management	Management R&D or Product development	Employee in R&D or Product Development	Annual reports Web pages Strategy documents
Method	Interview	Interview	Interview	Document analysis
Reference	1	2	3	4

FIGURE 2. Data and methods

Interviews in category 2 and 3 were carried out with persons working either in R&D or in the development of new products or services. These interviews were designed to obtain a description of work relating to the development of new products and services, including They comprised examples of whom they interacted with and how learning occurred on an everyday basis. Some of the themes explored in the interviews included:

1. Education and work experience
2. Opinions on the link between learning and innovation.
3. The organisation of work tasks:

— Autonomy (freedom to plan work, freedom to take decisions or involvement in the decision process, freedom to experiment)
— Variety of tasks & novelty
— Problem solving
— Security of tenure
— Opportunities for forming new relations
— Access to further education and vocational training

We supplemented these questions with some from the PIAAC survey (2013), as described in the article by Støren in this issue

— Sharing work-related information
— Extent to which one can organise one's own time
— Negotiating with colleagues and others

Interviews in category 1 explored how the case firms developed their strategies for competence development and how this could be related to R&D and product development. We also explored the role and responsibility of HR departments and how they interpreted innovation and their potential contribution to innovation processes. We also asked HR managers to describe what kind of training programmes and other initiatives they had followed to stimulate learning in the firm.

The document study (4) was designed to give an indication of whether firms viewed their commitment to learning as important enough to share with the outside world and if they saw any links between learning and innovation.

In order to analyse the data on competence development and find a meaningful way of categorising data we used those developed by Eraut (see Figure 1).

The firms have the following characteristics:

The interviewees' names or positions were not attached to citations in order to protect the privacy of the firms.

Findings

How Innovation and Product Development Activities were Organised

With respect to the way in which work on new products and services was organised, there was a difference between firms that had an R&D department and those who did not. Three of the firms had an R&D department, but in one, the emphasis on R&D had been greatly reduced in recent years and the main R&D tasks were frequently related to adapting existing technologies for use in different countries. In this particular firm, the R&D projects were typically short-term and R&D employees worked closely with client departments. Firm number 2 had long-term plans related to the development of a particular technology and each R&D project was typically a new version of the same technology. This firm had close contact with its customers and many of the developments were improvements that had been suggested or requested by customers. Firm number 3's strategy was much more long-term. When a decision had been taken on a new line of business or a new technology, a research group was created with a long-term perspective, i.e. 5 years or more. New people were frequently recruited to work on a new project, often doing their PhD as part of the project. As the project neared a stage where the product could be commercialised, it was moved from R&D to the relevant business unit. At this stage, it was quite common for employees in the R&D team to move to the business

Firm	R&D	Number of employees	International	Business
1	Yes	35 000	Yes	Telecom
2	Yes	680	Yes	Defence
3	Yes	15 000	Yes	Engineering services
	No	11 000	Yes, but most business within Scandinavia	Finance

FIGURE 3. Firm characteristics

unit. In this way, it became part of the career development pattern in this firm and most employees stuck to the same technology, with some even taking on more operative roles. In firm number 4, there was no formal R&D department. It developed and sold financial services, most of which were based on ICT. New product development was organised in the form of an ICT development project, normally consisting of a specification of user requirements, development of a test or pilot version of the new software, which was tested by a selected group of users before its commercialisation. These projects rarely lasted longer than a year, with many lasting only a few months.

How the Firms Communicated their Commitment to Learning

In the interviews, all stressed that their firms were committed to learning and the development of their employees. This is reflected to a certain extent in their published annual reports from 2014:

Firm 1

'Through Firm 1 Research, the company develops insight and competence on current and future customer behaviour and preferences'.

'Firm 1's aim is to further develop a differentiated culture, ensure unrivalled competence and develop an adaptable organisation'.

'Firm 1 continues to focus on improving the adaptability and agility of the organisation to foster innovation and future growth. The approach has been to improve awareness, develop competence and platforms, and ensure the right environment across markets'.

'We are approaching this [change] from a continuous learning and improvement perspective"

"...new business opportunities which enhance skills and reduce a country's brain-drain'.

Firm 2

'It is Firm nr. 2's core strategy to continue to grow both organically and through acquisitions. Growth through diversification based on core competences is also being considered'.

Firm 3

'As a global knowledge company, we rely entirely on our people, so promoting the continued well-being, competence and development of our employees is fundamental to our business'.

'Strategic research projects explored topics that are considered important for the future, and where Firm 3 can leverage its history and competence to catalyse the transition'.

'A number of exchange programmes were conducted to facilitate competence development and knowledge sharing in the organization'.

'The combined competence and synergies of Firm 3 legacy organizations are powerful propositions for the sector'.

'As a knowledge driven company, we actively nurture and develop the competence of our people and formally encourage curiosity and the sharing of knowledge across disciplines'.

'As a knowledge company, we aim to develop the competence of our employees, safeguard their well-being and create a workplace that is attractive and challenging and where people are motivated to fulfil our Purpose and Vision and live our Values'.

'Our IT platform and collaboration tools are also helping the merged organization to operate as one company and are essential for the utilization of shared competence across geographies'.

Firm 4

'Competence and talents must be nurtured, and the Group offers a range of training programmes. There are also good opportunities for professional and personal growth'.

'Initiatives to retain and develop talented employees in Firm 4 include highlighting internal career opportunities and offering targeted competence training'.

'Developing a corporate culture is a central part of the group strategy, and a wide range of measures has been implemented to strengthen employee engagement and managers communication skills'.

Firm 4 also listed the average number of hours spent on training and cost of training per employee.

Concerning global initiatives: 'This provides a basis for learning and knowledge sharing and for exerting influence'.

The information in annual reports is mainly directed towards shareholders and investors. Hence, it may reflect different priorities. Firms, 1, 3 and 4 are interested in communicating their commitment to the development of their employees and stressing the importance of their work force as part of their competitive advantage. Some statements suggest that learning and competence development are viewed as a way to motivate employees and retain them within the firm, whilst some suggest that firms are also aware of their competitive position and of the role that competence plays in expansion and globalisation. Annual reports from firm 2 are less revealing. However, in interviews it was evident that management viewed competence as a key factor in international competition.

Learning Activities in the Firms

One firm was in the process of implementing a new learning philosophy based on collaboration with US consultants. The programme focuses on learning in the

workplace and suggests that as much as 70% of an employee's learning is practice-based, on-the-job learning, 20% is from coaching and feedback from others with more experience, while only 10% is based on courses. 'A workplace where learning is work and work is learning'. This philosophy does not build directly on traditional theories of learning and it seems to ignore the fact that on-the-job learning usually happens in interaction with others. However, it does emphasise practice-based learning. The case firm working with this philosophy was eager to use it to promote flexibility and create a more agile workforce who can adapt to changing circumstances. The concepts of formal and informal learning have been introduced to the workforce and managers are urged to create 'collaboration sites', physical meeting places, supported by digital media and electronic access to others.

Management training was typically organised as programmes for all managers with responsibility for other employees and in some cases there were special courses for more junior employees who were judged to have a high potential to become managers. This kind of management training typically had several sessions where participants were given practical tasks to work on between meetings. There was a strong emphasis on developing individual capabilities. However, there was also an intention to develop teams of managers who would be able to cooperate in the future.

Two of the firms interviewed had developed training programmes in management of change. These were initiated by HRM and designed by external consultants and consisted of theoretical and practical tasks spread out over a period of time. One of the firms also had a programme aimed at turning new ideas into prototype products. It was designed to allow talented employees of all ages and in all parts of the organisation to present their ideas and receive support in terms of funding, coaching and advice from senior management on how to develop their ideas.

One firm had developed a course for engineers and other employees who were considered to be experts in their field. The programme was designed to develop individual skills, to build company-wide teams who could collaborate in the future and, most notably, to develop knowledge of other fields outside one's own. It also included activities aimed at developing promising ideas into potential products. The course consisted of theory and practical tasks and the content was provided by an international university. This programme has been running now for 6 years, with good feedback from participants and their managers. Its impact on innovation has not been evaluated, but it has been linked to the retention of key employees.

All firms offered their employees courses on new technologies and new ways of working and programmes designed to acquaint them with company ethics. These courses often included certification in the use of new technology or safety standards. In some cases, particularly those involving certification in certain technologies, the training courses were carried out by supplier firms. This was typically the case with information technology. All employees had access to further education and vocational training, although it was normal to demonstrate the relevance of more expensive training courses.

Unintentional Learning

Most employees were aware of the importance of learning while working and of interacting with others. Several cited examples of technical problems which were solved after a conversation with a colleague. As well as contacts with employees,

most had frequent contacts with external experts, often in competing firms, or with consultants or academics.

> We keep up to date by reading academic articles and new research. We have a lot of contact with academic environments. Many of our employees are in committees like Norsok[2]. The company supports those who want to participate in these groups and encourages us to interact with universities. The company also sponsors professors in CeSOS[3] an initiative where public funding and private complemented each other. Most of our contact with academic research is informal, we have a lot of engineers who have PhDs and have close contact with their university. Often a university department or institute will participate in a JIP [Joint Investigation Project].

None of the firms had programmes aimed at improving mobility, but one had a funding programme that was available for those who wanted to work with colleagues in another country for a short period. Otherwise, it was up to individual managers to encourage employees to apply for positions in other parts of the firm in order to expand their experience. Experiential learning was not examined specifically in this study. However, many recounted learning episodes which occurred when they compared current challenges with similar ones in previous projects. 'There are almost always similarities with other projects. Sometimes it is a direct development of something we have done before'.

Many recounted examples of contacts with customers:

> If a floating platform becomes unstable or starts sinking, we have to investigate the air gap, between the platform and the water, which might have become smaller. We would typically analyse if the platform is still safe or if the power of the waves at this distance is more than the platform was originally designed for. We also have to suggest plans for safety, is it safe for personnel to continue to work there? We have to develop criteria for our clients to know which conditions might make the situation unsafe. This is a kind of problem solving. The experience we gain from this kind of situation is useful for us and we could use this again in other projects.

Sometimes contact is not initiated by the customer, but by the innovative firm:

> We are world leaders in our field. I think it is because we are used to moving the boundaries all the time. We are also a relatively small and agile organisation. We can react to changes quite quickly. We are good at taking the first step, we see the potential and build a demo. Often we build demonstrations of new technologies, we apply for funding in Norway to build the demo, then we take it to show potential customers and research partners in other countries. Often it is better for us to cooperate on further development of the technology, then it is easier to move the technology across national borders.

