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Innovating teachers' professional learning through digital technologies

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INNOVATING TEACHERS' PROFESSIONAL LEARNING THROUGH DIGITAL TECHNOLOGIES

OECD Education Working Paper No. 237

By Andreea Minea-Pic

This Working Paper has been authorised by Andreas Schleicher, Director of the Directorate for Education and Skills, OECD.

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Abstract

Digital technologies offer immense potential for transforming teacher learning and the delivery of professional development activities throughout teachers' careers. As the COVID-19 pandemic has made face-to-face professional learning challenging or impossible for teachers to attend in many contexts, online professional learning options for teachers have been receiving renewed attention. This paper puts forward research evidence on the effectiveness of various forms of online learning for teachers and adults, and examines prerequisite conditions for enhancing teacher learning through digital technologies. Teachers' engagement in online learning activities, as captured by OECD surveys, remained limited in many OECD countries before the COVID-19 pandemic. This paper provides a basis for investigating how policies can support teachers' engagement in professional learning using digital technologies and help strike a balance between system-level provision of online teacher professional learning opportunities and the facilitation of teacher-led initiatives.

1. Introduction

As, in many countries, the 2020 disruption of schooling related to the COVID-19 pandemic has made face-to-face professional learning either very difficult or impossible for teachers to attend, online professional learning options for teachers have been receiving renewed attention. Many governments and higher education institutions, but also the private sector, have made learning resources available for teachers or provided professional development options on line to support teachers in adapting to remote teaching, and new opportunities to build online professional learning communities are being explored.

Data from a recent Harvard Graduate School of Education - OECD survey revealed that the provision of professional support and advice to teachers has been one of the key instruments of governments' education continuity strategies during the disruption of schooling caused by the COVID-19 crisis (Reimers and Schleicher, 2020[1]). Such support has mainly included the provision of access to resources and peer networks, and has mostly been online-based (e.g. digital platforms). In some systems, there has been work on the development of massive open online courses (MOOCs) or intensive training for teachers dedicated to the creation of distance learning courses (Box 1.1). A majority of respondents in the recent Harvard Graduate School of Education - OECD survey also indicated that training and counselling for teachers are part of school reopening plans in their country.

New technologies bring immense potential for transforming teacher learning and the delivery of professional development activities throughout teachers' careers. Teachers can browse the Internet for relevant information, use open education resources to support their work, participate in MOOCs or engage in online communities to share resources and experiences with other teachers. Descriptive analyses based on TALIS (2018) data show that teachers who use information and communications technology (ICT) more frequently in the classroom and those who feel more at ease supporting student learning using new technologies, are more likely to have participated in online courses or seminars as part of their professional development activities. ICT can also provide new solutions for preparing lessons, assessing student learning or completing administrative tasks more effectively, thereby allowing teachers to save time for their own learning. At the same time, many gaps remain in research related to teachers' professional learning on line, and there is room for countries to learn from each other.

This paper brings together background information on the opportunities and challenges brought by new technologies for teachers' professional learning. In particular, it puts forward research and analytical work on what is already known on teachers' use of ICT for professional learning prior to the COVID-19 pandemic in order to provide a basis for exchanging on the current situation and on how well countries are prepared for ensuring the continuity of teachers' learning. The paper first presents research evidence on the effectiveness of various forms of online learning for teachers and for adults more generally. It then examines prerequisite conditions for enhancing teacher learning through new technologies, focusing on teachers' access to ICT and digital competence. Teachers' engagement in online learning activities, as captured by OECD surveys, provides a basis for investigating how policies can support teachers' engagement in professional learning on line.

In line with the conceptual framework of the Teachers' Professional Learning (TPL) Study, teacher professional learning is defined as "formal and informal activities that aim to update, develop and broaden the skills, knowledge, expertise and other relevant characteristics of in-service teachers" (Boeskens, Nusche and Yurita, 2020[2]). Online professional learning covers therefore learning activities in a broad way, whether these are

formal online degrees or exchanges in online communities that allow teachers to enhance their skills.

Box 1.1. Enhancing teachers' professional learning using digital technologies before and during the COVID-19 disruption

Chile

Part of the Ministry of Education in Chile, the *Centro de Perfeccionamiento, Experimentación e Investigaciones Pedagógicas* (CPEIP) is responsible for teachers' professional learning, and in particular, for strengthening initial teacher education and supporting the professional development of teachers. CPEIP develops standards for the teaching profession, provides training to teachers and school leaders, and develops digital tools for teachers' professional learning.

