

# Enterprises are greatly important for Lifelong Learning activities

POLICY BRIEF  
SEPTEMBER 2015

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alphabetical order

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## IMPRESSUM

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This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 290683.



# ENTERPRISES ARE GREATLY IMPORTANT FOR LIFELONG LEARNING ACTIVITIES

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Please cite this publication as follows: Greiff, S., Jaster, C., Kretzschmar, A. & Mainert, J. (2015): Enterprises are greatly important for lifelong learning activities. Policy Brief, proceedings of LLLight'in'Europe research project.  
Retrievable at: [www.lllightineurope.com/publications](http://www.lllightineurope.com/publications)

*This Policy Brief aims to give recommendations to human resource practitioners in enterprises on how and why they should facilitate CPS skills and, eventually, the lifelong learning activities of their employees by applying human capital development in order to increase human capital. Three main questions frame this approach: (1) Can an enterprise increase human capital by facilitating CPS skills, training transversal skills and other lifelong learning activities? (2) How does CPS interact with innovation and entrepreneurial behavior? Can a company use CPS skills to become more innovative? (3) How is CPS distributed across companies and sectors? The first two questions will be addressed by using pre-existing findings from widely acknowledged research, whereas the third question will be answered by delineating recommendations from our own empirical findings in an international convenience sample of over 1129 working individuals. In line with the LLLight in Europe's ([www.lllightineurope.com](http://www.lllightineurope.com)) research goal of measuring the actual skill levels of European and non-European adults, we collected data in company-based on-sight assessments in rapidly changing and innovative industries, such as IT, engineering, service, research, entrepreneurship, and health care.*

## **Introduction**

### **What role do companies play for lifelong learning?**

Workplaces are gravitating toward complexity as they become more dynamic and utilize more elaborate technology. This development puts higher pressure on each enterprise to facilitate lifelong learning, to maintain, if not even increase, a firm's human capital and remain competitive. Efforts on an enterprise level are crucial since companies have a unique set of resources that can be applied to lifelong learning. Company efforts to support lifelong learning target, for example, task variety, challenges that fit their employees' skill levels, trainings, as well as the monitoring of systems to measure human capital development with aptitude tests and assessments of on-the-job performance. Through purposeful Human Resource Management (HRM), companies are able to equip employees with a broad variety of transversal skills while ultimately becoming more efficient and productive. Transversal skills are similarly relevant to jobs but different from the job-specific skills that employees currently have.

## Transversal skills apply to different context

For instance, transversal skills can generally be learned in informal and genuinely new problem-solving situations that could then be transferred to various other problems with similar underlying structures. Interpersonal skills, time-management, as well as skills for solving complex problems exemplify such transversal skills that apply to different contexts.

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## Complex problem solving in modern working realities

One way of increasing human capital with respect to transversal skills is to enhance employees' complex problem solving (CPS). CPS can be defined as a non-routine analytical skill involving domain-general mental processes that are required across diverse problems (e.g., Funke, 2001) such as acquiring new knowledge, building an internal problem representation, applying this knowledge, and strategically interacting with a dynamically changing situation (Novick & Bassok, 2005). These domain-general mental processes enable problem solving in modern working realities that are characterized by uncertainties, contradictions, and dynamic changes (Smith & Reio, 2006).

## An example of complex problem solving at work

An everyday example of CPS at work would be a situation in which a field service manager replaces an old cell phone with a new smart phone that he/she must now use to carry out work duties. This change poses a typical complex problem because not all variables (e.g., the functions of every smartphone key) are known to our service manager, yet he or she still has to fulfil a specific task (e.g., sending a message with attachments to a new business customer). Ideally, one would first try to obtain as much information from the device as possible, a process called knowledge acquisition. The service manager could press the phone keys in a systematic way to navigate through the menus, thereby building a "mental map" of the device's functions. He or she would then receive instant feedback from actively engaging with the device (e.g., which key serves which function). As a second step, this newly gained knowledge can then be purposefully applied to eventually reach one's goal of attaching visual product information to a message and sending it. This process is called knowledge application.

## Experience enables transfer

Prior knowledge, or experience with similar problems, can offer a lot of assistance in these situations because the knowledgeable user will be able to transfer previously learnt skills to deal with nonroutines and apply them to acquire new skills that are specific to this task.

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## The role of complex problem solving for lifelong learning

Especially in one's working life, finding ways to better understand CPS is crucially important, as it is potentially a core skill necessary for acquiring job-specific skills, meaning that one needs to have a solid foundation in domain-general knowledge acquisition skills to be able to acquire a concrete, job-specific skill. Furthermore, as employees can build upon the domain-general skills they have acquired, CPS offers a crucial contribution to lifelong learning: Employees will be faster at acquiring new job-specific skills if they already have experience with knowledge acquisition based on similar situations from the past.