Or the customer contact may be online:

> We have an online lab where anyone can log in and share their ideas for improving products or developing new services. A lot of young people get in touch. It is easy for them to give short, quick comments and suggestions. When someone has registered an idea or suggestion, others who are online can vote on it. It is very dynamic and we can include new ideas in the next version.

Many described examples of situations where learning had been provoked by interaction with a customer:

> We do learn from problem-solving, but it is our clients' problems which steer a lot of our learning. We have to analyse a problem, understand it and describe it. There is some learning there, but often it is others who design a new solution for the client, so they are the ones learning from problem solving.

This example highlights an interesting feature of interactive learning. In some examples, employees described learning from customers. However, what they were learning was about new problems, not solutions. Those who worked on developing a solution may also have experienced interactive learning in dialogue with the customer, like in the online example above. However, many had little or no contact with the customer after the task was agreed upon.

Learning on-the-job: In all cases, the predominant form of work was the project. These projects varied in length and affected the stability of the learning environment. In one case, the organisation was regularly adjusted so that those with the appropriate competence were working together, could communicate easily and were less dependent on a management decision before they decided to work together on a particular issue. At the other extreme, there was an example where new themes arose through corporate R&D and after perhaps several years, these themes would be approved for commercialisation and moved out of R&D to another department where they would be further developed in collaboration with clients. In this latter case, it was common for employees who had worked in R&D to follow the project to the commercialisation stage. This meant that many of the same people were working together over a period of years. One firm mentioned attempts to share knowledge with busy colleagues and had developed an ICT system to provide a simple overview of where one could find a colleague with the required knowledge.

Some R&D employees commented:

> 'I think a lot of learning occurs when we are building demonstrations'.
> 'It is not just learning about technology, we have to learn how to organise R&D projects. You have to know the right people to get a team together, you have to know who is best and who you can rely on. You also have to know what the customers need. You cannot learn all this on a course, you just have to do it again and again until you get good at it and know all the right people'.

All mentioned that they had gained from contact with external sources, many mentioning universities or people they had previously studied with. Apart from the case in financial services, all the others stated that they were relatively free to attend academic or thematic conferences of their choice.

The Learning Environment

In all these cases, the employees working with product development or R&D were highly-educated, and many had PhDs. The breadth of their experience varied. Most had international experience and, in finance and telecom, the employees had experience working in different parts of the organisation and in different positions. In the two other firms, it was more common to work in a long-term project. In all

firms, most reported frequent interaction with customers, with external experts and with competing firms. Everybody (except HRM) worked on projects with external partners and most said this was typical for them. These employees had great freedom in planning their work. In most cases, aims were clearly stated, often in terms of KPI (key performance indicators). It was clear that these were important for employees and managers and were used in follow-up. However, it was up to employees to decide *how* these KPIs were met.

Awareness of Innovation and How Learning Could Contribute

HRM departments were aware of the importance of new products and services for their business. Indeed, most HR-managers were aware of the company strategy encouraging innovation and were of the opinion that learning and competence development were important aspects of being an innovative firm. As one HR manager stated:

> In our strategy it says that we should be more innovative as an organization and better at dealing with uncertainty. In recent years, I think this has become more important than being good at planning.

Managers of product development teams or R&D managers were much more specific about what contributed to innovation. They wanted people who had excellent formal education, but who had also worked in several different locations within the firm, preferably with different cultures as well. All managers placed a very strong emphasis on adaptability and a willingness to work with new things in unfamiliar situations:

> 'We need people who are willing to tackle problems which they are not really trained to solve'
> 'It is not so difficult to find people with good PhDs and good technical knowledge, the challenge is to get them to become adaptable and to be good at communicating with people who do not have the same education as they have. This can take a few years of working in teams'.

These managers were also very clear about the practicalities of implementing change. They wanted people who could make things happen and in order to do that, they needed to 'know enough people, know the right people and be able to negotiate with those they don't know'

Managers agreed that it was important for employees to attend in-house and external courses, but most were of the opinion that most of the 'real learning' took place in projects:

> In the traditional part of our organisation there is little willingness to take risks and experiment, new services are developed based on careful analysis, then planning, testing and changing, while the more modern part of the business works fast, lots of changes and less planning'.

Discussion

All firms seemed to be committed to the development of their employees and had one person, or a small group, with explicit responsibility for personnel development

and training. Most made a clear division between management training, which was largely designed to develop personal abilities and build networks, and what we have called *thematic* training, which provided up-to-date knowledge on themes such as ICT, health and safety, company ethics, new procedures and technology. In all cases, HR were involved in the design of management training programmes and programmes related to company culture and ethics, but most of the thematic training was carried out by external firms, including technology providers.

The learners in this study are employees who fall within Lorenz's and Lundvall's (2011) definition of the creative worker and match Florida's definition of the creative class. Employees were highly-educated, had good access to vocational training and were largely responsible for developing their own plans and taking their own decisions. In all cases, the work was organised in projects and, in most cases, employees worked at the same location with frequent and often unplanned contact with colleagues. Employees recognised the importance of training courses and further education, but acknowledged that most of the learning during their careers occurred unintentionally while working. When asked how they learned, most reported that they had experience of working in challenging projects where the exact way in which one will reach the goal is not known, or in some cases where the exact goal is not known. All these situations have provided them with the opportunity to learn.

Some HR departments were aware of the importance of unintentional learning while working and one was in the process of implementing a programme to increase awareness of this and to stimulate employees to recognise this and to influence their own opportunities for learning.

There was evidence of interactive learning in all the case firms. This typically consisted in initiatives to promote network building between managers and one firm had its own version of this where it worked to promote networking between non-management experts. Mobility was encouraged, but only one firm had an arrangement for funding secondments in other parts of the firm and only one had a specific salary plan to promote mobility. One firm actively encouraged contact with universities, while the others made funding available for participation in conferences. All firms had frequent contact with customers and employees viewed this as a source of new ideas and were aware that close collaboration over time increased understanding of practical issues and developed shared knowledge.

Despite the small number of cases in this study, the findings do provide some interesting insights and perhaps a more nuanced interpretation of learning and innovation in practice. The interview data suggest that employees working in R&D environments are very much involved in 'doing, using and interacting' (DUI), as well as the more traditional ways of developing scientific and technological knowledge through carefully planned research tasks (STI). All cases demonstrated contact with customers and in some cases worked very closely with them on developing working versions of new products or services. The frequency of these experiences suggests that they may be an important kind of learning in these innovative firms. This customer contact occurs at several levels. In the R&D firms, their long-term plans are based on a combination of perceived technological opportunity and market needs. Customer contact also occured within R&D projects and joint initiatives. The result of this is that the customer contact is influencing, not only R&D strategy and long-term plans, but also short-term problem solving and tuning of new products and services. It is influencing learning content and creating many incidents of

individual or group learning. Not only are employees in R&D learning from customers, but they also stated that they could not start R&D projects without knowing the right people, a typical feature of the DUI mode of innovation. This suggests that firms predominantly in an STI mode may have incorporated DUI processes into their learning. This is supported by studies of innovation by Aasheim & Parrili (2012) who concluded that firms should not be categorised as exclusively STI or DUI, suggesting that many firms that invest in formal R&D also communicate and learn from their practical experiences.

Based on what the managers deemed to be important in an innovative firm, we can summarise what employees learned:

- How to communicate and negotiate
- How to work with people from different cultures and fields of expertise
- How to be adaptable and tackle new situations which one is not trained for
- Who to contact and how to involve them in one's work
- Mastered new technologies and keeping up-to-date with developments.

This list suggests a predominance of what Lundvall and Johnson (1994) called 'know-how'. However, the learning studied here is based on the assumption that employees already have higher education and are often already experts in their field. In other words, they already have the "know-wy" kind of understanding (Lundvall and Johnson 1994).

Based on the analysis of interview data we can summarise what has contributed to interactive learning:

- Working in different environments and cultures
- Contact with others outside the firm, including clients
- Being confronted with novel situations and problems to solve
- Being mobile
- Being free to plan one's work
- Being free to attend conferences
- Having the opportunity to attend courses and development programmes

One of our initial questions was 'what activities in the innovative firm contribute to interactive learning?' The list above suggests that many of the things contributing to interactive learning are not central or strategic activities for the firm. What the firms are doing, perhaps inadvertently, is creating environments and work practices which are conducive to interactive learning. If firms do not intentionally create these learning environments, there is a risk that they might not survive future changes in the organisation. Employees working on R&D and product development are spending time keeping abreast of the latest developments in their field and building and maintaining relationships with key experts outside the firm. If the link between these activities and learning is not understood, then the importance of these kinds of activities will not be recognised and there is a risk that it could be rationalised away in the next round of cost-cutting. The predominance of unintentional and/or informal learning suggests an unutilised potential for improvement. The cases in this study provided only one example of a firm that intentionally tried to do something about this, i.e. the firm that introduced the new learning philosophy. It is too early to know if this philosophy has been successful or if a special emphasis on on-the-job learning will have any effect on the firm's ability to innovate.

The other question we asked was, 'Are innovative firms aware of the relationship between learning and innovation?' The findings suggest that, although the firms were well aware of the importance of learning and competence development and how these might affect their competitive position, they did not express any awareness of a link between learning and innovation. There was no evidence of this kind of awareness in documents, in interviews with managers or in interviews with HRM. Despite this lack of awareness, all firms had carried out activities which resulted in the kind of communication and cooperative work that we would classify as interactive learning. This raises the question of whether firms could improve their ability to innovate by actively promoting interactive learning and thus move more of this kind of learning from the unintentional to the intentional category.

All the firms had developed programmes which included building up teams who could work together across the organisation. Only one of the four cases did this for non-management experts. We know from the work carried out by Lorenz and Lundvall that innovative employees or the creative class are not necessarily management, therefore it would be interesting to know if the firm with high-level training for non-managers is more innovative than the others. Unfortunately we do not have these kinds of data. We know that the firm involved reported success in retaining key employees after they had participated in the programme; they have also had positive feedback from participants and their managers. It would be interesting to study the long-term impact of programmes of this type. For the firms with well-developed management training courses, it might not be a great financial risk for them to develop programmes for non-management in order to promote interaction between different groups within the firm.

