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Literature review

Skills formation and skills matching in online platform work: policies and practices for promoting crowdworkers' continuous learning (CrowdLearn)

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1. Introduction

A growing number of people are earning some or all of their income from work mediated through digital platforms, in what is variously known as platform-based work, crowdwork, and online gig work, among other names. Emerging research suggests that such crowdwork is an increasingly important new non-standard form of employment around the world, including in Europe (Katz and Krueger, 2016; Huws et al., 2016; Kässi and Lehdonvirta, 2018). The purpose of the CrowdLearn research project is to examine this phenomenon from the perspective of skills development and skills matching, laying the groundwork for potentially new practices and policies in this area.

In this report, we build a picture of the current state of the art on this topic within the research literature. The review is structured as follows. We begin with a background section that summarizes some of the broader transformations taking place in economies and labour markets over the past few decades that set the scene for crowdwork. At the end of this section we also present the project's research questions. This is followed by a brief section that outlines the methodology that we used to identify literature on skills development and skills matching in crowdwork across relevant social science disciplines as well as the human-computer interaction (HCI) subfield of computer science. The literature is then presented as a review structured around the research questions.

The overall conclusion from the review is that research on the topic of skills development and matching of online crowdworkers remains as of yet very scarce. However, the existing research gives us hints as to the potentially important dimensions of the phenomenon, and to the big picture of platform-based work, changing skill demands, and public policy.

2. Background

In recent decades, small start-ups have grown into new commercial ecosystems called the platform economy. Platforms are companies that rely on data, information technology and the Internet as the core of their business models. They are built on digital infrastructures that enable them to act as intermediaries between different users, such as clients/buyers, workers/sellers, advertisers, producers, and suppliers (Srnicek, 2017). We focus here on platforms that mediate between freelance workers and contract employers. According to research commissioned by Upwork and the Freelancers Union, an estimated 57.3 million Americans are freelancing via platforms (36% of the US workforce) and contribute approximately \$1.4 trillion annually to the economy, an increase of almost 30% since last year (Edelman Intelligence, 2017). Other studies using different definitions and methodologies have yielded different, usually smaller figures (Katz and Krueger, 2016). The European Commission's COLLEEM online survey (Pesole et al., 2018) estimated that one in ten European adults has had some experience of platform work, with about 2% engaging in such forms of labour on a systematic basis.

Although platforms and the crowdwork that they facilitate have emerged only within the past few years, they can be seen as parts of broader transformations in labour markets and society. In many ways they are products of decades of structural change, technological advancement, developments in business and management techniques, and government policies. To understand the potential futures of work mediated by platforms, it is useful to place them in their historical contexts. For instance, freelancing and piecemeal work as such are nothing new. For centuries it has been usual for writers, artists and musicians to work independently, and in the twentieth century, freelancing was common (though by no means universal) in broadcasting, the film industry, journalism and the music industry (Huws, 2016). The industrial revolution relied on piecemeal work namely unpaid or paid-by-results outsourced domestic labour, usually performed by women and children (Alkhatib et al., 2017). Similarities to crowdwork abound, but there are also differences.

2.1. The road to platform-based work

During the late 1970s and 1980s a structural shift began in advanced industrial economies that gathered momentum and was consolidated in the 1990s and 2000s. It saw automation and just-in-time supply chains helping to phase-out Fordist production lines, together with the decline of heavy industry, such as coal. Simultaneously, the economy experienced increasing financialization, globalisation and proliferation of global value chains. Multinational corporations in industries, including electronics, clothing and automobile manufacture, began to split up their production processes, distributing them around the world to regions where labour was cheap and there were strong inducements for inward investment. Success came to be measured by efficiency, cost savings, returns on investments from venture capitalists, and the delivery of shareholder value. The practises that were seen to make businesses

successful including audits, financial incentives and penalties were also increasingly applied to public services and public servants (Brown, 2015).

This shift saw employment in the service economy grow while employment in manufacturing declined. An escalation of property prices and in the cost of living also saw a rise in double-income households. This increased women's participation in the freelance economy (Huws, 2016). For example, studies carried out in the 1970s found a large 'hidden army' (ibid) of mainly women carrying out low-skill repetitive work from their homes, much of it broadly classifiable as clerical work, including data entry, copy typing, addressing and stuffing envelopes and checking the accuracy of entries in directories (ibid). Like other workers in the informal freelancing economy, they formed part of a temporary workforce, operating below the radar of official regulations, earning low wages and largely unaware of their rights. These workers were often recruited by dubious means, including door-to-door leafleting and misleading advertisements. Nevertheless, some were employed more legitimately (ibid). In the days before word processors, there was, for example, an enormous demand for copy typing, often supplied by typing agencies with large numbers of home-based typists on their records. Similarly, before telephone answering machines, and later voicemail, became prevalent, there was a demand for home-based workers to respond to telephone calls-forerunners of today's call centre worker telephone answering services (Huws et al., 1990).