## Complex problem solving in international large scale assessments

The high relevance of CPS and closely related skills<sup>1</sup> for education and work is indicated by findings from the Programme of International Student Assessment (PISA; OECD, 2014) as well as the Programme for the International Assessment of Adult Competencies (PIAAC; OECD, 2013). A selection of these findings, together with our own research, will be presented in this Brief.

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<sup>1</sup> PISA and the current organization-based project LLLight<sup>in</sup> Europe ([www.lllightineurope.com](http://www.lllightineurope.com)) have assessed CPS as defined in this report, whereas PIAAC has assessed problem solving, literacy, and numeracy in technology-rich environments, aiming to give recommendations on how to improve these skills in the working population.

## Key Observations

Can an enterprise increase human capital by facilitating CPS skills, training transversal skills other lifelong learning activities?

The primary goal of analyzing CPS at the enterprise level was to determine its connection to human capital. We maintain that an enterprise can increase its human capital by facilitating CPS skills, other transversal skills, and other lifelong learning activities, thereby becoming more valuable to its owners. The reasons and specific relations behind this statement are discussed here on the basis of earlier research findings on transversal skills in general as well as on the best company practices that we have identified.

Continuous support of trainees

Analyzing successful leader behavior, Yeo (2007) identified three crucial factors that contribute to meaningful learning: problem definition, open communication, and the utilization of resources. He furthermore advises ongoing mentoring after the initial training session. Companies should therefore set clear goals for employees while laying open the purpose of voluntary and mandatory trainings. The continuous support of trainees is strongly recommended.

“Best German Employers”

One of the “Best German Employers” with special acknowledgments for their efforts in lifelong learning, as awarded by the German Ministry of Labor („Ministerin von der Leyen“, 2010), was found to put a heavy focus on employee training. They emphasize cooperative leadership, work-life balance, vocational training, and on-the-job health management. In relation to Yeo (2007), they define prominent problems (e.g., employee motivation), openly communicate their approach to employees, and utilize many resources (e.g., time, financial, and human capital). They also propagate continuous and comprehensive mentoring throughout the work experience, aiming to enhance both their employees’ transversal skills and employee retention.

Trainings increase an enterprise’s human capital

On-the-job, transversal skills training, especially for (future) leaders, can strongly and permanently increase an enterprise’s human capital.

Training employees in transversal skills (e.g., creativity, team building, team leading, teaching, writing, and lecturing skills) will increase their efficiency and challenge them on a productive level. Formal training further supports continuous practice. On-the-job training facilitates the instantaneous combination of newly learnt skills with company goals, such as increased overall efficiency and long-term revenue (Yeo, 2007).

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How does CPS interact with innovation and entrepreneurial behavior? Can a company use CPS skills to become more innovative?

Second, we looked at how transversal skills interact with innovation and entrepreneurial behavior and asked how a company can use transversal skills to become more innovative, again turning to pre-existing research. As an example of a well-researched transversal skill, Leach (2008) regards divergent (out-of-the-box) thinking as a direct precursor of increased creativity and innovation. In-depth knowledge facilitates divergent thinking, whereas a positive assessment of one's own creativity is empowering. By "weaving innovation into the fabric and core values of learning" (Leach, 2008), companies can utilize employees' enhanced divergent thinking skills to meet company goals.

Complex problem solving as a specific transversal skill

We will now focus on CPS as a specific transversal skill for dealing with complexity, as opposed to out-of-the-box thinking, time-management, or interpersonal skills. While CPS and divergent (out-of-the-box) thinking are theoretically distinct constructs, we argue that there are some commonalities that legitimate a comparison. Both skills are needed primarily in complex and novel situations. Also, both are subsumed, together with other constructs, under the term transversal skills, which describe the conglomerate of skills necessary to survive and flourish in the complex workplaces of the 21st century. Due to these similarities, a transfer of Leach's findings onto CPS, stating that CPS might best be used by "weaving it into the fabric and core values of learning," is a possibility. Of course, future research will have to test this hypothesis further.

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How is CPS distributed across companies and sectors?