As well as the implications for firms and their HRM practices, there are also potential implications or perhaps opportunities for other actors such as work or trade associations and public bodies. The examples described in this article suggest that much of the learning which improves the competitive position of the firm is informal and often unplanned. It is not certain that this situation can be improved by trying to formalise it, however there may be opportunities for skills councils and work associations to provide courses or development programmes which integrate thematic learning more closely with the development of more intrapersonal skills. There might also be a potential for universities and colleges to include more of this type of learning in their bachelor and masters studies. Many already do this to a certain extent, but perhaps this could be further developed in cooperation with business organisations.

Another aspect of learning related to innovation which emerged was the importance of working and communicating with people from another discipline or another firm, people who work with different tasks from the learner. Opportunities to develop this kind of experience could be provided by work associations which could fund networking or mobility initiatives to stimulate the cross-fertilisation of ideas and provide the opportunity for employees to experience multiple working environments and cultures. Another important way to develop the skills that are necessary for an innovative firm is by having mobile employees. However, the firms studied were not very proactive and only one provided formalised financial stimulation to move between business units or between countries. This could be an area where publicly-funded initiatives, such as those currently aimed at promoting mobility between academic researchers, could be extended to include more employees in private firms.

The cases in this study are all based in Norway where there is a variety of publicly-funded programmes designed to bridge the gap between formal education and work practice. They range from the apprenticeship system for juniors to work-based PhDs. There is perhaps room for new initiatives aimed at employees who have been working for a few years and have developed some expertise in their chosen field. Such initiatives could be managed by work or trade associations or by universities and colleges that are eager for more cooperation with local businesses.

The methods chosen in this study have resulted in rich descriptions of activities related to innovation and examples of different kinds of learning. This provides us with new explanatory data and adds to our understanding of learning processes in innovative firms. This study, however, is based on information from only four firms and the sample is not representative of national or sectoral learning processes.

Acknowledgement

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NOTES

1. There are various interpretations of the term *innovation*. In this article, we use Schumpeter's definition (1947), i.e. that innovation is the set of activities resulting in new products, services or processes, which are designed to produce economic and/or social value. Thus we are not necessarily looking for innovative ways of learning, but learning which produces something new and valuable. In this respect, it is important to understand how innovative companies develop the necessary competence, which is so important for their success.
2. NORSOK (Norsk Sokkels Konkuranseposisjon') are standards developed by the Norwegian Technology Centre. 'They are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are as far as possible intended to replace oil company specifications and serve as references in the authorities' regulations.' http://renown-engineering.co.uk/wp-content/uploads/2013/12/What-is-NACE-and-NORSOK-Renown-Engineering-Ltd.pdf (accessed 10.12.2015).
3. Centre of excellence on shipping and ocean structures, based on a combination of public funding and private investment partly funded by the Research Council Norway. http://www.cesos.ntnu.no/

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Learning Strategies in Enterprises: empirical findings, implications and perspectives for the immediate future

Ulrik Brandi & Rosa Lisa Iannone

Introduction

With an empirical study at the enterprise level, we direct our attention to learning strategies, how they may be conceptualised, operationalised and leveraged towards competence development and high-performance. We present a conceptual model of learning strategies, laying the foundation for our empirical research into today's enterprises' learning needs and human resource (HR) commitments.

We begin by introducing the impetus for the current undertaking, arguing that our knowledge of the enactment of learning strategies in enterprises demands further inquiry. Secondly, based on a synthesis of past empirical and theoretical work, we devise a conceptual model that helps us to grasp and interpret empirical data on learning strategies in enterprises. Our model consists of three main dimensions: skills development; learning systems and incentives; and work design and the organisation of work. We then present findings from our empirical research along these dimensions and follow up on each with a discussion of immediate and practical implications for areas of great impact on learning strategies in enterprises.

Framing Workplace Learning between Research and Practice

For the EU, lifelong learning has long been considered a primary vehicle for adapting and developing competitive capability and economic growth in order to support social cohesion (Aspin & Chapman, 2000; Elfert, 2015; Holford *et al.*, 2008; Riddell, Ahlgren, & Weedon, 2009). To that end, governmental bodies have turned to learning strategies to build individual, civic, social and economic knowledge and skills by prioritising investments in competence development and HR, emphasised by the European Community as part of its key messages in the Memorandum on Lifelong Learning (CEC, 2000) and the Lisbon Agreement (CEC, 2001).

The policy discourse – also comprising other transnational governmental bodies such as the OECD and UNESCO – states that lifelong learning is necessary and valuable for individuals, organisations and societies in order to be able to meet the challenges posed by the knowledge economy (Tuijnman & Boström, 2002). From lifelong learning research, we can perceive a shift in the main focus of continuous *education* throughout life, from the early 1990s to a contemporary focus on the term *learning* as a signifier for learning that takes place beyond the boundaries of formal education in institutional systems or enterprise trainings (Billett, 2010; Felstead *et al.*, 2009; Hager, 2011).

Correspondingly, organisational and workplace learning researchers and practitioners have, for decades, gravitated towards how to manage and understand learning and competence development in the workplace (Argyris & Schön, 1996;

Billett, 2004a; Edwards & Usher, 2001; Eraut, 2007; Hager, 2004). This has led to a more prevalent distinction between formal (including formalised non-formal) and informal learning. In general, formal learning is identified as traditionally organised 'educational' events, whilst informal learning refers to learning that emerges from situated activities and practices, e.g. solving a work-related problem, collaborating and being part of a community of practice (Beckett & Hager, 2002; Nilsson & Rubenson, 2014). Workplace and organisational learning research has produced a vibrant body of knowledge on learning at, in and through the workplace (Billett & Choy, 2013; Easterby-Smith, Crossan, & Nicolini, 2000; Eraut, 2007; Evans, 2006; Marsick, 1987). Current empirical and theoretical knowledge underscore that workplace learning is multi-facetted and deeply contextualised, e.g. influenced by political and economic systems, industry type, size and profession, forms of organisation and knowledge, work environment and individual knowledge, and experiences in specific work situations (Billett, 2004b; Felstead *et al.*, 2009; Hager, 1998, 2004; Nilsson & Rubenson, 2014; Tynjälä, 2008).

However, though the value of workplace learning continues to receive careful consideration from researchers and practitioners, actualised through private and governmental initiatives, knowledge on how organisations can strategically arrange and support (rather than customarily 'manage') formal and informal learning in workplaces still largely eludes us (Billett & Choy, 2013, p. 272; Felstead *et al.*, 2009: 204; Fuller & Unwin, 2011, p. 21). Hence, our knowledge of how learning strategies are perceived and deployed in today's enterprises and what policymaking can do for the enactment of such strategies call for further empirical and theoretical scrutiny. Practitioners and policymakers are currently tasked with tentatively applying strategies in their search for 'optimal' and 'best fitted' learning designs for their workplaces. As also evidenced in our empirical findings presented below, this provokes an emphasis on formal learning, a concentration on hard skills' development, and outcome-oriented learning, meaning that training is often strongly linked to tangible business goals.

As Fuller and Unwin (2011, p. 21) and Felstead *et al.* (2009) underline, we see an important challenge to the often-mentioned dominating approach to learning which emphasises the acquisition and transfer of knowledge and hard skills through behavioural and cognitive learning. Greater attention to 'soft' skills and knowledge that are located and created in specific work contexts echoes the need for a balance between Sfard's acclaimed metaphors of learning – acquisition and participation; as 'too great a devotion to one particular metaphor can lead to theoretical distortions and to undesirable practices' (1998, p. 4).

We argue that learning strategies are very closely intermingled with on-the-job needs, connected to the informal arena, and that employees mostly respond to intrinsic motivational enterprise policies and to how work is organised. Overall, this impresses our espousal of a socio-cultural understanding and design of learning strategies, rather than a focus on workplace learning as being primarily a question of access, procurement, control and management of formal educational initiatives. In this respect, we have endeavoured to research more globally on learning that emphasises processes – strategies – rather than control or HR managerial tactics. This stance has also enabled us to link strategic learning

dimensions to learning approaches that can resolve dynamic learning gaps in our workplaces. Thus, in this article, we examine *learning strategies* in workplaces so that a useful connection can be made between the vast empirical and theoretical studies that address learning in workplaces, which, nevertheless, inadequately explain *how* workplace learning becomes transformed into value creation and high-performance. Deeper knowledge on this issue has implications for practice and policy. Specifically, this article focuses on two questions: 1) how can learning strategies used for value creation and high-performance in workplaces be succinctly conceptualised, empirically and theoretically, in a way that embraces the spectrum of formal and informal learning?; and 2) what are the (contemporary and empirically evidenced) main learning needs according to this conceptualisation?

Conceptualising Learning Strategies in Enterprises

We began our examination of enterprises' learning strategies by synthesising insights from empirical works published between 1990 and 2012 (Brandi *et al.*, 2013; Brandi & Iannone, 2015), giving particular attention to the association between workplace learning and high-performance work systems. The literature predicates that learning strategies in enterprises encompass policies, practices, processes and outcomes used in the ongoing inclusion and development of competences so as to close employment and socio-economic gaps. These aim to attract and enhance employee and organisational capacity in order to integrate, manage and develop knowledge and skills. Lepak *et al.* (2005, p. 43) present a concise categorisation of the various HR practices used by enterprises, revealing a broad spectrum that involves transactional strategies (e.g. record keeping, benefits administration) at one end, moving towards traditional (e.g. performance management, training, compensation), and then transformational strategies (e.g. knowledge management, organisational development, strategic planning) at the other.

It is noteworthy that HR strategies from transactional and traditional practices emphasise the cognitive and behavioural aspects of learning, leaning very much towards Sfard's (1998) metaphor of acquisition. HR administration that compensates according to capacity and outcome-specific results, such as through benefits, recruitment and performance management, cultivates learning that reinforces, can be managed and specialises. Transformational strategies begin to open towards a socio-cultural understanding of learning, encouraging learning from Sfard's (ibid.) participation metaphor, with possibilities for what Argyris and Schön (1996) describe as the root of productive learning patterns which have longer-lasting perspectives and results. Overall, Lepak *et al.*'s (2005) categorisation considers practices that address enterprise and employee needs, as well as learning. This inspired our overall conceptualisation of learning strategies in enterprises; however, rather than using a spectrum to identify and interpret strategies, we began seeing interrelations between them. Thus, our conceptual model is non-linear, emphasising how – together – learning strategies support value creation and high-performance.