The amount of more visible freelancers, including cleaners, gardeners, plumbers, couriers, private tutors, hairdressers, and caterers also increased. These ranged from 'trades' with professional qualifications, provided by self-employed individuals acting alone or with a few employees (e.g., plumbing, electrical wiring, repair of domestic appliances, tree surgery, gutter clearing, dress-making, taxi driving or providing catering services for weddings or funerals) to work carried out casually or occasionally, as a supplement to a main job or a source of additional income, for people whose domestic responsibilities limited their ability to work for long periods away from the home (e.g., cleaning, baby-sitting, assistance with home decorating or assembling flat-pack furniture or running errands). When they did not find new customers on the basis of word-of-mouth recommendations from former clients, family or neighbours, such workers relied on paper-based advertising, whether this took the form of leaflets posted through letterboxes or in the windows of local stores or listings in telephone directories (Huws, 2016).

As the world of employment was being reconfigured, there were private and public investments in telecommunications infrastructures. This was a global shift: in the low-income economies, telecommunications was the largest sector for foreign direct investment in the 1990s – with over \$331 billion invested in it (Srnicek, 2017: 22). This investment meant that millions of miles of fibre-optic and submarine cables were laid out, major advances in software and network design were established, and large investments in databases and servers were made. The provision of this infrastructure accelerated the outsourcing tendency initiated in the 1970s, as coordination costs were drastically cut since global communication and supply chains became easier to build and manage (ibid). By the 1980s, the overseas

relocation of work extended to service industries as well as manufacturing ones (Huws, 2016). Companies became successful by exploiting the opportunities this new infrastructure offered and mobilising free technologies, such as HTTP and later open source software such as Apache and Hadoop. This virtualization of work went hand in hand with a virtualization of its organization, with websites substituting for the old paper-based directories and telephone information lines (Huws, 2016).

Out of this new political economy emerged online labour platforms: new companies able to take advantage of the new economic conditions, including a workforce acclimatised to a freelance mode of work and globalised telecommunications infrastructures. As a result, the global market for work mediated by digital platforms grew by 26% last year (Lehdonvirta, 2017). Recent studies suggest that between 2 and 11% of the European Union (EU) population and a similar proportion of the US population has earned a part or all of their income through the platforms (Huws et al., 2016; Katz and Krueger, 2016; Pesole et al., 2018). Standing (2015) speculates that within the next decade, platforms could mediate a third of all labour transactions. This could raise global annual GDP by up to \$2.7 trillion, with 540 million individuals worldwide - a number equivalent to the entire population of the EU – participating in crowdwork (Manyika et al, 2015). The global division of labour and the growth of virtual work exemplified by the platform economy is predicated on the standardization and modularization of tasks (Huws, 2016). Once tasks are standardized, this work can be quantified, monitored, managed, and paid by results (Huws, 2003).

2.2. Platformization and skills

What implications does the emergence of platform-based work have for skills? The digital economy is often portrayed as a merciless and unstoppable destroyer of traditional jobs. For example, in December 2016 in its reaction to a speech given by the Governor of the Bank of England the British media carried the headline 'Robots to steal 15 million jobs' (BBC, 2017). This discourse is produced by global leaders, such as the head of the World Economic Forum, who stated that the '4th Industrial Revolution' is already upon us, gathering momentum and creating 'exponentially disruptive change' (Schwab, 2017). Governments are warned by, for example, the McKinsey Global Institute, to embrace this disruption or preside over a sharp economic decline (Manyika et al., 2015 and 2016). However, it is suggested that all is not lost because technology also creates jobs (WEF, 2018) while OECD and Cedefop research has also revealed that the share of jobs facing a high risk of automation in advanced economies is relatively low (Nedelkoska and Quintini, 2017; Pouliakas, 2018). Increasingly, therefore workers are driven towards or attracted to digital platforms to develop and operationalise their entrepreneurial skills, find work, and sustain an episodic portfolio career during which they have proven they are able to adapt to disruption beyond their control.

Individuals who want to find work in the platform economy are called upon to respond by taking responsibility for their education, skills, professional profile and become more flexible

so they could follow capital and compete in this new open job market: become self-investing units of human capital (Brown, 2015). Higher status, middle class jobs are not immune to this change. Digitalization introduced new skill requirements, with the 'physical' skills of such varied workers as graphic designers, film editors, fashion designers, typesetters, animators, architectural draftsmen and prop makers replaced by the need for proficiency in standard software packages such as InDesign, PatternMaker, Archicad, DigiFab, Photoshop or Final Cut Pro. The standardised nature of these packages has meant that, even as they had to invest in learning how to use them and purchasing licenses to do so, creative workers found themselves increasingly competing with a global pool of others who had made similar investments and are now bidding for the work online (Huws, 2015) Relative exposure to risk in the platform economy is defined by the nature of the industry including its norms and organised support for workers, the status of the work, and the skills and assets the worker has at her/his disposal. Therefore the growth of platforms has had contradictory impacts on the workforce which activists, and also more recently policy makers, have begun to debate (Bergvall-Kåreborn and Howcroft, 2014; Standing, 2015; De Stefano, 2016; Wood, 2016).