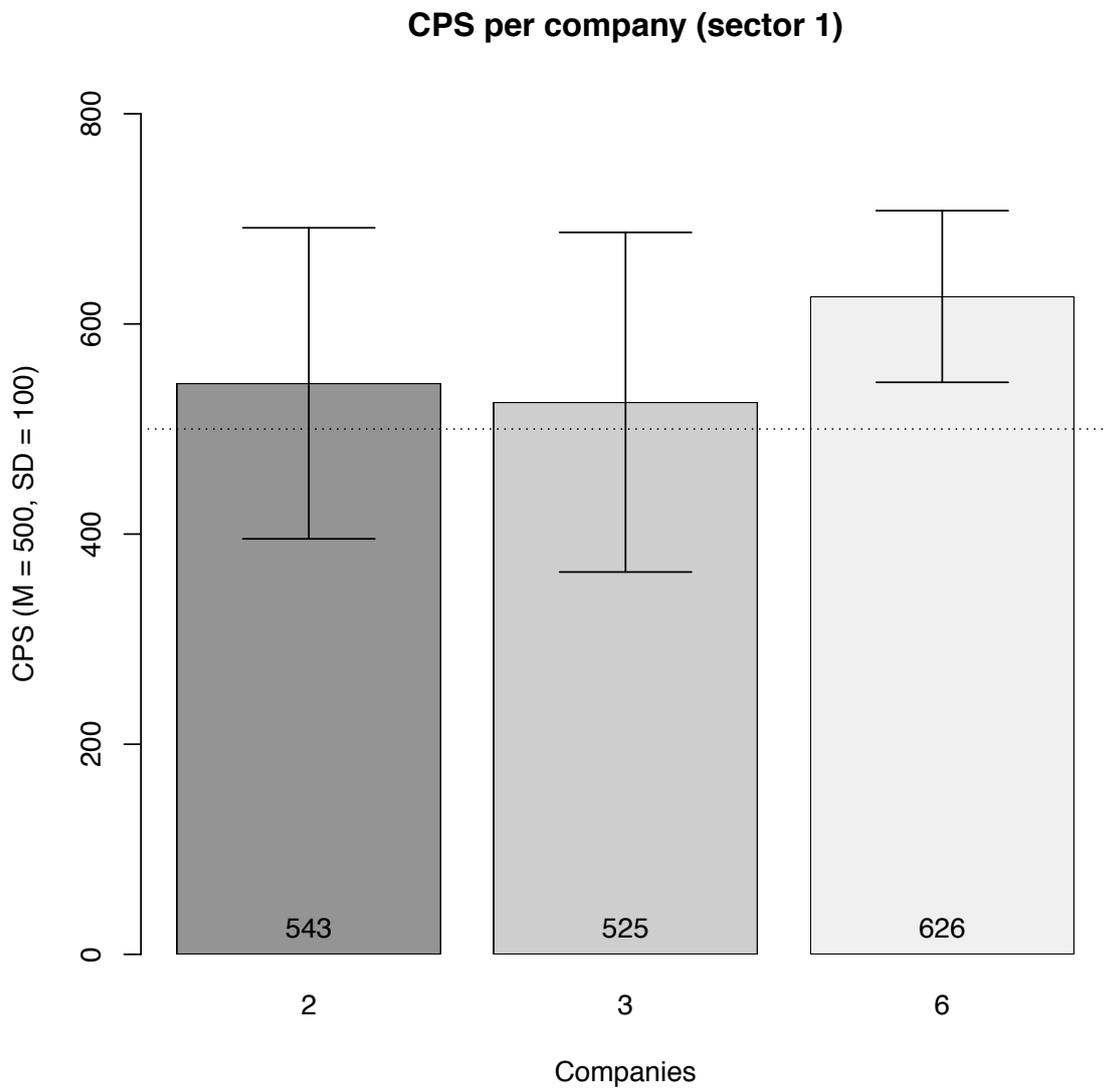
The top-performers in solving complex problems

As part of our own research, we looked at the current distribution of CPS skills across different industry sectors.

The surveyed companies were divided into sectors, and their respective CPS scores were analyzed. Figure 1 shows the CPS score distribution for IT companies, whereas Figure 2 shows CPS scores for each of the agricultural companies that were tested. A significant difference in CPS scores is evidenced by the respective mean scores (IT = 592; MAgriculture = 455). As can be seen in Figure 3, technology-rich enterprises were the top-performers on CPS tests, as companies in the IT, engineering, and science sectors showed average to above-average scores.<sup>2</sup> This could be a result of a working environment that requires complex problem solving skills on a daily basis, where CPS training is continuously woven into everyday work situations. However, there is currently no formal, evidence-based CPS training available. Building on this policy report, future research should try to combine the findings on transversal skills from the literature in general and specifically our initial results on CPS with the upcoming recommendations in order to develop a research-based CPS training that can be used in a variety of work contexts.

<sup>2</sup> Figures 1-3 were also used in the Policy Report „Transversal Skills“ on the individual level to analyze the relations between CPS and company sector, as well as CPS and job complexity with a focus on the individual.