Given the COVID-19 disruption, CPEIP has refocused its activities on the use of digital technologies to help teachers adapt to online teaching and ensure the continuity of their professional learning. It has organised webinars in the form of free weekly online conferences with national and international experts on topics of relevance in the COVID-19 context (e.g. strategies for online teaching, teacher well-being, students' socio-emotional development). It has also developed a new platform, *Desarollo docente en linea* ("Online Teacher Development"), to provide free access to online courses and digital resources to teachers and school leaders, focusing on the following areas: social-emotional learning, digital tools and curricular prioritisation. The platform includes guidelines, videos and other material to support teacher professional development, as well as digital tools to help teachers design and manage online classes, online assessment and develop collaborations with other teachers.

In addition, the Ministry of Education has also incorporated a section devoted to teachers – *AprendoenlíneaDocente* – into the platform *Aprendoenlinea* ("I learn on line"), in order to support teachers as they implement the prioritised school curriculum developed after suspension of classes (CPEIP, 2020[3]). The platform contains more than 20 000 pedagogical resources, including guides, formative evaluation activities, pedagogical files, videos, webinars and orientation documents.

Korea

In Korea, a wide range of institutions, including primary and secondary education training institutes and distance education institutes, provide in-service training to teachers (Ministry of Education, 2020[4]). Teacher training based on e-learning was introduced at the beginning of 2000 (KERIS, 2015[5]), and by 2015, 58 online teacher-training centres (both private and public) had been authorised, providing both purely online and blended learning experiences (Kang, 2016[6]). The Korean Education and Research Information Service (KERIS), under the Ministry of Education, has acted as a Remote Education Training Support Centre since 2009, checking the quality of remote training centres (KERIS, 2018[7]). KERIS manages a range of projects related to the use of ICT in school education and the education system (e.g. Edunet e-learning site, Wedorang online school/class community for teachers, educational administration data services, support for the cyber education system). On the Edunet T-CLEAR (Teacher Curriculum, Learning, Evaluation and Activity Resources) portal operated by KERIS, teachers can access information regarding teaching resources as well as training sessions

and a range of online services (e.g. online classroom platforms, digital textbooks) (KERIS, 2020[8]).

Among OECD countries with available data, Korea displays the highest share of teachers engaging in online professional development (Figure 3.6.) and around 68% of lower-secondary teachers engage in peer networks (relative to 40% on average across OECD countries). While participation levels are high, the quality of online training could be further enhanced, for instance by expanding practical exercises, increasing interactions between instructors and learners and moving beyond a model of simple knowledge delivery (Lee, 2019[9]).

Supporting teachers' capacity-building has been one of the main pillars of the governments' preparation for full-scale online learning during the COVID-19 pandemic. 495 schools became pilot schools for online learning, sharing both their expertise in this area with teachers and supporting them in addressing issues faced while teaching on line. The government also launched the "School-On" platform that teachers could use to share educational and teaching resources and materials (e.g. videos, student assignments) regarding distance education, while the "Teacher-on" platform provided support on the use of online contents (real-time online class counselling, 1:1 troubleshooting, etc.) (Ministry of Education, 2020[10]).

The Korean government also created the Community of 10,000 Representative Teachers to support teachers in adapting to online teaching during the COVID-19 crisis and help them address problems experienced during online schooling or while using learning management systems software. One teacher, proficient in online teaching, was selected from each school and the Community allowed for real-time exchanges between the Provincial Offices of Education, the 10,000 representative teachers and the Ministry of Education (Ministry of Education, 2020[10]). The online provincial communities collected suggestions from teachers and delivered them to the Ministry so that issues signalled by teachers could be addressed or solved. A group chat in which Ministry officials also participated was created to foster real-time communication between teachers and representatives of national authorities and thereby enhance teacher engagement in the community.

Spain

Part of the Ministry of Education and Vocational Training, the National Institute of Educational Technologies and Teacher Training (INTEF) is responsible for the integration of ICT in school education and teacher training. In 2019, INTEF provided the majority of its training activities on line, including MOOCs (12% of training activities), Nano-MOOCs (NOOCs) (28%) and online tutored courses (35%) (INTEF, 2019[11]). Online tutored courses encompass around 60-70 hours of training, last two months and rely on expert tutors and co-ordinators who guide participants in the course. The catalogue of courses is updated yearly, and teachers who complete a course receive a certification for the training hours undertaken (INTEF, n.d.[12]). In the case of MOOCs and NOOCs, training hours are not certified, but digital micro-credentials are issued to recognise learning upon completion and stored in an "INTEF Badges" backpack. Open digital meta-credentials that recognise teachers' learning paths can be issued when teachers collect several micro-credentials (INTEF, n.d.[12]). In addition, INTEF has also developed a micro-learning app (Edupills), accessible by tablet or mobile phone, to help teachers develop their digital competencies. The micro self-learning activities ("pills") are categorized according to the five areas of INTEF's Educational Digital Competency Framework (INTEF, n.d.[12]).