Crowdwork's critics argue it has replaced Taylorism with 'virtual Taylorism', separating design from execution and fragmenting the work process in elementary units that can be outsourced to anybody in the global crowd, without any quality-control of crowdworkers' skills (Valenduc and Vendramin, 2016). Workers can find it difficult to earn a full income through platforms, and actual temporal flexibility depends on the availability of suitable work (Lehdonvirta, 2018; Standing, 2015). We are told the environmental working conditions of crowdworkers can be poor leading to, for example, social isolation (Wood et al., 2018). There are concerns that platforms are eroding labour standards under the guise of technological innovation (De Stefano, 2016). It is argued platforms cultivate crowdwork as independent contracting rather than protected employment placing workers in direct competition against each other for tasks, projects, or gigs. The power asymmetries in favour of platform providers and task owners as well as the crowdworkers' dishonest and malicious behaviours (Huws et al., 2016; Valenduc and Vendramin, 2016) are also cited as offsetting some of the benefits of crowdwork. The temporary nature of platform work can also reduce social mobility, as precarious jobs such as crowdwork could become 'traps' as opposed to 'bridges' into permanent or more regular work (Huws et al., 2017).

The advocates of platform-based work argue that it offer temporal and spatial flexibility, making it easier to combine paid work with caring duties, studies, or other commitments (Eurofound, 2015; Sundararajan, 2016). By allowing partial engagement with paid work that accommodates the worker's individual ability it is often also claimed platform-based work can help prolong work later into life (Barnes et al., 2015). Furthermore, crowdwork could open up career pathways and job opportunities that, due to relatively higher information and transaction costs or inopportune geographic location (Horton et al., 2015), were previously unavailable to workers. Moreover, platform work has offered some workers some liberation from the symbolic violence and enforced constraints on their lives. For example, refugees and women have found new opportunities to work (Hunt et al., 2018). Crowdwork may also

offer a proposition for people with disabilities (Vashistha et al., 2018). Features of crowdwork as such as the ability to work from home (avoiding the frustrations of navigating inaccessible transportation), flexible work schedules, and new personal adaptive technologies allow disabled people to access jobs and labour markets denied to them in the past (Zyskowski et al., 2015). Further benefits cited include the potential increase in labour force participation and productivity through easier access to overseas labour markets; better skills matching and enhanced transparency of outputs, qualifications and endorsements; and greater opportunities for worker agency. Platforms are said to potentially enable workers to engage in long-distance knowledge sharing and collaboration, as well as offer opportunities to exploit data from crowdwork markets to inform the design of educational systems and training provisions (Manyika et al., 2015 and 2016; Schmidt, 2017).

Key factors that could enable workers to maximise the opportunities and minimise some of the drawbacks of the platform work are thus skills, dispositions, and mindsets required to learn and develop professionally within these new work settings. However, as a context for skills development and the matching of skill supply to demand, crowdwork differs radically from standard employment. For instance, most online labour platforms typically do not provide any form of support or infrastructure for training or development of crowdworkers, so learning and skill development appear to be largely the responsibility of workers themselves (Margaryan, forthcoming). Relatedly, skills matching appears to rely more on proprietary sociotechnical mechanisms than public certificates. This gives rise to concerns around whether and how workers form and develop skills through and for platform work; whether and how they are able to match and transfer skills acquired through other previous or parallel work and life experiences, and how they organise, direct and regulate their own workplace learning in general. In this literature review, we will examine extant empirical evidence on these issues, structuring our review around the following six research questions:

- (a) what skills do crowdworkers develop through their work on online platforms?
- (b) what are the learning processes – both individual and social – through which crowdworkers develop skills; in particular what types of workplace learning activities and self-regulatory learning strategies do they use to develop these skills?
- (c) what, if any, quantitative and qualitative differences in learning practices and skill development are there between different types of workers (e.g. microworkers and online freelancers) and between different national contexts in which platforms operate?
- (d) if and how do the platform service markets currently promote effective development and utilisation of crowdworkers' skills; in particular through what formal and informal certification practices, or other types of support for learning and development?
- (e) what are the challenges of facilitating inter-platform recognition and portability of crowdworkers' skills?
- (f) how can skill development and matching in online platform work be improved; in particular what design and policy recommendations can be made to improve these?

3. Methodology

Following the protocol described in the original project plan, we searched three academic databases: Web of Science, Elsevier's database (Scopus), and the authoritative database for educational research and resources ERIC (Education Resources Information Center).

In order to identify and synthesise the available evidence, we employed multiple strategies, including snowballing and qualitative exploration of citation networks of relevant literature. We began with a structured and systematic literature search using relevant search criteria and range of different keyword combinations, in accordance with search affordances of databases employed (e.g. (crowdwork* OR platform economy) w/10 (learning OR self-regulated OR skills) AND LENGTH (>400)) and DATE (>2000-01-01)). To maximise our search coverage, we extracted and concatenated key words in different combinations from each research question and excluded common words such as pronouns, connectives and determiners. For example, RQ 1 (What skills do crowdworkers develop through their work on online platforms?) resulted in a search for 'crowdworkers' AND 'skills' followed by another search for 'crowdworkers' and 'skills' AND 'platforms'. We also introduced wild card or closely related terms such as 'freelancer' in place of 'crowdwork' or 'digital' in lieu of 'online' to ensure no research escaped our attention.