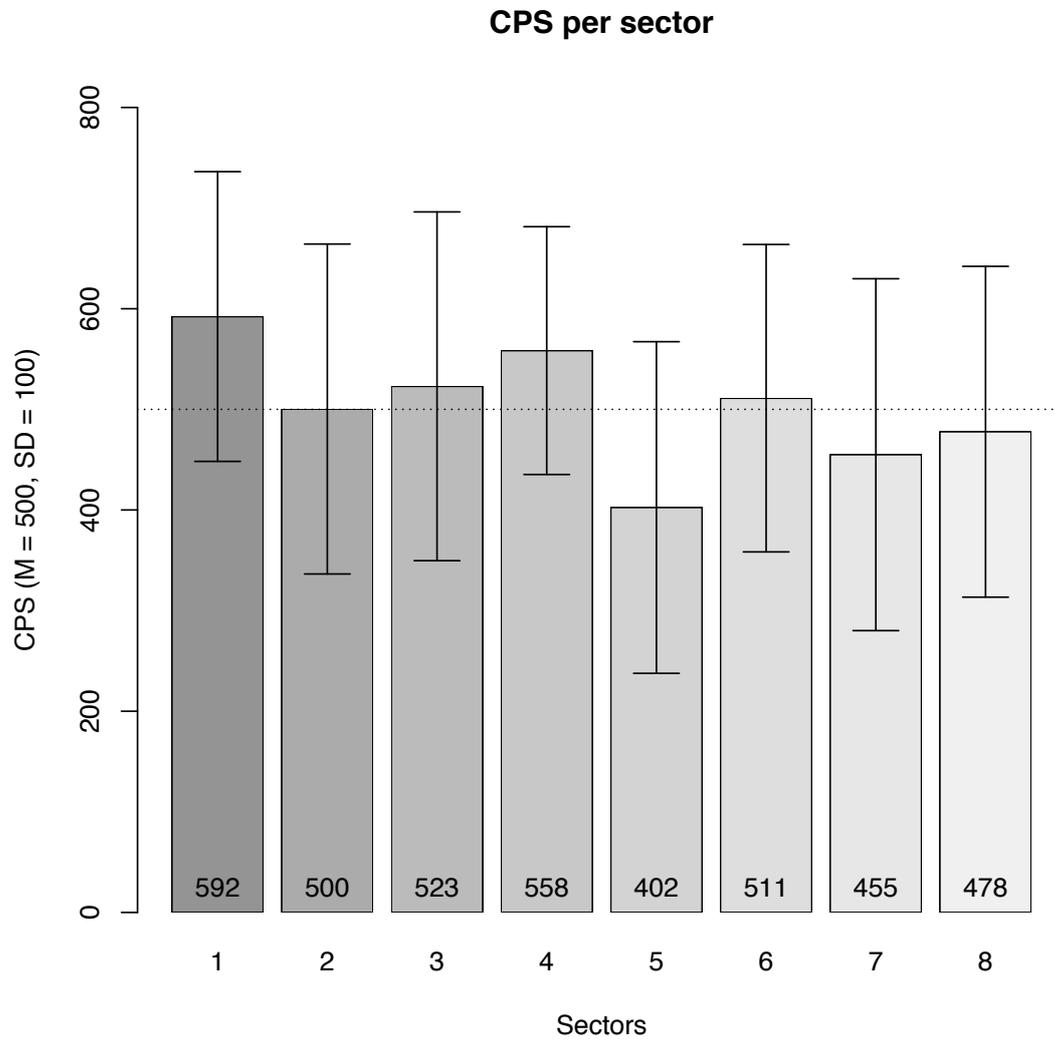
Figure 1: Descriptive CPS scores based on company sector



*M = Mean, SD = Standard Deviation*

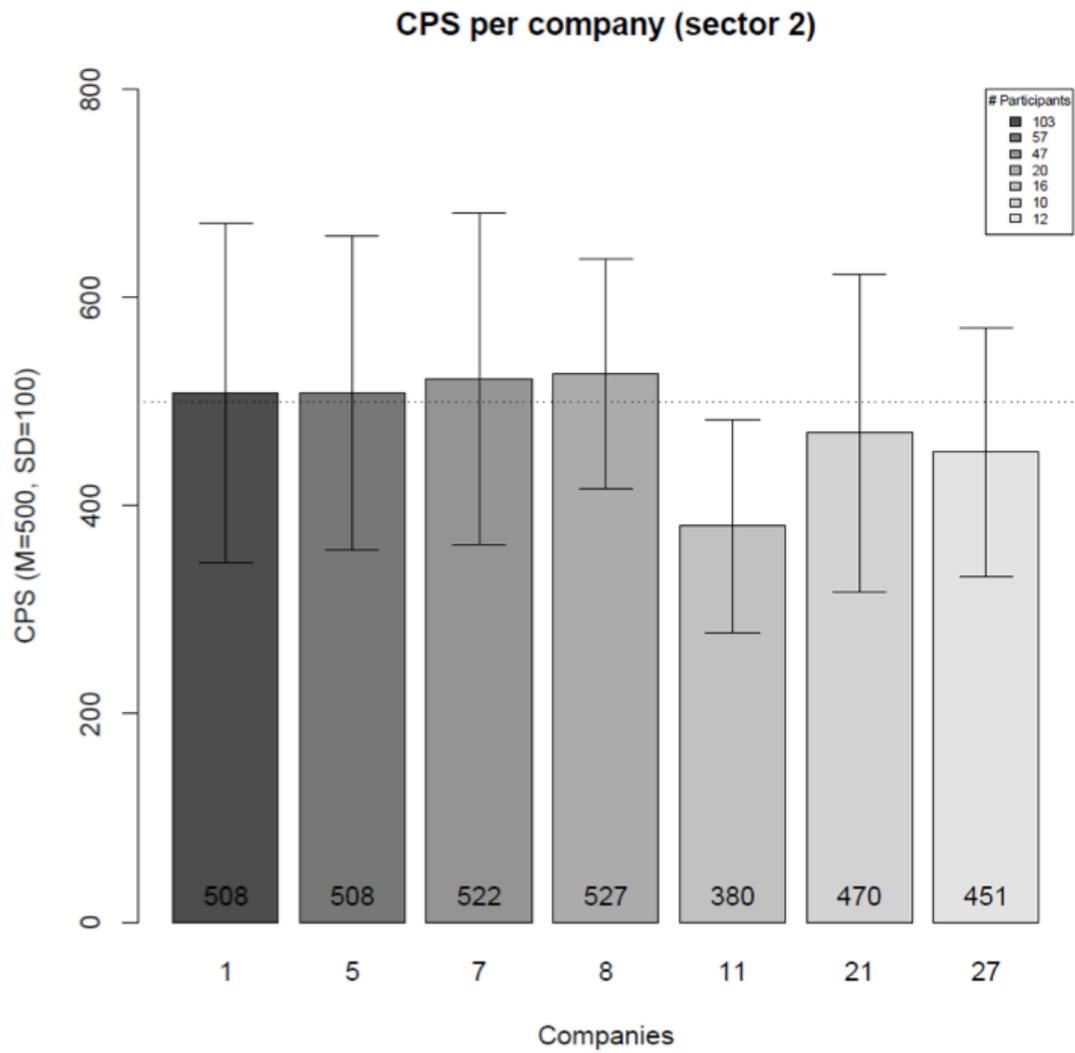
*This graph shows three companies with 8 (company 2), 18 (company 3) and 47 (company 6) employees based in IT and their respective CPS scores and standard deviations. CPS scores are scaled to have an average of mean 500. For the IT companies, the average score was mean 592.*