Before the COVID-19 disruption, INTEF and teacher-training centres at the regional level were carrying out many teacher professional learning activities related to innovative pedagogies using new technologies (e.g. Moodle use, flipped classrooms, virtual reality, coding). While these training activities supported teachers in using technology in their classrooms, the COVID-19 disruption led to the implementation of online training activities to help teachers adapt to remote teaching.

In this context, INTEF has focused on the design of open education resources and the provision of online courses for teachers, to help teachers design their own teaching resources and to co-ordinate ICT projects. In addition, at the national level, the web portal *Aprendo en casa* ("I learn at home") provides educational resources, training tools and apps for teachers, families and students. In their dedicated section, teachers can share resources, access training and receive support, as well as benefit from a number of initiatives and tools (e.g. platforms for distance learning, educational materials) put forward by private and public sector entities.

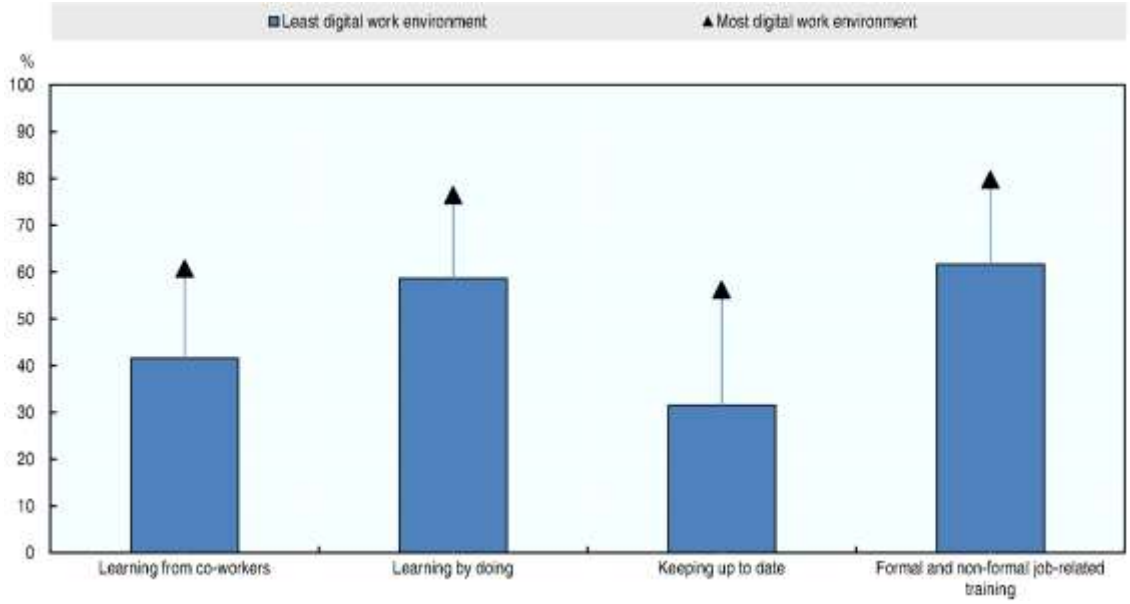
2. The potential of new technologies for transforming teacher learning

Digitalisation can enhance teachers' learning opportunities, by transforming the delivery of professional programmes and materials but also the way in which teachers connect to each other and conduct other teaching-related activities. Online delivery of professional development can allow for reaching a greater number of teachers more rapidly and from anywhere, diversifying the design of traditional professional development courses in terms of duration, depth and topics covered, providing new certification options (Vuorikari, 2018[13])and offering new opportunities to expand teacher-centred collaborative learning opportunities in the virtual space.

At the same time, digitalisation also transforms the way workers, including teachers, carry out their tasks at work. Some tasks can be automated, whereas others can be performed differently or more efficiently thanks to the use of digital tools (OECD, 2019[14]). For teachers, new technologies have the potential to transform the way some tasks (e.g. administrative work, assessments) are carried out, allowing teachers to free up time to devote to their own learning. In addition, workers evolving in more digitally-intensive environments are more likely to maintain their skills, tend to learn more from co-workers, learn more by doing and keep up to date; and this is also the case for teachers (Figure 2.1). As workers and teachers increasingly use technology in the workplace, they perform tasks differently and this impacts the way they develop their own skills (OECD, 2019[14]).