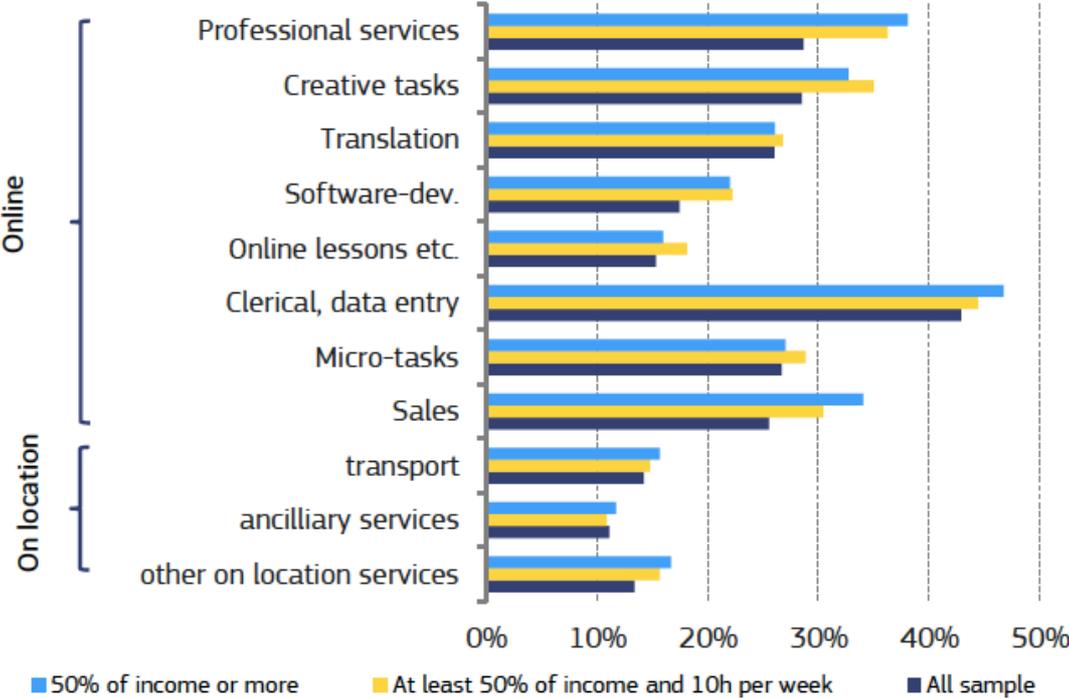
Following our protocol, we included research outputs that had been through peer review in high-quality social science journals. Non-peer reviewed grey literature and marketing materials published by companies were excluded as a rule. However, given the scarcity of the results obtained through this protocol, we used discretion to also include some high-quality emerging research, such as important relevant working papers. In the following sections, we introduce and discuss the literature thus identified.

4. Review of empirical evidence

4.1. RQ1: What skills do crowdworkers develop through their work on online platforms?

Crowdworkers are engaged in a wide variety of different occupations or skills groups. For instance, Kässi and Lehdonvirta (2018) identify six broad occupational categories into which crowdworkers can be placed: software development and technology, creative and multimedia, clerical and data entry, writing and translation, sales and marketing support, and professional services. They find that software development and technology is the largest group by number of projects. European Commission's Joint Research Centre (JRC) COLLEEM Survey 2017 identifies a similar list of categories of crowdwork, but they find clerical and data entry to be the largest category. This disparity is most likely due to methodological differences. Kässi and Lehdonvirta (2018) use digital trace data collected directly from the five largest English-language platforms, while COLLEEM uses a survey methodology with a different coverage.

Figure 1: Types of services provided in online crowdwork and on-location gig work



Source: European Commission's JRC COLLEEM Survey 2017

Platform companies also sometimes publish skills-related statistics extracted from their marketplaces. For instance, Upwork's quarterly breakdown skills in most demand for 4th quarter 2017 showed the top three 'fastest-growing' skills in that quarter to be Bitcoin,

Amazon DynamoDB, and React native. While these statistics concern more specific skills than the broad categories identified in independent studies, their proprietary nature and unclear methodology make it difficult to draw reliable conclusions from them.

Although the above literature gives a broad idea of the types of occupations or skill categories employed in crowdwork, they do not address the question of what skills workers actually develop through their work. This could involve substantive skills such as specific software development architectures, but also soft skills related to succeeding as a crowdworker. Empirical evidence on this topic remains extremely meagre. One of the exceptions is a study by Barnes et al. (2015), which touches on crowdworkers' skill development, although based on a sample of only 18 workers on two UK-based platforms. They found that work mediated by these platforms ranged from administration, hospitality services and social care work to writing and editing, web development, and design and marketing. While most of the 18 participants had 'well developed skills, which they deployed in crowdsourcing', many were 'developing and expanding them as a result of their crowdsourcing activities' (ibid: 2015). For example, one of the research cohort had reported developing visualisation skills alongside design skills, while others said they improved their customer service and information management skills.

In 2013, Gupta (2017) interviewed 32 Indian-based workers who were active on Amazon Turk. She identified a range of different skills that microworkers reported developing through their engagement in crowdwork, including honing email communication skills; improving their English or learning new languages (such as German) in order to communicate with clients; cultivating their digital literacy and enhancing technical skills such as software development, problem-solving, maths and writing skills.

Margaryan (forthcoming A) discusses complementary research showing that crowdwork also requires a set of complex and non-trivial skills, such as learning how to use and navigate the often opaque and non-intuitive interfaces of the platforms and how to find stimulating and well-paid tasks (Gupta, 2017; Martin et al., 2016; Silberman et al., 2010). Furthermore, a recent scoping study of crowdworkers' learning practices identified a range of workplace learning activities and self-regulatory learning strategies which crowdworkers reported undertaking to support their work on the platforms (Margaryan, 2016; Margaryan, forthcoming A and B).