Figure 2: Company sectors ranked by their respective CPS scores



Note. Sector 1: IT (73 participants); 2: Engineering (267); 3: Entrepreneurs (194); 4: Management (33); 5: Health (93); 6: Science (40); 7: Agriculture (175); 8: Other (service providers and students; 85)

Figure 3: Distributions of CPS scores across different companies in the Engineering Sector



In the Engineering sector with seven companies of 103 (company 1), ..., and 12 employees (company 27), nearly all companies scored above 500 with a range of mean scores from 451 to 527 except the lowest score in CPS in the engineering sector, which was company 11 (Engineering) with 380 points.

## Policy Recommendations

What can be finally re-commended how to facilitate transversal skills, and CPS in specific?

First, we present ways to increase human capital by facilitating and training transversal skills in general and CPS more specifically, as well as other lifelong learning activities. Further, we discuss whether and how these trainings could assist companies to become more valuable to their owners.

Focus on training in complex environments!

a. It is recommended that work areas within a company be differentiated on the basis of the frequency of demands to acquire and transfer skills and knowledge from one work situation to another as a useful criterion for classification. Work areas that require workers to constantly acquire and apply new knowledge are very likely to profit from employees' CPS skills. Thus, we recommend that companies first focus on training CPS in such complex environments.

Increase company awareness of complex problem solving!

b. Efforts on the awareness, selection, and training of CPS should focus on specific target groups that work in dynamically changing, technology-based environments. As an example, CPS testing can be used as a measure that can complement candidate selection and job-candidate-fit measures or for advising compositions of work teams.

Prevent cognitive decline!

c. Strengthening CPS where it is particularly required is essential for improving human capital in a company. Employees in less CPS-heavy positions should be compensated with cognitive trainings in order to prevent cognitive deprivation and boredom.

Rotate jobs positions!

d. Employing job rotation on the basis of CPS maintains employees' flexibility and learning abilities by temporarily exposing them to complex tasks.

Leadership matters!

e. Leadership behavior can facilitate problem-solving-oriented behavior.

Therefore, future leaders should be supplied with trainings for enhancing their transversal skills, such as creativity, motivational ability, or time management. These trainings are ideally accompanied by long-term mentoring.

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What can be finally re-commended how to use CPS skills to become more innovative?

Facilitate out-of-the-box thinking!

Connect trainings and company goals!

Give incentives!

Offer new perspectives to broaden skills!

Second, interactions between transversal skills and innovation and entrepreneurial behavior were examined. Recommendations that integrate different findings are presented here.

- a. Companies should offer trainings for divergent, out-of-the-box thinking, thereby empowering and motivating employees.
- b. Connecting CPS training to company goals (e.g., through on-the-job training) can help companies reach their goals (e.g., increased efficiency, long-term revenue, or employee retention) faster. For example, if a company's goal is to adapt quickly in dynamic environments, it could provide its employees with simulations of work-related tasks that require them to solve complex problems with learnable strategies, such as vary one thing at a time (VOTAT; Vollmeyer & Rheinberg, 1999). Positive learning experiences in these simulations might transfer to real job demands and encourage employees to use similar strategies on the job in order to increase efficiency in complex tasks.
- c. The motivation to participate in CPS trainings and lifelong learning can be increased by giving incentives to participating employees. Incentives could be symbolic in nature, such as certificates and acknowledgments for the most active trainees who excel in personalized training accounts, or of a monetary nature, such as paid training days, additional holidays, or increased salary.
- d. Sending employees in and out of their comfort zone through job rotation and CPS training will maintain their learning abilities.