Figure 2.1. Teachers' formal, non-formal and informal learning in digital work environments

Share of teachers performing each type of learning activity, by work environment type



Notes: Each bar displays the share of teachers performing each type of learning activity in a least digital work environment (below median of the 1-digit occupation in both non-routine and ICT intensities). Each triangle displays the share of teachers performing each type of learning activity in a most digital work environment (above median of the 1-digit occupation in both non-routine and ICT intensities). Teachers are defined based on the population of adults aged 25-65 years old. Teachers are adults self-reporting working in the following two-digit occupations as classified by the International Standard Classification of Occupations (ISCO-08): Teaching Professionals (ISCO 23). The non-routine intensity of jobs indicator is computed following the methodology proposed by Marcolin, Miroudot and Squicciarini (2016[15]), and builds on items that capture the extent to which one's job is codifiable and sequentiable. It is close to 0 when the job is routine-intensive and close to 1 when the job is not routine-intensive. The ICT intensity of jobs indicator was developed in work by Grundke et al. (2017[16]) and describes tasks associated with ICT use, from reading and writing emails to using word-processing or spreadsheet software, or a programming language. It is close to 0 when the job is not ICT-intensive and close to 1 when the job is ICT-intensive.
Source: Adapted from the OECD (2017[17]) *Survey of Adult Skills (PIAAC) (2012, 2015, 2017)* (database), http://www.oecd.org/skills/piaac/ (accessed on 15 May 2020).

2.1. Effective online learning for teachers and other adults: What we know from research

2.1.1. Research and evidence on teachers' learning: Online courses, MOOCs and communities

Research on teachers' online learning has relied on a diversity of methodological approaches, but many gaps remain in the area. Existing studies tend to suggest that the principles and features that enhance the effectiveness of traditional professional development can also guide the design and assessment of online teacher professional learning (Vuorikari, 2018[13]; Prestridge and Tondeur, 2015[18]; Philipsen et al., 2019[19]). While the type and features of technology (e.g. personalisation, designs based on gamification) can enable the organisation of new forms of training that can better support teachers in their learning, technology alone cannot be a sufficient driver for the quality or effectiveness of online teacher professional development (Dede et al., 2016[20]). Factors such as the context of technology-based professional development activities (e.g. the policy

environment, the characteristics of teachers and schools), their nature (e.g. blended or virtual) or duration equally shape the outcomes of online professional learning activities (Dede et al., 2016[20]).

To design effective professional learning for teachers, there is a need to understand how teachers learn, how they are motivated to learn, and how and in which context can specific features facilitate their learning (Boeskens, Nusche and Yurita, 2020[2]). A series of characteristics have been associated with successful professional development – content focus, active learning, modelling of effective practice, provision of coaching, expert support and opportunities for feedback, sustained duration, and embeddedness in collective practice (Darling-Hammond, Hyler and Gardner, 2017[21]). However, recent evidence emphasises that an automatic compliance with a set of specifically defined design features is not sufficient to ensure the effectiveness of teacher professional learning and that no specific type of learning activity is universally effective (for a detailed review of the literature on the effectiveness of teacher professional learning design, see Boeskens, Nusche and Yurita (2020[2])). At the same time, research reviews have also illustrated a shift away from passive, one-off learning experiences and the need to provide teachers with the appropriate opportunities to reflect and practice in structured ways. Involving external expertise has also been found by most reviews as one of the common features of effective teacher professional learning opportunities, while collaborative activities tend to be effective when well-structured and focused on aspirations for students. In a similar vein, while professional learning of sustained duration tends to be associated with more impactful learning, shorter learning experiences can also be successful when learning goals are narrowly defined (Boeskens, Nusche and Yurita, 2020[2]).

An inventory of innovative practices of teacher professional learning[1] analysed in relation to the key features of effective professional development, (Vuorikari, 2018[13]) shows that all identified practices rely on active learning, and a great number of them are based on modelling effective practices and support collaboration in job-embedded contexts. Coaching and expert support were less recurrent. Other evidence emphasises that online programmes aimed at teacher learning should account for teachers' background (experience, skills, needs), be aligned with the curriculum and include design features (e.g. interactive videos) that stimulate teacher motivation to remain engaged with the course (Qian et al., 2018[22]).