Contemporary studies in the field of HR management (Becker & Huselid, 2006; Huselid & Becker, 1995; Kang, Morris, & Snell, 2007; Lepak *et al.*, 2005; Prieto Pastor, Santana, & Sierra, 2010) have attempted to capture the relationship between learning in the workplace, competence development and enterprise

performance so that best practices and stronger policies can be responsibly used to sustain and strengthen these aspects. From our research, we perceive that HR practices are used strategically to attract and enhance employee competences in order to secure and strengthen enterprise competitiveness and increase enterprise value in varied ways. Delery and Doty (1996, p. 802) stress the strategic perspective in the design of HR practices and the desire for researchers to be able to establish the best composition of practices for optimal enterprise performance. They touch upon one of the fundamental issues and challenges for HR management, i.e. how to best arrange and deliver learning strategies in enterprises so that business goals are attained. One of the main results of their study is that HR, though easily overlooked as a driver of business, is unquestionably linked to value creation and performance. In light of this, learning strategies can be viewed as central in HR management's domain. Delery and Doty (ibid., p. 815) further elaborate on the particular characterisations of HR practices in use (focusing on high-performance work systems), resulting in the following index:

1. Internal career opportunities: the existence of clear internal career ladders and staffing systems in an enterprise;
2. Appraisals: the use of performance appraisals focused on output or results in the enterprise;
3. Training and education: the degree and quality of formal and informal training programmes offered to employees;
4. Employment security: the degree to which employees can anticipate to continue in their job over an extended period of time;
5. Employee participation: the degree to which employee input and ideas are allowed and valued by the enterprise;
6. Job descriptions: the extent to which job tasks are clearly defined;
7. Profit-sharing: the degree to which employees receive bonuses based on the enterprise's revenue.

Once again, we see that both of Sfard's (1998) metaphors for learning are highlighted and that the spectrum of transactional, traditional, and transformational HR practices (Lepak *et al.*, 2005) are included as part of strategic and effective enterprise value creation. Other researchers in the field have developed similar indexes to the one above, e.g. Pfeffer (1999, p. 37), arguing for the strategic importance of developing knowledge, skills and competences in optimising performance and establishing HR practices as essential to business success. Overall, we note a strong homogeneity in the field with respect to the delivery options available to deploy HR practices, and strong coherence in the premise that learning is integral to enterprise performance.

Inspired by Delery and Doty (1996), Huselid and Becker (1995), Batt and Colvin (2011), and Prieto Pastor *et al.* (2010), and based on our review of relevant empirical and theoretical work published between 1990 and 2012, we find that the main HR practices to foster and strengthen high-performance capacity are: training and development, selective hiring, performance appraisal and career management, employment security, compensation and work organisation, and the provision of learning opportunities. We therefore conceptualise learning strategies in the workplace as:

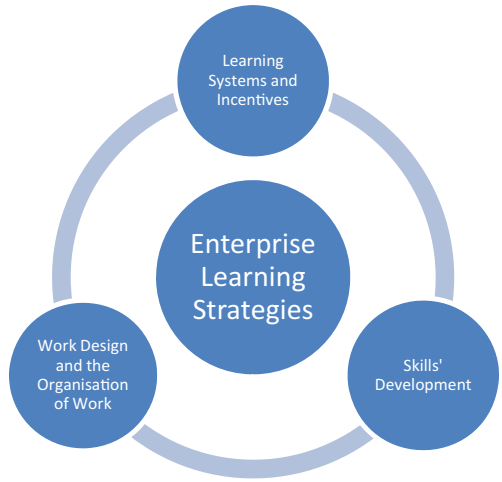

FIGURE 1. Learning strategies in enterprises

The skills development dimension underscores the importance of formal and non-formal learning initiatives in and around the workplace, as well as staffing and career development chances in the enterprise. Combinations of learning strategies within this dimension aim at providing the enterprise with direct means of improving competence thresholds and inducing the workforce as a whole with the capacity of ongoing learning. Focus on the skills development dimension is characterised by *an outlook on hard (specific) and soft (non-specific) competences in combination with training and learning activities that are highly sensitive to different types of enterprise needs* (e.g. project needs, client needs, employee needs, knowledge gaps, etc.). This connects to the cognitive aspects of learning. Hence, cognitive and action learning approaches (Argyris & Schön, 1996) can be seen as most effective when considering the learning strategy (Figure 2).

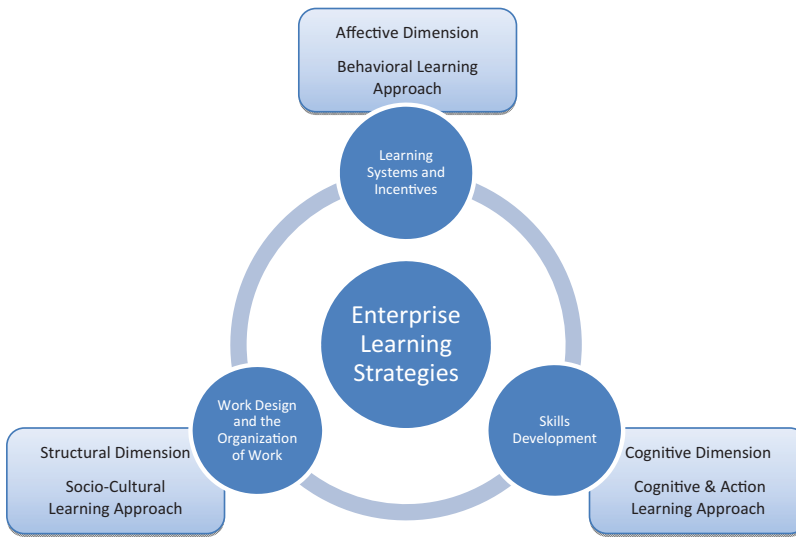

FIGURE 2. Learning strategies in enterprises, with learning dimensions and approaches

The second dimension, incentive structures, relates to generating, managing and facilitating a learning system that is conducive to producing and sustaining the high commitment, security and motivation of the workforce with different types of rewards, wage levels and appraisal inducements. Prieto Pastor *et al.* (2010, p. 2456) describe this dimension as oriented towards *building trust in and across the enterprise, thus indirectly facilitating a productive platform for creating new ideas and sharing knowledge*. This addresses the affective aspects (Kang *et al.*, 2007) of learning, for which learning strategies that draw from behavioural learning approaches are most effective.

The third dimension, work design and the organisation of work, addresses how enterprises organise work in order to create an all-encompassing foundation for the creation of learning and competence development. Batt and Colvin stress that the main aim of work design in high-performance work systems is to 'provide opportunities for individual discretion and ongoing learning through collaboration with other employees' (2011, p. 588). *Creating a coherent enterprise that draws on a socio-cultural set-up where continuous learning is a sine qua non through participation in self-directed teams and problem-solving tasks is mandatory according to the vast majority of research and empirical findings*. Concerning the relation to well-functioning work design, studies underscore that employees should be given a high degree of independence, decision-making and influence on how work processes are organised. In order to create and sustain learning and innovation, low risk-aversion and embracing challenges are seen as significant factors, together with a flexible and team-based work organisation. This dimension relates to the structural dimension of learning (Kang *et al.*, 2007), which benefits from socio-cultural learning strategies (Brown & Duguid, 1991; Wenger, 2000).

To come back to our first question, *How can learning strategies employed towards value creation and high-performance in workplaces be succinctly conceptualised, empirically and theoretically, in a way that embraces the spectrum of formal and informal learning?*, our analysis of past empirical and theoretical studies leads us to understand more precisely *what* learning strategies in enterprises are, whilst embracing a wide spectrum of available methods and actions in each of the dimensions, Sfard's (1998) learning metaphors, formal and informal learning, and the behavioural, cognitive and socio-cultural approaches to learning, contextualised by an enterprise's value creation goals.

Empirical Findings for Learning Strategies in Enterprises

Our empirical study focused on workplaces as learning sites and how the conceptualised learning strategies (see Figure 1) were being actualised in today's enterprises, addressing specific learning needs and HR commitments. It was designed according to abductive reasoning, which is characterised by a transaction between data and theory as a way to account for empirical findings (Bertilsson, 2004; Locke, Golden-Biddle, & Feldman, 2008; Timmermans & Tavory, 2012). The empirical findings draw on research we undertook between 2013 and 2015, including semi-structured interviews with selected management, HR and union representatives and questionnaire responses from a total of 194 enterprises (staff and management from 31 EU and 163 EU-competitors) across 53 industries. Our interview guide and questionnaire were structured along the learning strategy dimensions we discerned (see Figure 1). Responses were analysed following a thematic approach

(Braun & Clarke, 2006) and synthesised into enterprise mini-cases per participating enterprise. The findings we present below address our second question: *What are the (contemporary and empirically evidenced) main learning needs according to our conceptualisation of learning strategies in enterprises?*

Skills Development

We noted a strong emphasis on the importance of soft skills, particularly in regards to interrelationships, and their contribution to productive patterns of work (Argyris & Schön, 1996). Respondents noted that both hard and soft skills were desirable in the workplace, with notable attention to soft, or transversal skills (see Figure 3). Irrespective of the technical complexity of our participants' work and the rarity or scarcity of hard skills in the various professions (e.g. in engineering, medical, accounting and aerospace enterprises), skills such as 'communication', 'creativity', 'customer service', 'interpersonal relations' and 'teamwork' came out as most valued. 'Knowledge' and cognitive skills were also highlighted as important, though it is the *ability to apply* and the *ability to communicate* knowledge that contribute to the valuation of knowledge as a skill.

FIGURE 3. Most valued employee skills

Despite this, HR remains ill-informed and ill-equipped to take stock of, or measure levels of soft skills in workplaces and their gaps for example. Thus, investment in soft skills is something that has more and more become an individual's responsibility. All our interviewees stressed that measurements/calculations were difficult, if not impossible, with respect to learning and development, particularly concerning soft skills. As a result, enterprises indirectly measure gaps and the benefits of learning in these areas by counting the number of training hours per year and clients, collecting experiential feedback from employees, staff peer-evaluations, self-evaluations, and other general performance appraisal information. Interviewees also revealed that there is a gap in the demand versus provision of soft skills' development:

> Interviewer: If you think of last year, did you have more, or less, training than asked for?
> Interviewee: Technical issues, we covered it all. [. . .] More general issues like language or project management we had significantly more people wanting courses than we offered (Director of Labour Relations, Enterprise DE250C29SSI7: pp. 1–2).

As suggested by the quote above, provided by a respondent in a large enterprise of the motor vehicle manufacturing industry, without tools that clearly define the value added of investing in soft skills' development, budgets will be allocated to hard skills' training. On this basis, there is a need for measurement tools in terms of

soft skills and impact on workplaces so that investments and commitments in soft skills' development may become a more strategically understood practice.