Offering new perspectives and skills by rotating assignments keeps employee satisfaction high while broadening their skill set and thereby increasing a company's human capital.

What can be finally re-commended how to staff complex job positions in order to support transversal skills to develop?

Foster complex problem solving in innovative positions!

More on-the-job trainings!

Ensure alternation of tasks!

Third, transversal skill levels in general and employees' CPS levels more specifically can potentially be increased by identifying job-specific CPS requirements, offering specialized trainings, and continuously monitoring the CPS training process.

- a. Detecting particularly innovative positions is crucial to administering efficient CPS trainings. Innovative positions are positions with high levels of personal responsibility and require strong conceptualization skills as well as high adaptability within the work process. Employees in typically innovative positions are managers, project leaders or initiators, head researchers, as well as any employee with a high level of freedom for a singular project (a short-term innovative position).
- b. Companies should focus on these innovative positions first when conceptualizing CPS trainings, as they are in high demand of transversal skills training. These trainings can include the practicing of transversal skills (e.g., creativity, team building and leading, or time management) while ideally being conceptualized within current or upcoming job assignments (on-the-job training). On-the-job training conveys high face validity, as trainees immediately understand the benefits through direct application to their current assignment. This type of training also saves companies time that is usually spent on initially training employees before these skills can be used in a company setting. On-the-job training therefore increases both employee acceptance of vocational training and the company's efficiency.
- c. When assigning employees to high- or low-level CPS jobs (job rotation), keep in mind that whereas novel assignments can lead to increased skill sets, continuous exposure to new,

high-demand situations can become exhausting or even repetitive. Therefore, assigning employees to innovative positions should be alternated with those that the employee knows well.

A well-promoted training is an incentive by itself!

- d. Again, the motivation to participate in transversal skill trainings and lifelong learning can be increased by giving incentives to participating employees. In addition to the previously mentioned ones, such incentives might include increased chances for promotions inside the company, prospects for exciting project-work positions, more company-related responsibilities, and tax-based compensation schemes. If well-promoted and closely aligned with the actual job, a training can even function as an incentive by itself.

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## Research Parameters<sup>3</sup>

### What did we assess?

Amongst other objectives, The LLLight in Europe FP7 research program studies ways to assess employees' CPS skills in a number of industries in order to measure people's actual levels of relevant skills at work instead of their qualifications. Therefore, as part of LLLight in Europe, we tested more than 1129 employees from various countries and companies with newly established CPS tests to establish for the first time ever a cross-national, cross-industrial reference set of CPS scores.

### Sample

Testing took place in 13 different countries (Argentina, Denmark, France, Germany, Luxembourg, Netherlands, Slovakia, South Africa, Spain, Switzerland, United Kingdom, and Uruguay) on three different continents. Data from 1129 employees (685 female, 13 missing values) were available for the analyses. Ages ranged from 18 to 64 with a mean of 36.2 (SD = 11.76).

### Material

In order to examine how CPS is distributed across companies and sectors (compare research question 3.), different testing tools were used to assess CPS proficiency levels. These are presented next.

<sup>3</sup> as published in the Public Report „Role of transversal skills“ on the person level

## Measuring complex problem solving with MicroDYN

MicroDYN is a computer-based CPS assessment tool with good psychometric qualities (consistent Cronbach's  $\alpha > .70$ ) and validity (Greiff, Fischer, et al., 2013; Schweizer et al., 2013; Wüstenberg et al., 2012). In line with current research, MicroDYN allows the administrator to assess the two core aspects of CPS that can be considered lifelong learning activities: knowledge acquisition and knowledge application (cf. Fischer et al., 2012), which we presume play significant roles in complex and technology-based jobs. In the MicroDYN simulations, problem solvers have to detect causal relations between several variables in the exploration phase (knowledge acquisition). After acquiring information about the system, problem solvers are asked to reach certain target values in the control phase (knowledge application). Figure 6 explains how these two phases are implemented in the MicroDYN Wind Power Station task. Defining CPS as a domain-general, analytical skill, we used tasks that allowed us to reduce the effects of prior knowledge while still being realistic and motivating.

Seven items were presented with different levels of complexity due to varying relations between variables (quantity, strength, pattern). The testing time was 35 minutes, including two trial laboratory tasks. Each task consisted of 3.5 minutes of unguided exploration followed by 1.5 minutes of controlling and applying acquired knowledge. At no point during the instructions was information given on how to best explore, understand, or control the tasks. The set of 7 tasks included 14 items and 14 performance<sup>4</sup> indicators for two dimensions: knowledge acquisition within an exploration of the system, and forecasting or system control via knowledge application. The actions of the participants were automatically recorded.