As teachers represent a large share of MOOC learners and as MOOCs providers are progressively shifting their model towards online professional degrees and credential programmes (more on this below), there is increasing potential for teacher professional learning to expand in online formats (Seaton, Coleman and Daries, 2014[23]; Reich and Ruipérez-Valiente, 2019[24]; Littenberg-Tobias, Slama and Reich, 2020[25]). Yet, research on the effectiveness of MOOCs for teachers and educational professionals is still emerging. Evaluating their effectiveness is complex, given that MOOCs face the double challenge of designing standard content to be delivered on a large-scale while at the same time aiming to provide the flexibility for teachers to link this content to their own practice and context (Littenberg-Tobias, Slama and Reich, 2020[25]).

A mixed-methods study of four MOOCs on change-leadership for educators implemented in the United States (Littenberg-Tobias, Slama and Reich, 2020[25]) emphasised that course content and in particular, "hooks" to teachers' own practices, providing them with opportunities to relate the content to their own activities, were important elements in driving transformations in practices. The flexibility of the course design is crucial, as it enables MOOCs to easily connect content designed for large-scale audiences to learners'

[1] All these practices are not necessarily technology-based.

own context. The context in which teachers or education professionals worked also mattered for how learners adapted to the course requirements (e.g. teachers in less supportive school environments tended to rely more on online collaboration with other learners rather than on sharing resources and collaborating with teachers in their own school, but it did not lead to more limited changes in teacher practices). Teachers adapted their interaction with the course content based on their specific contexts and needs. In addition, teachers' skills and previous experience in online environments also shape their engagement in MOOCs. Without guidance and a design that supports less-experienced teachers, MOOC environments can be challenging for novice participants who may face difficulties in engaging or navigating through resources (Karlsson and Godhe, 2016[26]).

Beyond the opportunity to expand knowledge, engagement in MOOCs, as well as in other forms of online learning, can enable teachers to be part of wider communities, with potential effects on a variety of social and organisational outcomes. While most teachers engage in courses or seminars as part of their professional development, participation in professional development networks or peer-observation is not widespread, despite increasing evidence on the effectiveness of the latter (OECD, 2019[27]). In this respect, online communities provide teachers with enhanced opportunities for exchanging, sharing resources and learning collaboratively.

Data on participants in informal online communities and networks collected from a number of studies between 2009 and 2016 showed that online community members were more likely to be women, aged 40-59 years-old and especially motivated by the potential to enhance their teaching practices thanks to exchanges with other teachers and emotional support (Macià and García, 2016[28]). Teachers engage in online communities and networks in a diversity of digital environments (e.g. wiki, networking sites, platforms, learning management systems) and rely on various tools (e.g. forums, instant messaging, podcasts) to interact with each other (Macià and García, 2016[28]; Cranefield and Yoong, 2009[29]).

Both formal and informal teacher communities can be useful at enhancing supportive and collegial professional practices and be valuable sources of professional learning. Recent research reviews of empirical literature on online communities provide evidence that teachers tend to engage in such communities primarily for topics related to teaching with technology or other educational technology issues (Lantz-Andersson, Lundin and Selwyn, 2018[30]; Macià and García, 2016[28]). Typically, there is a lot of variation in the intensity with which teachers engage in online communities, with a minority of them participating actively and thereby influencing the way the community unfolds its exchanges, whereas most teachers act as more passive users or consumers.

A case study on a Korean teacher-created online community brings an illustration of these findings, as teachers use the online community more as a resource bank rather than for collaboratively developing teaching materials (Seo and Han, 2013[31]). Teaching materials created by less than 1% of teachers in the community were massively used by the remainder of teachers, without any changes made to these materials after their use in class. The community led to a standardisation of teaching practices, especially since teachers rarely criticised materials posted by other teachers. In fact, teachers' reluctance to criticism in the online space tends to replicate similar attitudes observed in face-to-face collaborations whereby teachers seek to avoid disagreements, which may also translate into reduced benefits teachers can derive from exchanging with their peers (Dooner, Mandzuk and Clifton, 2008[32]).

Indeed, online communities, and in particular, informally-developed ones, have been found to often serve as a means for teachers to filter information thanks to their colleagues (Lantz-Andersson, Lundin and Selwyn, 2018[30]). However, information sharing or exchanges appear to be done quickly or in superficial ways, and discussions often occur in consensual

forms, conforming to, rather than challenging, community norms. At the same time, communities can also benefit from more silent participants or "lurkers", as passive participation can be a first step to engaging more actively (e.g. posting material, participating in discussions). In the Korean teacher-created online community, teachers who posted materials frequently reported having been passive users at first (Seo and Han, 2013[31]). More research is needed on the impact of more passive or superficial forms of interaction, both on teacher learning and on teaching practices, but also on how different types of users (active or passive) benefit from these exchanges and on how time affects participation. Similarly, many gaps remain with respect to how different types of technological configurations, applications or platforms shape teachers' practices in online communities (Lantz-Andersson, Lundin and Selwyn, 2018[30]).