Learning Systems and Incentives

We also noted from participants that there was a clear pattern of intrinsic rewards being more important and valued than extrinsic ones (Figure 4):

FIGURE 4. Appeal of the work environment, acquiring and keeping staff

A positive atmosphere, providing access to state-of-the art tools and software, strengthening employee cohesion and the like are all enabling aspects of performance in the workplace and value creation. These motivational factors act to attract staff and ensure retention. To begin, financial compensation was mentioned the most, together with benefit packages, which include medical, retirement, vacation and other traditional compensation items. This satisfies the extrinsic motivational factors of having a job and earning enough to secure a livelihood and future. Following this, we have 'people' and 'teamwork', as well as 'reputation', 'flexibility' and 'stability' – all intrinsic motivators. In fact, there are mentions of many more intrinsic aspects of workplace environment than extrinsic aspects, as illustrated in Figure 4. Altogether, our participants' responses reinforce Herzberg's (2003) thesis that there are elements that lead to satisfaction in the workplace and others that directly contribute to dissatisfaction. People first need to satisfy the basics of earning for the present and some for the future (e.g. retirement); but there is much more that contributes to a sense of satisfaction. Several of our interview narratives tell of these positive motivators, strengthening the premise that intrinsic motivators, addressing higher-order needs, result in happiness in the workplace and benefits for the enterprise. This was the case at one enterprise which is a large (250+ employees) and newly established enterprise in the IT (information Technology) and computer services industry: 'For us, we think that training and giving options to all is a huge way of making people happy here and making people stay with the company. So this is the goal' (Senior Manager Research and Development, Enterprise

DE250J62SSI10: pp. 4–5). This is an example of how a fast-growing, highly technical enterprise uses training and development as a concrete reward that is closely tied to the business strategy of strengthening the impetus for employees to stay with the company.

To bridge the needs and provisions of learning in workplaces, we found that the most successful types of learning reported by our participants related to job-specific, learner-centred, in-house, classroom, group and one-to-one initiatives. Certificates and policy-mandated trainings were also noted as popular and effective, particularly since they directly target the highly practical requirements of work. This highlights a focus on the cognitive and behavioural dimensions of learning as current learning strategies for enterprises. Noteworthy are 'soft-skills' being mentioned as a successful type of learning outcome, emphasising again their importance in workplaces and HR commitment. Respondents reported informal, workshop-type, seminars, short courses and online/digital contexts as befitting to continuous learning. In line with the premise that learning must be continually renewed, we can discern that the most effective learning occurs *on-demand*.

Work Design

Disjuncture, as we know from adult and experiential learning theory (Dewey, 1938/1988; Jarvis, 1987), prefaces learning and growth; it presents opportunities for learning in that we face an unexpected change which demands some thought from us or a team. In line with this, work design that incorporates collaboration, team-based work, special assignments and job-rotations plays an important role in ongoing learning in the workplace, whilst also serving employees' intrinsic needs. Stress and conflicts, however, present unhealthy, unproductive, unconstructive challenges that may severely impinge on employee happiness and enterprise goals. The most common workplace conflicts our respondents reported, relate to soft skills' gaps, depicted in Figure 5. They highlighted 'stress' as the most onerous, linked to burn-outs, followed by communication problems, conflicts with clients, workload difficulties and conflicts between management and staff.

These point to interpersonal difficulties and other challenges that deal with the skills' development dimension. For example, stress and burn-outs could be alleviated by either better time-management skills, or managed expectations from the enterprise. As we begin to contextualise some of the challenges and conflicts that employees reported, we see that pressures from industry, clients, resources, etc. all influence communication patterns, work organisation in general and employee stress sources at work. Of course, in high-performance work systems, priority to responsiveness in conflicts and challenges are characteristic. And, from organisational learning theory, we know that some solutions are in the detection and correction of problems, whilst others require a deeper examination of and change to inherent values in the organisation of work (Argyris & Schön, 1996).

Top-down and bottom-up decision-making power could be legacies from socio-historical conditions. In enterprises whose operations rely mostly upon labour-intensive work that is routine, we have an example that tells how to leverage employee agency, despite the organisation of work that reduces independence and decision-making power. The head of a Slovakian enterprise of around 120 employees, operating in the manufacturing of porcelain and ceramic products explained:

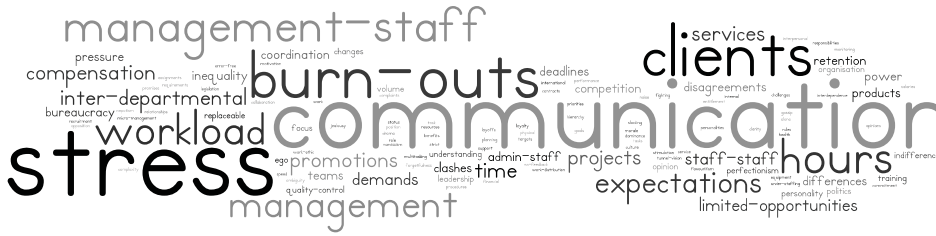

FIGURE 5. Most common conflicts size

> I personally seek to make them [employees] understand the underlying processes, and to act proactively, to anticipate problems and avoid larger damages. [...] We are world-wide leaders in enameling technology for steel bathtubs and shower trays. That gives us major strength in terms of quality, aesthetic parameters and the production costs of the products. [...] For individual employees, crucial is that they have to understand and believe in their own importance, of their own position for the company outcome (Owner and CEO, Enterprise SK11C23SSI8: p. 2).

From the empirical data we gathered in our interviews and questionnaire responses, the pattern of decision-making power over work organisation depicts about half who have personal influence over their work, decreasing as enterprise size increases:

FIGURE 6. Employees having independence, decision-making power and influence over their work design, per enterprise

Individual, as well as collective agency also appear as the most desired aspects of a workplace, as noted in Figure 4, including 'freedom', 'independence', 'flexibility', 'teamwork', 'collaboration' and 'people'. Agency can become overwhelmed by hierarchy, bureaucracy and status distinction, which are more pervasive in larger (250+ employees) enterprises. The administrative distinction of an HR-area also tends to lead to a rather *top-down* organisation of work and this may impinge on enterprise flexibility, employee autonomy and agency, as well as learning and adaptation processes. As expressed by several of our interviewees and our synthesis of past

empirical studies, these aspects pose challenges to ongoing training and development, particularly with respect to informal and non-formal workplace learning. However, for traditional and transaction HR-practice deployment, such as the administrative management of personnel (e.g. leave, benefits, contracts, etc.), coordinated and transparent HR operations function as facilitators. Nevertheless, and as we have seen from our empirical narratives, hierarchy, bureaucracy and status distinction encroach on feelings of belonging, 'a sense of family' (Senior Manager Research and Development, Enterprise DE250J62SSI10: p. 5) and may also stall performance: 'I think, our general management isn't often in the house, and so you have to wait until they are there to talk about problems you've had for three weeks…' (Loyal Employee of more than a decade of service, Enterprise Anonymous I: p. 8). Also, hierarchy and bureaucracy are highlighted by our respondents as barriers to the most successful types of learning: *on-demand*, responsive learning to work-related needs, chiefly guided by job-specificity (emphasising informal learning).

Implications and Future Actions for Learning Strategies in Enterprises

Based on the above, we have new insights on learning needs and commitments in enterprises, which learning strategies and HR can address. Although certain systems give necessary structure and stability to learning, we found that the most effective learning strategies in enterprises were informal initiatives that create modes of learning at work, also influenced by new learning technologies. At the same time, the responsibility for competence development still largely rests on the justification of HR and organisational investment, as well as the impetus of individual and workgroups to be proactive. Our view is that there is ample opportunity for public policy and practice to play a greater role in designing and deploying learning strategies in enterprises around the three learning dimensions of: (hard and soft) skills' development; learning systems and incentives; and work design and the organisation of work.

Firstly, our informants' knowledge of external support for competence development is deficient; there is substantial room for fostering more awareness of, for example, the availability of public funds and other government-sponsored activities that provide opportunities for employees to learn. Of all of our participants, only a handful were aware of the availability of EU-funds and grants. In addition, this blind spot demonstrates that network channels, particularly between policy and practitioners, need to be strengthened. An example of how helpful funding and networks can be for employees is captured in the following narrative from Enterprise ES51QSSI2 in the human health and social work industry in Spain:

> Interviewee: When going through the EFQM [European Foundation for Quality Management, www.efqm.org]. process, one of the things that we identified was the need to improve internal communication. To this end, we set up an IT system covering all premises. The implementation of this system was very costly and took a lot of time. In this context, IT training for all staff has been fundamental. The training is for enabling everyone to use our new management software and has been very successful. We have conceived of this training to progress gradually, with very little things to be learned each time. [Because…] We have employees who are 40-50 years old and have

> never completed upper-secondary education or professional training, [...some] personnel had never used a computer before this training initiative! [...] Last year, we contracted a company for doing the management of this [particular financial, government] credit [...]. This year we have decided to use the credit for training in EFQM (Director, Enterprise ES51QSSI2: pp. 4–5).

This enterprise, registered as a not-for-profit charity, is located in a fairly remote part of Spain, which as our four interviewees explained, poses some challenges with respect to staffing and access to skill development opportunities. Yet by leveraging network channels championed by the Director, creative use of social funding sources enabled up-skilling and continual workplace learning. The enterprise successfully achieved ISO certification as well as a certificate of excellence in quality management through the EFQM and introduced new technology, which, as our interviewees emphasised, strengthened competence, confidence, and even local pride.

Secondly, public policy can lend greater support to and recognition of learning that occurs on-the-job and on-demand, as our results highlight that these are the most efficient, relevant and effective learning strategies that can be prompted by emergent needs.

> Interviewer: Okay, so [...] you are using these blogs and these online networks then to get answers if you have questions?
> Interviewee: Yeah [...]. That's right, but it's an incremental process, it's not like 'you have a session for two days', like a guerrilla camp or something [...]. It's more that it's 'learning by doing'. [...] So, if you have a problem, you have to look at how you can solve it and afterwards, maybe you can select good solutions for it. You have to look for it yourself of course. But it's not... formal. [...] I think the main source [for learning] is the Internet right now (Project Manager of Software Development, Enterprise DE51M69SSI3: pp. 6–8).