The two facets of knowledge acquisition and knowledge application were combined into a general CPS factor (i.e., a latent second-order factor), following Kretzschmar et al.'s (2014) recommendations. A closer look at the scoring is presented next for the second CPS measure MicroFIN.

<sup>4</sup> in total, the set of 7 tasks and 14 items involves 21 indicators, but only 14 refer to the two dimensions of interest: knowledge acquisition and knowledge application

## Measuring complex problem solving with MicroFIN

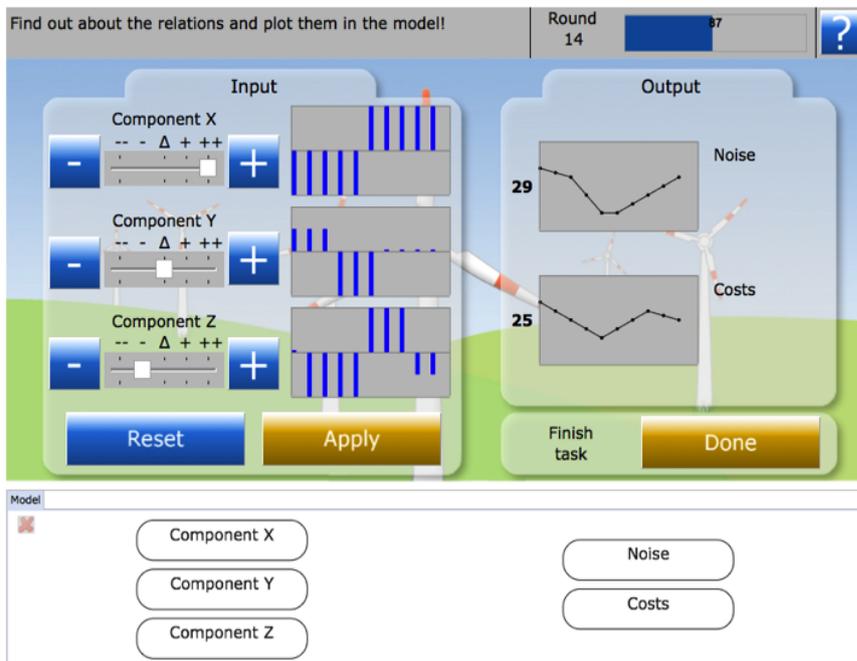
Also considered a measure of the lifelong learning activities of knowledge acquisition and knowledge application, MicroFIN assesses CPS with multiple, dynamic tasks based on a formal framework. The layout can be described by input variables that influence output variables with certain relations (explore and derive causal structure) and is in accordance with the theoretical background as outlined in the introduction. MicroFIN has demonstrated good reliability (McDonald's  $\Omega = .78$ ) and convergent validity (a correlation with MicroDYN of  $r = .56$  to  $.73$ ; cf. Neubert et al., 2014). For example, test items contain (a) values that change dynamically with the user's interaction and (b) various nontransparent interactions between variables, such as threshold or equilibrium states in the input variables (Fischer et al., 2012). Examples of situations are the management of a concert hall (variables: type of music, price level, atmosphere) and the planning of a city (needs of different interest groups).

Two items per task asked participants to explore several states and relations and, from there, to derive the causal structure of the task (i.e., knowledge acquisition). Subsequently, one more item per task asked participants to apply their knowledge to manipulate each task toward achieving a previously set goal to thereby gain control over the system, or in other words, to solve the complex problem (i.e., knowledge application). Both phases contributed to a general CPS performance score.

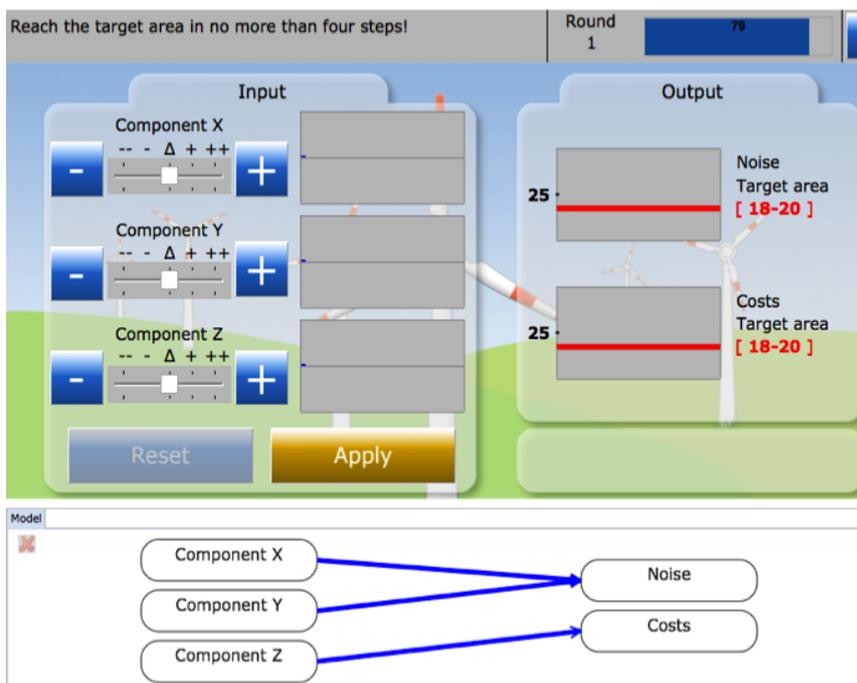
Testing time was 5 minutes per task or 35 minutes per test. The performance-based measure of CPS stemmed from theoretical considerations (Greiff, Holt et al., 2013) and was empirically validated (Neubert et al., 2014).