Participation in online communities or networks can be shaped by a variety of factors. A first precondition relates to the quality of the ICT infrastructure that underpins it, including the presence of appropriate and varied collaborative online tools and a well-designed, user-friendly platform (Dede et al., 2016[20]). When it comes to how online communities are designed, blended models of online communities that combine virtual and in-person interactions appear to be preferred by teachers relative to purely virtual ones (McConnell et al., 2013[33]), and also to translate into stronger member relationships and participation. Such models tend to be associated with higher levels of trust and sociability between community members, which favour knowledge sharing and exchanges but are more difficult to foster when participants only meet on line (Matzat, 2010[34]; Matzat, 2013[35]). In addition, moderators play a key role in encouraging member participation, and in guiding and ensuring the continuity of the community (without dominating exchanges) (Lantz-Andersson, Lundin and Selwyn, 2018[30]; Macià and García, 2016[28]). The time they need to support the community, as well as their skills and experience in the area of online community building are likely to shape the extent to which they are able to effectively co-ordinate and moderate the community. Time constraints can, in fact, be a significant barrier for teacher engagement in both formal and informal communities, either because such activities take place during teachers' free time and amplify their work burden, or because of the difficulty in organising synchronous activities with teachers from different time zones, or who lack the skills to rapidly navigate in the virtual environment (Lantz-Andersson, Lundin and Selwyn, 2018[30]).

Evidence on the extent to which engagement in online forms of learning, and in particular in online communities, translates into actual changes in teacher practices remains scarce and is often based on teacher self-reports. In a randomised experiment, Dash et al. (2014[36]) show that while participation in an online professional development course of sustained duration translated into enhanced pedagogical content knowledge and changes in pedagogical practices, it did not lead to higher student achievement. Given the evaluation design, teachers are likely to have had only limited opportunities to actually implement the learning material content in the classroom, despite measured changes in indicators of self-reported practices. In contrast, Choi and Morrison (2014[37]) rely on classroom observation data, together with threaded online discussions, to investigate changes in classroom practice and teacher perceptions following a blended professional development programme for teachers. Participation in the professional development programme was found to be associated with positive changes in classroom practices.

At the same time, outcomes derived from participation in online learning activities can extend beyond the more conventional set of professional development activities related to improvements in teacher knowledge and changes in teaching practices (Yurkofsky, Blum-Smith and Brennan, 2019[38]). While participation in online learning can allow teachers to enhance their content knowledge and skills, it can also impact on other types of outcomes (e.g. professional identity, reflection on own learning, social relationships, self-confidence

and enthusiasm for own work) (Karlsson and Godhe, 2016[26]; Beach, 2017[39]) (Lantz-Andersson, Lundin and Selwyn, 2018[30]). Examining teacher participation in a technology-related MOOC, Yurkofsky, Blum-Smith and Brennan (2019[38]) find evidence that the course provided teachers with new ways of engaging with colleagues and administrators (e.g. by constructing similar courses for colleagues in their area), as well as to connect and construct virtual communities (e.g. with teachers from other places) for sharing resources, building their identity and solving issues they encounter in the classroom. Teachers reported feeling less isolated, as they could locate their own work in a wider community. Similar evidence from research on online communities shows that teacher engagement in such networks can be particularly beneficial to novice teachers in terms of building their professional identity and confidence (Macià and García, 2016[28]).

2.1.2. Research and evidence on adult learning more generally: Online courses and MOOCs

General research on effective adult learning on line can also provide insights relevant for teachers' professional learning specifically. A range of experimental studies have examined the effectiveness of both more conventional online courses - either as part of online degrees or as modules of in-person degrees combining online and in-person learning - as well as emerging forms of online learning in the form of MOOCs (Escueta et al., 2017[40]).

Online courses offer the possibility of both reducing costs associated with the implementation of face-to-face learning as well as providing flexibility for learning for those who would otherwise not engage due to time or location constraints. Experimental and quasi-experimental studies on online courses unfolded at the post-secondary level tend to find, however, that purely online learning environments are less beneficial to learners than in person, in terms of participants' achievement and further progression (Escueta et al., 2017[40]; Bulman and Fairlie, 2016[41]).