As Barnes et al. (2015) conclude, the 'evidence base needs to be deepened and widened; there is a need to examine more platforms in more depth. Local and macro contexts also need to be investigated further'. To inform a systematic overview of the relationship between platforms, workers and their skills, this new research needs to include a broader range of platforms and forms of work and workers; skills and modes of learning; different national contexts, and it needs to engage with all the stakeholders with an interest in learning and skills. This broader range of skills should include all the skills necessary to gain entry to the market place, establish a reputation, self-promote, and manage what is effectively a small business enterprise. This includes administering finances, taxes, welfare

support, and pensions: jobs that permanent employees usually entrust to another department in their company.

4.2. RQ2: What are the learning processes – both individual and social - through which they develop these skills, in particular what types of workplace learning activities and self-regulatory learning strategies do they use to develop these skills?

Following on from the lack of research about skills development, learning processes are also a neglected area of research that needs to be addressed. This includes both, formal and informal as well as individual and social practices involves in crowdworkers' learning processes.

The existing literature contains some hints as to the significance of social practices in crowdworkers' learning processes. Because the platforms do not typically include social spaces, workers congregate off-platform in forums, mailing lists, and groups hosted on social networking sites (Martin et al., 2016; Wood et al., 2018). For instance, workers exchange advice on high-paying work, talk about their earnings, talk about best practices, and discuss good and bad clients (Lehdonvirta, 2016; Lehdonvirta 2018; Alkhatib et al., 2017). While the existing literature rarely conceives of these interactions as a form of peer learning, they can potentially be important sources of knowledge and skills necessary to succeed in crowdwork.

The only study to explicitly address crowdworkers' learning processes is Margaryan (forthcoming B), which is based on a survey of 167 microworkers and 15 online freelancers. It suggests that crowdworkers are statistically just as likely as conventional knowledge workers to use individually and socially-oriented self-regulatory learning strategies to support their work on the platforms. Additionally, they are statistically likely to be as self-efficacious, self-reflective and motivated by learning opportunities within their work tasks as are conventional knowledge workers (Margaryan, forthcoming B). These include learning and self-development practices such as setting personal performance standards and short-term learning goals; monitoring and modifying learning strategies that underpin learning goals; articulating explicit plans for achieving learning goals; note taking and writing reflective notes on learning progress; soliciting feedback and sharing learning; observing and replicating other people's learning strategies, and reflecting on the long-term implications of learning through crowdwork for career development (Margaryan, forthcoming B). Overall, the emergent findings suggest that crowdworkers are highly self-regulated and learning-oriented (Margaryan, 2016; forthcoming A and B). However, significant gaps remain in obtaining a more qualitatively rich understanding of learning processes in crowdwork, addressing questions such as:

(a) how do crowdworkers learn on the job, individually and with others?

- (b) are some modes of learning incentivised - explicitly or implicitly- by platforms?
- (c) what learning opportunities do crowdworkers' social networks and online workspaces offer?
- (d) how do geographically isolated online workers obtain access to learning resources, including opportunities to learn socially?
- (e) geographically dispersed online workers can only socialise with each other online; what are the barriers to social learning and how do crowdworkers overcome these?

4.3. RQ3: What, if any, quantitative and qualitative differences in learning practices and skill development are there between different types of workers (e.g. microworkers and online freelancers) and between different national contexts in which the platforms operate?

The few existing studies addressing crowdworkers' learning practices and skill development discussed above tend to offer snapshots of learning in very specific contexts, such as specific types of work (microwork vs. highly skilled freelancing) and specific national contexts. A systematic understanding of the differences and similarities in learning practices and skill development between different contexts is thus missing. Yet for policy purposes, such an understanding is crucial. Interventions appropriate in one context might be inappropriate in another.

4.3.1. Differences between types of platform work

A major exception to the lack of empirical evidence in this area is a study by Margaryan (forthcoming A), which compares patterns of learning activities and self-regulated learning strategies between microworkers and online freelancers. The study finds that despite differences in the nature of the platforms and work tasks, these patterns were broadly similar across the two types of work, with no statistically significant differences identified. However, these results should be validated with larger and more diverse samples of microworkers and freelancers.

4.3.2. Differences in national context

As for national contexts, transnationality is an important feature of the platform economy: workers can in principle be located anywhere in the Internet-connected world, including in countries and regions with no previous history of outsourcing industry (Martin et al., 2016).

It is conceivable that national context would influence learning practices due to, for instance, differences in national education systems. However, crowdwork also relies less on national institutions than standard employment, and more on transnational 'digital institutions' and standards set by platform companies (Lehdonvirta et al., 2018). It is therefore also possible that national context has a small influence on learning practices.

The existing literature includes one survey study that suggests differences in learning goal orientation and motivation between crowdworkers using Amazon Mechanical Turk in different countries during 2011 (Behrend et al., 2011). However, all but 11 of the survey's 259 respondents were from North America, so it is difficult to draw any conclusions from this data. As with previous research questions, this topic thus requires wider and deeper investigation.