This example, which is representative of today's configuration of skills' development learning strategies, reinforces the premise that learning in the workplace is prompted by individuals in response to immediate and work-/task-related needs and that cognitive learning has evolved into a more social and community sphere through online networks, social learning technologies and the like. Having access to knowledge in and beyond an enterprise (e.g. knowledge repositories, networks, etc.) and to relevant communities of practice (Wenger, 2000) bolsters connectivism (Griffiths & Guile, 2003; Kop & Hill, 2008; Siemens, 2005) and also emphasises individuals' skills to collaborate and *know where* to find solutions – quickly – rather than *know* the solutions first-hand. Being resourceful and problem-solving *on-demand* outranks knowing vast amounts of information, particularly since information is in a continual cycle of renewal and update.

Thirdly, we discerned an important knowledge gap in terms of 'optimal' systematic arrangements that promote coherence between structured HR practices and ad-hoc arrangements in learning strategies. New knowledge would enable us to better leverage learning strategies according to available resources and determine a sensible balance between industry standards, globalised business demands and individual skills development. Enterprises would benefit from strategic follow-ups with project and work demands, as well as employee requests, and at the same time, they could plan for flexible training and development offerings that address

multi-stakeholder needs. And, as our data demonstrate, systematic approaches to learning strategies do not necessarily require top-down planning, even in large enterprises.

Fourthly, our empirical research reveals a scarcity between the valuation of soft skills and investment in soft skills, and that there is also a gap between the demand for soft skills' training and provisions. As such, policy can play a strong role in closing these gaps by focusing social funds and non-financial activities on soft skills' development in workplaces. Also, research on the economic value of soft skills in workplaces would empower decision-makers in enterprises who currently struggle with calculations of return on investment in soft skills' training (Andrews & Higson, 2008; Bartel, 2000). Our findings reveal that enterprises recognise an existing connection between soft skills and business value creation, but they are still largely ill-equipped to measure and explain how the connection can be leveraged: 'There is though little evidence that we have good and effective systems and process for assessing soft skill' (Gibb, 2014, p. 468); there is much more than cognitive ability '...valued in the labour market' (Heckman & Kautz, 2012, p. 451). Specific research on the valuation (measurement) of soft skills' training and development in cross-cultural and cross-industry contexts, drawing on short-term and long-term, quantitative and qualitative data would shed light on this largely intangible connection. Governments can lead the way towards innovative evaluation tools that enterprises can co-create and use in the future learning strategies they adopt.

Fifthly, we see an immediate need to address workplace stress and conflicts and how to counter their effects. Despite important research evidencing an inverse relationship between stress and conflicts and employee wellbeing and performance (Ryan & Deci, 2000), our respondents, together with data from the European Company Survey from 2009 and 2013, evidence that enterprises still remain ill-equipped or uninformed as to the appropriate strategies that can minimise or counter negative retrogressions and stagnation. Research findings might not be linked enough to workplace practices, practitioners may be under-resourced, or worse, there may not be a strong enough business case made to justify investments in addressing these issues. Our participants reported burn-outs, communication, employee relations and relations between management and staff as their main struggles. Tracing these, understanding them and then finding examples of how to overcome such challenges will directly contribute to a happier, healthier and more productive workforce.

Conclusion

We have asked how learning strategies used for value creation and high-performance in enterprises could be theoretically devised in a way that would embrace the spectrum of formal and informal learning, HR practices, as well as the acquisition and participation strategies to learning. Based on our synthesis of relevant empirical and theoretical publications (1990–2012), we note that learning strategies in enterprises can be organised into three main dimensions in a model that connects learning strategies to learning dimensions and approaches (Figure 2). Learning systems and incentives connect to the affective dimension of learning, which behavioural learning addresses effectively. Skills' development strategies chiefly address the cognitive dimension of learning to which cognitive and action learning principles can be applied. And, work design and the organisation of work attend to the structural dimension of learning and socio-cultural approaches.

Based on our conceptual understanding, we empirically explored the learning strategies of today's enterprises, searching for the most pressing needs and commitments. Regarding skills' development, results show that the most valued employee skills are soft skills. Yet for the most part, there is a focus on the development of hard skills that explicitly and directly contribute to new business formation and financial bottom-lines. We found that it was primarily the individual's role to prompt learning in the workplace and that HR remains challenged on how to evaluate soft skills' levels and gaps.

On learning systems and incentives, findings indicate that enterprises strive for a balance between the use of systematic and ad-hoc arrangements, yet still lack the knowledge on how to proceed. We also found that the implementation of incentives that respond to intrinsic needs, such as offering interesting and challenging work, being flexible and fostering a sense of belonging and ownership, were essential learning strategies for high-performance work systems.

Work design and the organisation of work also directly contribute to overall enterprise high-performance and value creation. The systematisation of certain aspects of HR helps, however, hierarchy and employee status distinction hinder learning processes and performance optimisation. Workplace conflicts and challenges emerged as highly influential for learning in enterprises, and ultimately, value creation and performance – stress and burn-outs being the most pervasive and in need of immediate attention.

Our theoretical and empirical results prompt insights that call for policy and enterprise practice to enhance mutual collaboration and knowledge sharing at a multi-stakeholder level. It is clear that the design and deployment of learning strategies in workplaces are key to bolstering lifelong learning, so that organisations and societies can become more agile in responding to the challenges posed by today's knowledge economy.

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Complex Problem-Solving Skills and Innovativeness – Evidence From Occupational Testing and Regional Data

Peer Ederer, Alexander Patt & Samuel Greiff

Introduction

In a seminal article by Nelson and Phelps entitled 'Investment in Humans, Technological Diffusion and Economic Growth' and published in the American Economic Review in 1966, it says: 'Production management is a function requiring adaptation to change, and the more educated a manager is, the quicker will he be to introduce new techniques of production. To put this hypothesis simply, 'educated people make good innovators, so that education speeds the process of technological diffusion'. The key insight behind their modelling was that human capital was not merely one more kind of capital input in the production function, but that particular kinds of human capital, namely better education, would raise productivity directly via innovativeness. Hence, they also observed that 'education has a positive payoff only if the technology is always improving' and vice-versa that 'the payoff to increased educational attainment is greater, the more technologically progressive is the economy'.

If Nelson and Phelps were right, then education could count as a direct determinant of total factor productivity (TFP) in the production function. The debate as to what degree the TFP was merely the 'measure of our ignorance' and whether with only better measurement and model specification it could be eliminated from the model (Hulten, 2001) was conducted between Solow, Jorgensen/Griliches and Denison in the 1960s and 1970s. It has not yet been settled, even conceptually. Studies find that growth regressions work better if human capital is used to estimate productivity level, rather than production input (Benhabib &Spiegel, 1994, 2005; Papageorgiou, 2000: 'for the entire panel of 82 countries over a 28-year period we can reject the Cobb-Douglas Specification' and in 2003: 'post-primary education contributes mainly to adoption and innovation of technology'). Nonetheless, to any degree that human capital and labour market researchers might have hoped that better measurements of education and skill achievement could have filled Jorgensen's 'gap of ignorance' in the production function, ever improved streams of data on educational and skill achievement failed to provide this evidence. As a most recent and most comprehensively comparable example of international skill assessments so far, using data from the OECD Program for the International Assessment of Adult Competencies (PIAAC) survey in 2012, Hanushek et al (2013) showed that economic returns to skills were starkly positive, but varied widely worldwide. This clearly suggests that the economic impact of skills, at least as measured by the PIAAC survey, is moderated by a wide variety of other factors in the economy, and thus does not qualify alone as a replacement for manna from heaven.

Instead of debating education at large, this article focuses more narrowly on only one set of skills, which Nelson and Phelps pointed out: the necessity and ability

to adapt to change. Ignoring the econometric specification for the sake of conceptual simplicity, we claim the following steps:

i. Increase in productivity can only derive from innovation
ii. Such innovation causes change to the work force involved in the production process
iii. The adaptation to this change is a process of learning and solving the new environment
iv. This particular process of learning is a set of problem solving skills.

Complex Problem-solving Skills: the skills that drive and enable innovation and change

The fourth step was already announced by Kenneth Arrow in his seminal paper in 1962 on 'The Economic Implications of Learning by Doing'. 'There are sharp differences of opinion about the processes of learning. But one empirical generalization is so clear that all schools of thought must accept it, although they interpret it in different fashions: Learning is the product of experience. Learning can only take place through the attempt to solve a problem and therefore only takes place during activity'. Arrow distinguished this problem-solving learning in contrast to learning by repetition. For this article, we chose a more specific definition of problem-solving skills, the Complex Problem-Solving Skills (CPS). The second and third links are based on Nelson and Phelps, assuming that with higher education they implied that a better educated man would be quicker to learn (adapt) and therefore quicker to introduce the new.

Regarding the first step: ever more detailed data on innovation activity in firms are shining light on the relationship between innovation and productivity growth (Griliches, 1994, 1996, 1998). Research has linked various proxies for innovativeness such as research and development (R&D) spending, rates of new product introduction, comprehensive definitions of innovation spending including training costs and others, as well as various surveys with qualitative indicators (e.g. from the EU Community Innovation Survey) to higher levels of productivity (Hall, 2011; Mohnen & Hall, 2013 for an overview on the relationship between innovation and productivity).

Despite the fact that it would be hard to think of another way in which productivity could increase without innovation of one sort or the other, and the fact that this link has been broadly proven, Bronwyn Hall (2014) declares: 'The full set of links between innovation, competition, exit/entry and productivity growth is not yet explored'. A particular puzzle of this link between innovation investments and productivity growth is why there is not more of such investments. Findings suggest that managers and companies may not invest enough in innovativeness in its various kinds (product, process, business model innovations). Knott (2012) showed that large corporations systematically underinvested in R&D despite its supposed benefits. The OECD (2010) finds the same for small and medium-sized enterprises.

The core hypothesis of this article suggests a shortage of CPS skills in the work force as one of the main reasons why there are not more innovation investments. It derives from Kenneth Arrow's observation mentioned above that a key resource of the innovation process is the problem-solving skills of all the work force involved in

the production process. If such skills are not spread widely enough in the work force of a firm (or in a sector or a region), then innovation investments become too risky, even if the rate of return of the innovation seems positive (in this scenario, it can look positive only if the constraint of shortage of CPS skills is not considered). Vice-versa, if the skills can be increased amongst the work force, then, all things being equal, the rate of innovativeness can be increased proportionally to it, and with it productivity.