There is also evidence that learning outcomes from online courses appear to be weaker, particularly among students with lower academic achievement (Xu and Jaggars, 2016[42]) (Bettinger et al., 2017[43]). Xu and Jaggars (2016[42]) focus on students from community and technical colleges in the United States, and show that performance gaps associated with participation in online courses were wider for students with lower grade point averages (GPAs), but also for students in some specific subjects (e.g. social sciences and applied professions). Bettinger et al. (2017[43]) study the performance of students in more than 700 courses at a large for-profit university in the United States that delivers both online and in-person courses. Participation in online courses translated into lower academic success and progression (grades in future courses and likelihood of remaining enrolled a year later) compared to in-person courses. Its negative impact is also higher for students with lower prior GPA.

In contrast, blended environments that combine online courses with face-to-face ones enable similar learning outcomes to in-person courses and may represent a suitable option allowing to decrease costs while ensuring high-quality delivery of learning (Escueta et al., 2017[40]) Alpert, Couch and Harmon. (2016[44]) simultaneously examine the effectiveness of online, blended and in-person course formats for students in economics at a large public university in the United States, thanks to a randomised experiment. In the blended format, students met with an instructor for a discussion period and had access to the online lecture material. In the online setting, asynchronous discussion took place via Facebook groups, the level of participation being part of the course grade. Students who attended the online course displayed poorer learning outcomes than those in the face-to-face format, whereas those engaged in the blended format performed on a par with students attending the face-to-face format.

Classroom time matters even when learning material is available for students on line. In an earlier study, (Joyce et al., 2015[45]) examined the effect of class time on college students' performance in a setting where students also had access to online course material. The study was performed at a public university in an urban area (in the United States) attended by many students who commuted. Students who benefitted from more face-to-face instruction (2 classes of 75 minutes per week in person with the teacher for the duration of the course) displayed higher learning outcomes than those enrolled in a compressed version (one class of 75 minutes per week); but non-cognitive measures (related to effort) were similar for both groups.

Little is known, however, on the success of online courses in expanding participation to those who would not have engaged in such learning activities otherwise. Goodman, Melkers and Pallais (2019[46]) provide first evidence in this respect, focusing on an Online Master of Science in Computer Science and showing that online delivery of education increases the number of individuals who pursue education. Flexibility in terms of location and time was an essential feature attracting candidates to the degree, even more than the lower costs relative to the in-person version. The online degree expanded overall educational enrolment, attracting mid-career individuals who would have not enrolled otherwise, while the in-person version drew younger applicants. Displaying lower costs than its in-person version, the online degree provided high-quality instruction and online students slightly outperformed those who attended in-person. In addition, surveys of applicants showed that the online degree had not substituted for non-degree options, but that the programme had increased total training participation.

Since 2012, the number of MOOC courses has been on a steady rise, and in 2019, there were more than 110 million MOOC learners around the world, excluding China (Class Central, 2019[47]). Since their inception, however, MOOCs have constantly displayed low retention and completion rates, and, similar to more traditional forms of adult education, have tended to draw learners who are highly educated, and from wealthier neighbourhoods and countries (Reich and Ruipérez-Valiente, 2019[24]; OECD, 2019[14]). MOOCs targeted at teachers have displayed similar issues in terms of low retention (Ericson et al., 2016[48]; Castaño-Muñoz et al., 2018[49]). At the same time, individuals may engage in MOOCs for a variety of reasons and non-completion may also reflect that individuals obtained the information they needed from the course without completing it. Similarly, early dropout may also be an indicator of the low quality of certain courses or their mismatch with learners' needs. Indeed, very little information is available on the quality of MOOCs and their effectiveness in enhancing learner' outcomes.

Research on adults' participation in MOOCs has therefore focused more on enhancing the MOOC experience, so that those who engage make the most of it. The experimental and quasi-experimental literature has examined interventions that seek to enhance effort and completion. Interventions based on social comparisons, by which learners receive information related to the performance of other learners, have been effective at improving MOOC learners' outcomes (performance and completion) (Escueta et al., 2017[40]). Davis et al. (2017[50]) develop a personalised feedback system that allows learners to compare themselves with previous learners who have been successful in the course. While completion rates increase, feedback benefitted more the highly-educated. Other studies have found that commitment devices seeking to minimise distraction and reduce procrastination, as well as planning prompts students receive at the beginning of the course and that encourage them to plan their course participation from the onset, were successful at enhancing completion rates (Patterson, 2018[51]; Yeomans and Reich, 2017[52]).