4.3.3. Differences between sociodemographic backgrounds

Beyond type of work and national context, other dimensions may also be important in explaining differences in crowdworkers' practices. In general, sociodemographic variables are often important in explaining individual differences in social science research. For instance, it is likely that a crowdworker's age influences the practices they adopt in the platform economy. A study of Europeans aged 20-35 shows that temporary work is a choice among the younger group (20-25) but tends to become a trap for the 31-35 who cannot find better employment (Nunez and Livanos, 2015). For older workers, temporary work may function as a bridge towards retirement. As an example from crowdwork, the Fiverr platform is dominated by young adults (only 2% of sellers are over the age of 55), but the company has stated that the rate of sellers aged 55-64 grew 375% at the end of the second quarter of 2015, compared with the year before.

Gender is also often an influential predictor of behaviour in working life and education, due to sociological factors such as occupational segregation (occupations perceived as appropriate for men vs. women), gendered divisions of household and caring labour, and gender roles in everyday life. Some disparate statistics are available on crowdworkers' gender; for instance, one survey finds workers on Amazon Mechanical Turk to be approximately equally likely to be female and male, and CrowdFlower's (recently rebranded as FigureEight) workers to be 73% male (Berg, 2016). No research is available on how crowdworkers' learning and skill development may differ between genders.

Even though learning and skill development in crowdwork is a matter of adult learning and continuing education, a person's formative educational background is also likely to influence the strategies through which they choose to pursue it. In part this could be due to formal constraints, such as graduate diploma courses only being available to those who have a university degree. In part this could also be due to how the person perceives the options available to them – for instance, those who did not go to university might not be aware of university continuing education courses. Better computer literacy might also help workers use more effective ways of learning and operating in the platform-based marketplace (Martin et al., 2016).

Some disparate statistics are available on crowdworkers' educational backgrounds; for instance, one survey on CrowdFlower (FigureEight) suggests only 14.1% have a high school diploma or less and most workers have at least attended some years of college (28.4%), or have a college (36.7%) or a post-graduate degree (16.9%) (Berg, 2016). Combining similar research on MTurk and FigureEight suggests 14.5% of crowdworkers are currently students (Codagnone et al., 2016). This could vary considerably by platform and type of work.

Socioeconomic background, sometimes conceptualized in terms of class background, is also often influential in explaining differences in individual practices and outcomes. Only disparate survey evidence on crowdworkers' socioeconomic backgrounds is available. Surveys from Amazon Mechanical Turk suggest that microwork is somewhat surprisingly done in all household income groups (Ross et al., 2010; Hitlin, 2016). But Weinberg and colleagues (2014) found that US respondents from Amazon Mechanical Turk were generally poorer than average US adults. No research is available on how crowdworkers' learning processes might differ across sociodemographic groups or most other sociodemographic dimensions.

4.4. RQ4: If and how do the platform service markets currently promote effective development and utilisation of crowdworkers' skills – in particular through what formal and informal certification practices, or other types of support for learning and development?

Our review uncovered a major gap in the literature regarding platforms' approaches to supporting learning and development of crowdworkers, including the practices of certification, promotion and utilisation of crowdworkers' skills. The information available in publications is largely anecdotal, patchy, unsystematic, marketing-oriented and not underpinned by an evidence base. The review nevertheless suggests that there are the following three main approaches through which some platforms support crowdworkers' skill certification and learning.

4.4.1. Skill categorisation and certification schemes

Almost all platforms presently offer some type of skill categorisation system as a key mechanism of matching workers to clients. Platforms achieve this by collecting, disseminating and matching the supply of such skills with demand (Codagnone et al., 2016). Furthermore, some platforms such as *upwork* and *people per hour* allow workers to undertake automated skill tests as a means to certify their skills to potential clients (Lehdonvirta et al., 2018). The provision of such skill tests may act as a source of competitive advantage for a platform. Such privately-led digital certification schemes have already been highlighted as a possible policy solution in times of rapidly changing skill demands (Bamfield and Painter, 2015). In the platform economy, they are likely to improve matches for both workers and clients especially in domains where skill demands are new and rapidly changing, but they may also increase workers' switching costs from one platform to another, and thus potentially hinder mobility between platforms, among other effects (Lehdonvirta et al., 2018). Understanding these issues and their relationships with national and EU adult learning and vocational training frameworks and policies, remains a conspicuous gap in the current state-of-the-art research.

4.4.2. Provision of online learning resources

Some crowdwork platforms also offer various types of learning resources that crowdworkers can use to improve various skills, including technical and non-technical skills (Kuek et al., 2015). Perhaps the most notable example in this regard is *upwork*, which provides the following range of self-study and social learning and development resources for workers, interspersed with the platform's marketing materials:

- (a) upwork freelancer education hub: a set of resources to enable freelancers to get started on the platform <https://www.upwork.com/hiring/education/getting-started-for-freelancers/>;
- (b) upwork community forum: a discussion forum where workers can ask questions and share experiences of the platform <https://community.upwork.com/>;
- (c) eBook freelancing tips from pros: general advice to freelancers <https://upwork.docsend.com/view/8eacqh2>;
- (d) upwork help centre: includes advice on upwork-specific aspects of freelance work, such as how to become a top-rated worker on upwork <https://support.upwork.com/hc/en-us/articles/211063208>;
- (e) <https://support.upwork.com/hc/en-us/articles/211068468-Become-Top-Rated>;
- (f) hiring headquarters for freelancers: includes general tips for freelancers <https://www.upwork.com/hiring/for-freelancers/>;
- (g) upwork readiness test: <https://www.upwork.com/ab/tests/test/1093>;
- (h) upwork twitter account: this regularly offers links to online resources on various aspects of professional development including interviewing skills, customer relations, time management, work-life balance <https://twitter.com/Upwork>.