Figure 4: Screenshot of the MicroDYN Wind Power Station task

Left side:



Right side:



Note. Screenshot of the MicroDYN Wind Power Station task. Left side: exploration phase. X, Y, and Z influence noise and costs. Participants are asked to draw their acquired knowledge about the relations in an onscreen causal diagram (Funke, 1985, 2001; see bottom of Figure 1, left side). Right side: Control phase (cf. Wüstenberg et al., 2012). Target values for each output variable (red areas and numbers in brackets) have to be met within a maximum of four steps. This task allows researchers to record the domain-general lifelong learning activities of knowledge acquisition and knowledge application.

Figure 5: Screenshot of the MicroFIN item “Plan-o-mat” (Neubert et al., 2014)



Note. Screenshot of the MicroFIN item “Plan-o-mat” (Neubert et al., 2014). Problem solvers have to balance the interests of various parties in a city by making alterations to the urban landscape that pose a complex problem to the solver by influencing each other and being non-transparent at the onset of the task. Along the bottom and the right side: the keys for altering the location of the interest groups. In principle, two stakeholders change places when triggered. On the right side: a city mall and a factory. On the left side: a family home and a playground. Between these parties, smiley faces indicate the atmosphere. The problem solver has to improve the atmosphere by finding one of several optimal setups.

## Statistical Methods

Descriptive statistics including means were computed to determine how company sectors differed in their CPS skills. We show the CPS points for 8 different sectors, namely IT, Engineering, Entrepreneurs, Management, Health, Science, Agriculture, and other (see Figure 3).

All statistics were calculated with the R software package (R Core Team, 2013).

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## Project Identity

LLLight'in'Europe is an FP7 research project supported by the European Union, which has investigated the relevance and impact of lifelong learning and 21st century skills on innovation, productivity and employability. Against the background of increasingly complex tasks and jobs, understanding which skills impact individuals and organizations, and how such skills can be supported, has important policy implications. LLLight'in'Europe pioneered the use of an instrument to test complex problem solving skills of adults in their work environment. This allowed for the first time insights into the development of professional and learning paths of employed individuals and entrepreneurs and the role that problem solving skills play. Additionally, LLLight'in'Europe draws on a series of databases on adult competences from across the world to conduct rich analyses of skills and their impact.

These analyses were conducted in concert with different disciplines. Economists have been analyzing the impact of cognitive skills on wages and growth; sociologists have been investigating how public policies can support the development of such skills and lifelong learning; innovation researchers have been tracking the relationships between problem solving skills, lifelong learning and entrepreneurship at the organizational level; educational scientists have investigated how successful enterprises support their workforce's competences; cognitive psychologists have researched on the development and implications of cognitive skills relevant for modern occupations and tasks; and an analysis from the perspective of business ethics has clarified the role and scope of employers' responsibility in fostering skills acquisition in their workforce. The team has carried out its research and analyses on the value of skills and lifelong learning in EU countries, USA, China, Latin America and Africa.

The result is a multi-disciplinary analysis of the process of adult learning and problem solving in its different nuances, and of the levers which can support the development of these skills for both those who are already in jobs, and for those who are (re)entering the labor market, as well as the development of effective HR strategies and public policy schemes to support them.

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EU Contribution	€ 2,695,000
EU Project #	290683
Project Duration	January 2012 – September 2015

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This policy brief is part of the publication suite of the FP7 Project LLLight'in'Europe. The publication suite consists of 21 policy briefs, 6 thematic reports and 1 synthesis report. The 21 policy briefs discuss findings and policy implications proceeding from the project's research; they are organized along three level of analyses (persons; enterprise; country) and seven topics.

01	Resources of society for learning
02	Institutions of learning
03	Circumstances of learning
04	<b>Role of transversal skills</b>
05	Role of job-specific skills
06	Productivity of skills
07	Outcomes of skills

This policy brief discusses findings related to **Role of transversal skills** at the analysis level **enterprise**. For further publications and multimedia material related to the project, please visit [www.lllightineurope.com](http://www.lllightineurope.com)