Absence of such CPS skills will impose a cost on the innovation investment and thus hinder it in the following way: The incentive to finance innovation is to achieve a positive rate of return to the investor. But the process of innovation is associated with initial adjustment costs, which reduce the rate of return to the investor and increase the risks. Such adjustment costs are conditioned by workers abilities to understand and cope with change. The novelty that comes with innovation creates conditions of complexity. Importantly, workers need to understand the impacts and relations of the novelty, as well as the other elements in the system to produce solutions. The longer the workers need to adapt to this complexity (i.e. solve it), the higher are the adjustment costs, and therefore the less likely is the investment to occur. Thus, poor CPS skills may hinder incentives to innovate. In that line of reasoning, we expect that workers with relatively higher CPS skills can attract a wage premium, which is what Ederer et al found in 2015.

This article also considers how job complexity and CPS could interact iteratively to provide a learning environment in which innovation succeeds. This should then be observable in higher rates of productivity and ultimately income. We build on the work of Nedelkoska, Patt, and Ederer (2015) to identify the degree of job complexity in different occupations. First, we test the relevance of the relation between job complexity and income by considering the aggregated mix of job complexity and GDP per capita across regions in Europe. Secondly, we consider the relation between job complexity and CPS skills in terms of a learning process. Finally, we discuss the policy and practical implications.

Assessing the Relation between Job Complexity and GDP at the Regional Level

Several in-depth surveys ask workers about the tasks that they perform in their occupations. As an example, the German Berufsinstitut für Berufsbildung (www.bibb.de/en/14781.php) tasks survey is a representative labour force cross-sections on qualification and working conditions in Germany, each covering between 20,000 and 35,000 individuals. It measures qualifications, career history, and detailed job characteristics in the German labour force (BIBB, 2016). As per Nedelkoska et al (2015), the index of complexity per occupation is constructed using a principal component analysis of responses to the questions of how often workers perform the following tasks:

- collect, investigate, and document data
- have to react to unexpected problems and resolve these
- have to make difficult decisions independently and without instructions
- have to recognise and close own knowledge gaps
- are faced with new tasks, which they first have to understand and become acquainted with

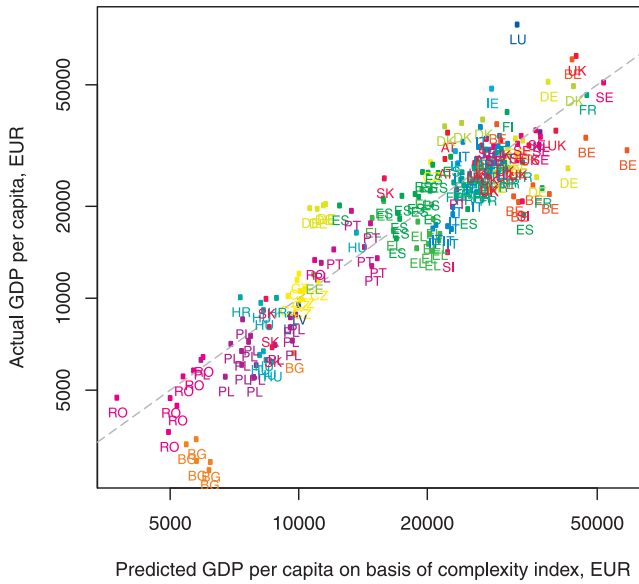

FIGURE 1. Predictive power of job complexity for regional GDP per capita for 197 European regions.
Source: Authors calculations. y axis: Eurostat regional statistics for Gross domestic product at NUTS 2 regions (2007), x-axis: predicted GDP per capita based on complexity index. Complexity index is calculated with data from European Labour Force Survey on occupational composition (2007), German BIBB for the calculation of job complexity scores for 2011/2012. Weighted correlation coefficient in logs is 0.76. Includes one dummy for regions from ex-soviet bloc. Each dot represents one region, each color represents one country. Eurostat country abbreviations are used. (post-crisis level data are not yet available, therefore we used the year 2007 as the last year that is not distorted by the financial crisis

- have to improve processes or try out something new
- have to keep an eye on many different processes at the same time.

This analysis yields a complexity index number for all 2-digit International Standard Classification of Occupations (ISCO) according to the International Labor Organisation classification. These are the same occupational titles that are used in the European Union Labour Force Survey (LFS). Aggregating results at the regional level for 197 Europeans regions, which we can identify in the LFS, we find that average job complexity of employees and income per capita are strongly related at the regional level (Fig. 1). This suggests that regions that have a mix of occupations that is more complex, on average, are more prosperous and have a more productive labour force. The relation is found to have regional implications. For example, there is substantial unevenness in the spatial distribution of job complexity both between and within countries (Figure 2).

The single construct of job complexity index that we created can explain 89% of all variance of GDP per capita across 197 regions in Europe, ranging from Southern Portugal to Northern Sweden, conditional only on one dummy of whether a region

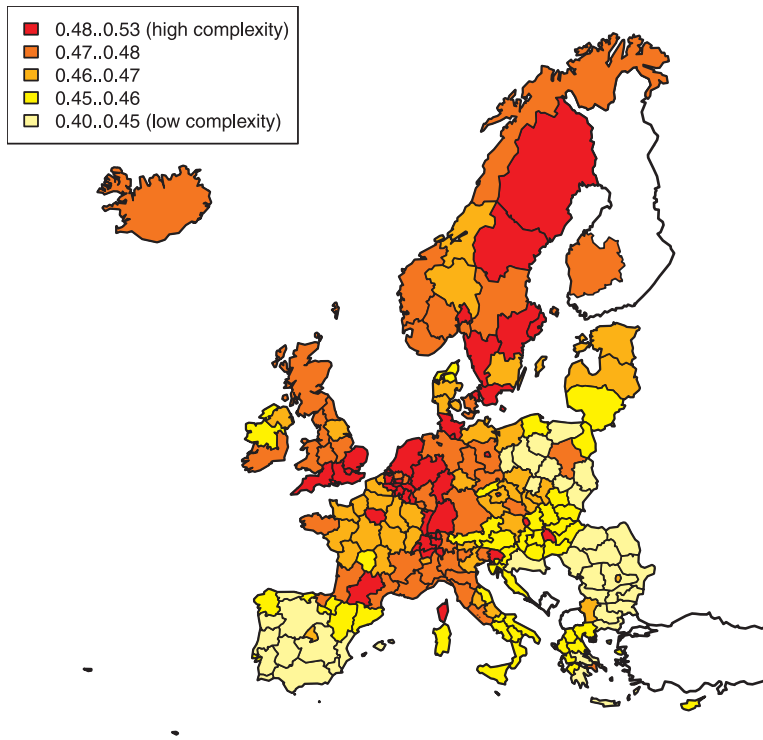

FIGURE 2. Average job complexity by region of the EU.
Source: Authors calculations. Complexity index is calculated with data from EU LFS on occupational composition on regional NUTS 2 level (2007), German BIBB for the calculation of job complexity scores for 2011/2012. The higher the index number, the more complex is the job content of all jobs held in the region.

used to belong to the Soviet bloc 26 years ago. This metric by itself does not explain causality: does a work force first face high levels of complexity and therefore become wealthy, or is a region first wealthy and therefore becomes complex? We argue that asking for causality in this relation hides the actual mechanism of wealth creation. We argue that the answer is causality in both directions, where wealth creation and job complexity are linked via an on-going, iterative learning process in the work force. As the work force is faced with high levels of complexity, it has the opportunity to learn, train, and maintain the skill set of complex problem solving and skills become more available and there are more investments in innovation, triggering yet even more complexity. In this model, it would be the iterative nature of the learning process that permits greater innovation, triggering higher levels of productivity and thus higher levels of income. Rather than asking which of the two came first, the real question would be how to install and promote the iterative learning process.

The Role of CPS

There is little reason to believe that complexity in itself is a creator of economic value. If anything, it would prevent economic value creation because it prevents

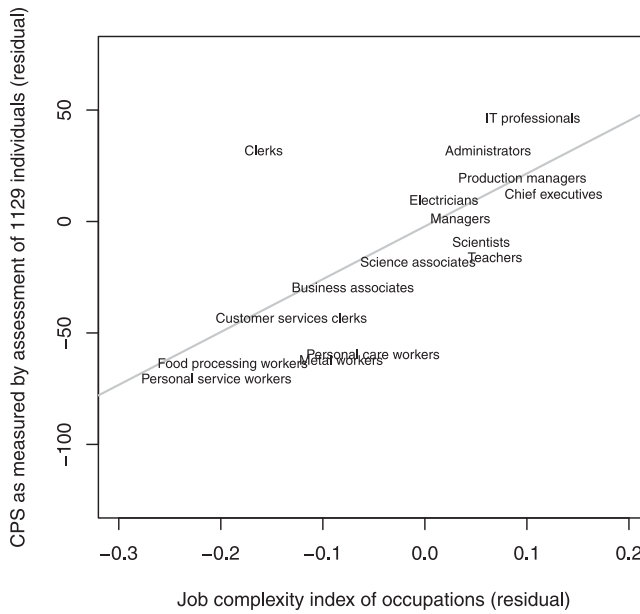

FIGURE 3. The relation between job complexity and CPS skills (residuals after controls).
Source: Authors calculations. y-axis: CPS as measured by authors among 1129 individuals in various occupations and aggregated to ISCO 2-digit level occupational classification. x-axis: job complexity scores as determined from the German BIBB 2011/2012 survey Both CPS and job complexity values are residuals after controlling for age, gender and country of the assessment. The sample is restricted to 18-55 years old. The correlation coefficient is 0.64, which is significant at 1%.

economies of scale from unfolding. Rather, the presence of greater job complexity could be a symptom for higher rates of change resulting from higher rates of innovation leading to greater productivity in the region. However, this innovation can only succeed if the work force can manage and solve this complexity. So the question is, are the higher rates of job complexity also matched by higher rates of complex problem skills? To answer this question, we measured the complex problem-solving skills of holders of different occupations in different countries.

According to Buchner (Frensch & Funke, 1995), CPS describes the set of skills that allows individuals to explore a dynamically changing and obscure system in a way that its structure is understood and can be controlled and orientated towards a desired goal. There are two conceptual aspects of complex problem-solving: a) knowledge acquisition and b) knowledge application. Knowledge acquisition describes the process of constructing a mental representation of a new problem situation through targeted exploration of the problem environment (Mayer & Wittrock, 2006). Knowledge application describes the process of actively intervening into such a system in a way that it moves towards a desired goal (Novick & Bassok, 2005).