4.4.3. Training as a key mission

Platforms that conceptualise training of workers as their key mission are rare. One notable example that has been highlighted in the literature is Samasource (Lehdonvirta and Ernkvist, 2011; Gino and Staats, 2012). Samasource is a microtask platform, which has established work centres in different developing countries in Africa and South Asia targeting disadvantaged workers and representatives of marginalised groups who often have little or no experience of participating in the conventional labour market (Gino and Staats, 2012).

Prior to commencing work on the platform, workers are trained in the Samasource regional work centres on a range of different aspects of crowdwork, from technical skills to basic professional skills such as time management, following a schedule, communication skills or building self-confidence. Samasource specifically focuses on understanding the skills available in and native to each region so that it can channel tasks to centers and workers best equipped to handle them. Importantly, Samasource utilizes a 'train the trainer' approach, by working closely with the instructors at regional centers while limiting interactions with individual workers. Samasource also provides learning resources – examples of tasks, tips, and videos – through the technology platform on which the work is done. Due to its partnerships and physical footprint in target countries, Samasource's model resembles conventional workplace training.

4.5. **RQ5: What are the challenges of facilitating inter-platform recognition and portability of crowdworkers' skills?**

As discussed above, the as-yet limited evidence base suggests that platforms play a key role in crowdworkers' skill development and skills matching by providing various skill categorization and certification schemes (Codagnone et al., 2016; Lehdonvirta et al., 2018). This is likely to improve matches for both workers and clients in domains where skill demands are new and rapidly changing (Bamfield and Painter, 2015), but also increase workers' switching costs from one platform to another, and thus potentially hinder mobility between platforms (Lehdonvirta et al., 2018). This reduced mobility could in turn have implications for crowdworkers' ability to follow skills development and career trajectories that take them, for instance, from a relatively less skilled platform towards a platform for more skilled work. It is thus worth asking how inter-platform recognition and portability of skills could be improved. However, our literature review did not uncover any research among the nascent crowdwork literature that would address this question, so this remains an important gap in the literature.

Some potential hints can be drawn from broader platform literature. Research on platform strategy suggests that interoperability is in general not in the business interests of the market leader, as it could make it easier for competitors to gain market share (Shapiro and Varian, 1999). Conversely, challenger platforms are more likely to be interested in interoperability schemes. Without some pressing reason, it may thus be difficult to recruit larger platforms to open up worker profiles. The EU's new General Data Protection Regulation (GDPR) contains provisions related to data portability, but interpretations differ as to their practical scope and impact (De Hert et al., 2018). GDPR's implications to crowdworker skill data remain unexplored in the literature.

4.6. **RQ6: How can skill development and skill matching in online platform work be improved, in particular what design and policy recommendations can be made to improve these?**

A better understanding of skills development and skills matching processes in crowdwork would open the door to considering how these processes could be further improved and supported, for instance by platform design decisions or through public policy. However, the existing literature provides almost no recommendations of this nature. An exception is a study by Lehdonvirta and colleagues (2018), which provides some design recommendations. It suggests that platforms could improve matches by implementing more stringent skill tests, and by developing ways of supplying clients with observational measures of crowdworkers' skills, such as 'measures of experience with specific software tools or technologies that are important to clients' (Lehdonvirta et al., 2018, p. 24). Various other studies also comment on

aspects of platform design (e.g. Pallais, 2014), but not specifically with regards to skills development or skills matching.

The existing literature is likewise low on policy recommendations related to skills. Some studies mention that policy makers should view platforms as a way to provide earnings opportunities for skilled workers if demand in the local labour market is insufficient (Kuek et al., 2015). More sophisticated policy recommendations would need to rest on a better understanding of how crowdwork relates to the already existing adult learning and vocational training frameworks and policies. This remains another conspicuous gap in the current state of the art. To this end, it is worth briefly reviewing here the landscape of potentially relevant frameworks and policies on the EU level, even if they are not designed with crowdwork in mind.

Several key EU policy initiatives have highlighted the importance of equipping people and organisations with knowledge and skills required to function effectively and to thrive in the workplace throughout the life course. Several targets and policy activities have been specified. In particular, the Europe 2020 strategy (European Commission, 2015), the overall framework underpinning EU adult learning policy landscape, has set a target of 75% of people aged 20-64 to be in work by 2020. To achieve this target, the *Agenda for new skills and jobs* (European Commission, 2017) stipulated a set of key actions including stepping up reforms to improve flexibility and security in the labour market; equipping people with the right skills for the jobs of today and tomorrow; improving the quality of jobs and ensuring better working conditions; and improving the conditions for job creation. Similarly, the *renewed European agenda for adult learning* (The Official Journal of the European Union, 2011) highlighted the importance of increasing the availability of workplace-based learning whilst making effective use of ICT, among other priority areas.

In parallel, the *Strategic framework for European cooperation in education and training* (European Commission, 2018a) was designed to address skills deficits in the workforce, technological developments and global competition highlighting the need for job creation and investment in education. Furthermore, a flagship initiative *New skills for new jobs* (European Commission, 2008) was previously put forward to promote better anticipation of future skills needs, develop better matching between skills and labour market needs, and bridge the gap between the worlds of education and work. Another key initiative is the *European framework for key competences for lifelong learning* (European Commission, 2018b), which defines the key competences of an EU citizen including knowledge of foreign languages; digital skills; literacy; basic skills in mathematics and science; learning to learn; initiative and entrepreneurship; and cultural awareness, among others. In a similar vein, the *Skills agenda for Europe* (European Commission, 2016) highlights the need to improve the quality and relevance of skills formation, making skills more visible and comparable, fostering 'skills intelligence' and information for better career choices.

As of yet none of these policy frameworks directly address platform-based work in any significant way. However, Pouliakas (2017) argues that EU policy makers should now start debating how to adjust and/or further adapt the EU Vocational Education and Training (VET)

policy framework. Some indicative areas for further reflection, which will draw also on the insights collected as part of the ongoing Cedefop study on the skills and learning practices of crowdworkers, include:

- (a) the need to adapt regulatory frameworks to promote and sustain the continuous learning and skills adjustment of platform workers;
- (b) the need to improve the visibility and portability of skills on platforms (particular by engaging platforms in a dialogue on how to translate individual's reputation scores into informal certifications and how to potentially integrate or recognise credentials acquired in the online platform economy within national and European qualification and skills validation frameworks);
- (c) the importance of designing appropriate measures to help European start-ups and innovative companies compete in online talent markets by facilitating transparency about the quality of platform workers' skill supply and protecting them from malicious behaviour;
- (d) ensuring equal access to training benefits and competency development for platform workers, together with portability of training rights across platforms;
- (e) incentivising platforms to promote the continuing vocational training of its registered crowd workforce via quality-assured courses, in collaboration with certified training providers;
- (f) the need to revise type of qualifications and curricula in VET programmes drawing on intelligence regarding the skill needs of different types of crowdwork;
- (g) the significance of cooperating with platforms in adopting and integrating EU-wide competency frameworks, with an aim to providing greater skills transparency and equal opportunities for rewarding work to especially lower-qualified individuals or first starters;
- (h) the importance of designing appropriate policies that will promote and enhance the value and benefits of independent platform working without raising its relative cost for firms and individuals.

5. Conclusions

Crowdwork or work mediated by online platforms can be seen as a continuation of broader transformations in the economy and labour markets. It represents a form of non-standard, flexible, market-based working arrangements, where individual responsibility over career and skill development is emphasized. At the same time, it is part of the digital transformation of labour markets that among other things heightens the pace of change in skill requirements in many occupations. It is also implicated in shifting international divisions of labour, as it allows skilled workers to access earning and learning opportunities outside their local labour markets. Against this background, we asked questions about crowdworkers' skill development and learning practices, the matching of skills supply and demand in the platform economy, and how platform design and public policy might influence these. Through a review of existing empirical evidence in the social sciences and human-computer interaction, we found that existing research addressing these questions remains extremely limited; for the most part, skills development and learning practices only come up incidentally in the emerging body of literature on crowdwork.

The picture that emerges from the literature is that crowdwork does involve skill development, and that crowdworkers engage in a variety of self-regulated learning practices. Often these practices are social in nature, taking place in online communities. However, this picture is based on a patchwork of studies from different contexts, and there is little understanding on how practices and outcomes may vary between types of work, by national context and workers' sociodemographic backgrounds. Further research both on the practices themselves and how they differ across contexts would be necessary for reliable policy design and recommendations.

The review suggests that online labour platforms play a role not just in matching skilled workers with demand, but also in the workers' skill development and learning processes, through means such as skill tests and facilitating access to learning resources. However, there is little systematic understanding of these learning and skill development provisions by the platform companies, and what constraints there may be on their further development. There is also a poor understanding of how well skills matching in the platform economy works overall, and what factors influence its success.

A broader question that can be seen underlying some of the issues around skills development in crowdwork is who bears the responsibility for ensuring that crowdworkers' skills develop and remain relevant to the markets' changing needs. In standard employment, the employer has an interest in ensuring that its workforce's skills stay up to date. Policy frameworks usually operate from this position. But as an individualized, market-based form of non-standard work, crowdwork shifts the responsibility over skills development to the individual worker. This may increase flexibility and allow workers to better respond to the rapidly changing skills requirements of today's labour markets. But it could also lead to skills mismatches and dead ends, when individuals are poorly informed about or insufficiently resourced to act on changes in skills demands. Research on skills development and skill

matching in online platform work should attempt to address this big picture and means of capitalizing on the platform economy's benefits and avoiding the pitfalls.

List of abbreviations

Cedefop	European Centre for the Development of Vocational Training
ERIC	Education Resources Information Center
EU	European Union
GDPR	General Data Protection Regulation
HCI	Human-Computer Interaction
JRC	Joint Research Centre
VET	Vocational Education and Training

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