CPS skills rely on a number of additional features that require complex cognitive processing, such as multistep planning processes or incorporating feedback in a

problem environment that changes by itself and lacks transparency (Wüstenberg, Greiff, & Funke, 2012). In addition, non-cognitive skills, such as self-regulation and need for cognition, are closely involved in complex problem-solving. CPS skills are considered very important for the workplace in the 21st century because they are assumed to equip workers with better capabilities to resolve complexity (Neubert et al., 2015). For example, the Programme for International Student Assessment (PISA) included complex problem-solving in its 2012 cycle (OECD, 2014). The assessment instruments we used to measure CPS for the results presented here are similar to those that were used in the PISA study. Both were developed on the basis of the MicroDYN- (Greiff, Wüstenberg, & Funke, 2012) and MicroFIN-approach (Neubert et al., 2015). In MicroDYN and MicroFIN, individuals work on a number of different problem environments for a short period each and their performance is then scored according to their ability to acquire knowledge of the problem situation and apply this knowledge. Knowledge acquisition and knowledge application scores are then further collated into overall CPS scores. (Detailed information on the reliability and validity of CPS scores within the MicroDYN- and the MicroFIN-approach are found in Greiff et al. (2012), Neubert et al. (2015), and Wüstenberg et al. (2012)).

In PISA, results indicated that complex problem-solving was markedly different from the three content domains that were measured (maths, reading, and science; OECD, 2014). This indicates that the set of skills involved in complex problem-solving differs to some extent from those needed to solve strongly content-related tasks and that the CPS assessments tapped into somewhat different skills. A number of additional studies have shown that measures of complex problem solving were strong predictors of academic achievement and could even predict school grades beyond established predictors such as general mental ability (e.g. reasoning, working memory; Schweizer, Wüstenberg & Greiff, 2013; Wüstenberg et al., 2012). Danner et al. (2011) showed that measures of complex problem-solving were relevant in the workforce, as they predicted supervisory ratings of job performance beyond general mental ability.

Using the test described above, we measured CPS skills of 1129 individuals in 40 organisations from various educational backgrounds. They were aged between 18 and 70, 824 were employed. 61% were men, and 95% came from Germany, Spain, Netherlands, Italy, South Africa, Argentina, Slovakia, UK, Switzerland, Denmark, and Uruguay, whilst the remaining 5% were from other countries.

Controlling for age of workers, we found a strong correlation between job complexity and CPS. The underlying mechanism is mutually reinforcing and difficult to address empirically in terms of causality. For example, young persons at the beginning of their career with a propensity for complex problem-solving may find jobs where this set of skills is required and rewarded, and while they hold this job, this skill set becomes more refined, and vice-versa.

Overall, the findings of our analysis are intuitive. The prevalence of complex jobs is matched by the capacity of workers to manage and solve complexity. Do we have evidence that this mutually reinforcing cycle can be promoted by training CPS on the job and during adulthood? If CPS cannot be learned, then the implication would be that any given labour force is stuck with a given quantity of CPS, for example from initial education systems. This would imply that the total amount of innovation possible at any given time was fixed. On the other hand, if CPS can be learned, then the rate of increase of innovation and productivity would become tied

to the speed at which the total amount of CPS in any given population is being trained.

Can CPS be Taught?

To what degree both intelligence in general, and problem-solving in particular can be taught and learned is a matter of on-going debate amongst educational psychologists. Kirkley (2013), basing himself on Gagne (1985), illustrates how problem-solving learning can be effective. Learners need to train two types of knowledge simultaneously: declarative and procedural knowledge, which would respectively translate into Know-what and Know-how. 'When teaching problem solving, authentic problems in realistic contexts are essential', Kirkley claims. Abstract teaching strategies and methods of problem-solving (procedural knowledge) do not seem to create better problem solvers because, when the time comes to apply these general methods, learners will typically not apply them (De Bono, 1983). Nor does teaching facts, concepts and principles (declarative knowledge) because these alone do not cause learners to express mental models from this knowledge and manipulate these with methodologies for problem resolution. However, learning formats in which both types of knowledge are taught in an interlocked way does create problem-solving skills.

Another dimension where training of cognitive skills that are related to problem-solving is effective is the length and intensity of training exposure. Resnick (1999) shows that several training methods have been developed to teach people particular cognitive skills such as logical deductions, creating and using memory aids or monitoring one's own state of knowledge. 'Most of the training was successful in producing immediate gains in performance, but people typically ceased using the cognitive techniques they had been taught as soon as the specific conditions of training were removed'. However, results from placing learners in demanding, long-term intellectual environments are more encouraging. 'We are seeing, that students who over an extended period of time are treated as if they are intelligent, actually become so'. Resnick concludes that intelligence is the sum of one's habits of mind, rather than a fixed endowment of either nature or early nurture.

In an edited volume on Computer-Based Learning Environments and Problem Solving (1990), de Corte et al brought together a wide variety of scholars on the question of how problem-solving could be learned. It reinforces the above insights that such learning is possible if embedded in context and sustained over a long period. Germine (2015) confirms that cognitive functions can peak quite late in life. The importance of these insights from educational psychologists is that they describe well a typical job situation with high complexity content: by definition, such a job represents a long term challenging environment and the performance of complex jobs almost always requires a great deal of contextual (declarative) knowledge. Thus, it seems that a job with many complex tasks represents the ideal learning environment to learn CPS skills. In labour economics, researchers have related task complexity in occupations to learning-on-the-job and skill accumulation (Yamaguchi, 2012, Nedelkoska, Patt, & Ederer 2015; Jovanovic & Nyarko, 1995, 1996), supplying evidence that this learning environment is indeed used. Hence, we come back full circle to Kenneth Arrow's economies of learning on the job. Arrow observed from studies in aircraft manufacturing that learning by repetition was one necessary element of learning a job because it sped up routines and

reduced mistakes over time. In this way, economies of scale can be achieved and productivity increased. However, learning by repetition clearly would have rapidly diminishing returns, so that it could have a short-lived boost of productivity at the most. Productivity increases will stop as soon as all routines are acquired. If this is all there was to learning on the job, then its impact on productivity increases would soon be exhausted. His second type of learning, learning by problem-solving can instead deliver sustained productivity increases. This learning also occurs on the job and its function is to be able to manage innovation. The pool of learning resulting from innovations to be introduced does not become depleted as it does for learning routines. Some 30 to 40 years after Arrow, educational psychologists have confirmed that such a job environment with continuous intellectual challenge and a great deal of contextual embedding was indeed a suitable learning environment for learning by problem-solving. Furthermore, with our investigation, we have confirmed that holders of complex jobs had, on average, greater complex problem-solving skills and that the prevalence of complex jobs was strongly correlated to high degrees of GDP income. We therefore conclude that at least some of these problem-solving skills were acquired or strengthened whilst learning on the job in the course of a career.

In economics, this conclusion would have far-reaching effects. If complex problem-solving can and is learned whilst performing a complex job, then this means that any given labour force is not stuck with a given endowment of problem-solving skills (either genetically inherited or somehow bequeathed during education), but that this endowment can be increased, provided there are suitably challenging working environments. If the stock of problem-solving skills can be increased, then this can lead to more innovation investments because more innovation can be expected to be successful and this will increase productivity and with it wealth creation and income.

All this would confirm the models of Nelson and Phelps for which they lacked the empirical data at the time. Only that it was not 'education' in general that would make a manager more innovative, but the set of skills to solve complex problems, which can be learned in an intellectually challenging environment (which could be a formal education setting or a complex job situation), which, in turn, will make any job holder more innovative, not just managers.

Discussion of Implications for Policy and Practice

Our interpretation of Nelson and Phelps needs to undergo further empirical tests to be solidly verified. As we have shown for the European labour market, we can explain observed differences in GDP per capita in 197 regions encompassing all of Europe with an index of prevalence of job complexity for the year 2007.

We assume that any kind of innovation of any type of technology introduces uncertainties and complexities. It is the capacity of the work force to manage and solve such complexity which will determine the rhythm of introduction of such new innovation, irrespective of educational level or occupational category. What primarily matters is the acquired skill set to solve complexity, not the education received. Routine that follows the introduction of a new technology in which problem solvers solved its complexities and made routine possible will then generate higher incomes through repetitive learning. We believe that when insights from educational psychology are combined with descriptions of occupational content on the job, it

emerges that this skill set can and is taught on the job. This would make it a possible angle of intervention to raise productivity and incomes in a labour force. This approach also corresponds to findings in sciences ranging from evolutionary biology to management and economics, where authors find that both the existence of complexity and pathways to resolve it are requirements for innovativeness (Hausmann 2011, Wagner, 2014; Ederer, 2014; Hidalgo 2015).

Insofar as CPS skills may be taught, it is worth investing in them in connection to lifelong learning for three reasons:

a) Independent of the absolute level of economic success of a region or company, this set of skills would accelerate innovativeness and thus improve productivity. It can therefore be a true 'catch-up skill' which helps to close economic and social gaps. With a higher rate of innovativeness, an economically disadvantaged region will not only converge towards economically prosperous regions, but can also surpass them (think of Singapore having overtaken much of Europe). By comparison, investment in highly specialised and valuable skills, e.g. aerospace technology or ICT, will only benefit those regions and companies that are already active in these fields and thus increase the gap. Targeted investment in problem-solving skills and methods should lead to increases in innovativeness, independently of the structure of occupations in the region
b) Since complex problem-solving skills contain elements of strategies and behaviours that can be taught throughout adulthood, this becomes a possible area of intervention for all age groups and for true lifelong learning, which should therefore be able to close social gaps. However, insights from educational psychology informs us that such targeted trainings need to be accompanied by the creation of work environments where such procedural knowledge can be immediately and over long periods interlocked with declarative and contextual knowledge.
c) The strategies and behaviours that enhance CPS performance are not necessarily difficult. It is assumed that relatively simple processing strategies such as VOTAT, OODA (observe, orient, decide act, Boyd & Tremblay, 2015) or rhythm-based resolution frameworks such as Scrum (Sutherland & Schwaber, 1995) can result in much better performance in problem-solving at different levels of cognitive strength. It is therefore likely that relatively small investments in training or work place conditions can result in significant increases in effective innovativeness over time – again, provided that the work environment also presents continuing challenges that make the deployment of such strategies useful.

Recent advances in assessment instruments in psychology have made the level of complex problem- solving competence measurable with reliable tests. Applying these tests to holders of different occupations have shown markedly different levels of such CPS. Thus, insofar as CPS performance is trainable and CPS reduces relevant complexity at the time of innovation introductions, this will reduce investment costs in innovativeness, and thus increase the likelihood of willingness to invest in it – which leads to higher productivity and higher incomes. The existence of this mechanism is also suggested when observing the relationship of the amount of complexity that is encountered by given work

forces in EU regions, and their productivity as measured by GDP income per capita.

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