3. Prerequisites for enhancing teacher learning through new technologies

3.1. Ensuring access to high-quality ICT for teachers

Access to new technologies is the first prerequisite for teachers, similarly to other adults, to make the most of digitalisation for developing skills, especially when the employer does not ensure the provision of such learning activities or teachers engage independently in such training. Whether learning activities take place in schools or at teachers' home, having the necessary digital devices, a good-quality Internet connection and the skills to rely on these tools to unfold more complex activities are required to allow teachers to engage in online learning activities.

Little is known, however, about teachers' access to digital tools and Internet connection outside of the school premises. While the digital divide in terms of access has progressively narrowed across OECD countries, inequalities in access remain, especially between rural and urban areas. Rural areas are lagging behind urban ones in all OECD countries in terms of their access to fixed broadband with a sufficient speed to allow using advanced connected devices and services (OECD, 2019[53]). Similarly to other individuals, teachers living in rural areas are likely to be affected by the lower quality of Internet connections and hence, to experience more difficulties in using online learning resources to their best advantage.

In addition, the COVID-19 pandemic has emphasised the importance of having access to a computer or a digital device to continue teaching and learning from home. According to a teacher survey run on the School Education Gateway, the most frequently mentioned challenge in switching to online or distance learning during the COVID-19 disruption was access to technology (computers, software, stable Internet connection, etc.), whether by pupils (mentioned by 49.2% of respondents) or by teachers (34.3% of respondents) (School Education Gateway, 2020[54]). One in two high-income and upper-middle income countries have thus supported teachers during the COVID-19 crisis by providing them with ICT tools and free Internet connectivity to ease their work during the school closures (UNICEF, 2020[55]). In 2017, on average across 25 OECD countries with available data, 65% of households with income in the bottom quartile reported having access to a computer at home in contrast to more than 96% of households with income in the top quartile (OECD, 2020[56]). Teachers' salaries display wide variability both across and within OECD countries (OECD, 2019[57]), and while data on teachers' connectivity from home are often lacking, some teachers may not have the resources to afford high-quality digital tools to engage in more sophisticated Internet activities.

3.2. Enhancing teachers' digital competence

In addition, teachers' skills are equally crucial to ensure they can tap into the potential of new digital tools for learning. The digital divide, which had initially focused on gaps in Internet access, increasingly relates to divides in the ways individuals use digital devices and the Internet. Skills are important drivers of such gaps. Higher cognitive skills – literacy, numeracy or problem-solving skills in technology-rich environments, or a mix of them – enable individuals who go on line to move from elementary uses of Internet to more complex and diverse uses (OECD, 2019[14]). In OECD countries with available data in the OECD Survey of Adult Skills (PIAAC), the share of teachers with low problem-solving skills in technology-rich environments ranges from less than 5% in Australia to 31% in Israel (OECD, 2019[14]). Substantial differences across countries are also observed in terms of teachers' literacy and numeracy skills (Hanushek, Piopiunik and Wiederhold, 2014[58]).

Box 3.1. Enhancing teachers' digital competence in Latvia – recent reforms

In Latvia, the COVID-19 crisis has accelerated and refocused a number of education policy reforms already in progress and related to curriculum, teacher education and the transition to digital education. In 2018, the government approved a new curriculum to be introduced progressively in schools from September 2020 and that integrated a series of transversal skills, including digital skills that would be provided starting with the first grade (Eurydice, 2019[59]). As digital skills are meant to be developed across all curricular areas, teacher professional learning and the development of teachers' digital competence have been brought to the forefront of efforts for implementing curricular reform.

In the context of the COVID-19 pandemic, teachers in Latvia have benefitted from a number of measures to support their transition to distance learning activities. The Ministry of Education and Science designed guidelines for distance education, and teachers could rely on a number of online platforms (e.g. *E-klase* school management platform) already available before the crisis. Teachers received support from IT specialists and online teacher professional learning activities were provided to them on relevant topics in the context of school closures (e.g. video lessons creation).

In Latvia, teacher professional learning courses are funded based on thematic priorities defined yearly at the national level. In 2020, the Ministry of Education and Science allocated additional budget for training activities, to be unfolded both on line and in person, aimed at developing teachers' digital competence. The Ministry developed the thematic framework for teacher professional learning courses in the area of ICT based on the identified skills gaps in a survey carried out in 2019 regarding teachers' digital self-efficacy. The improvement of teachers' digital competence has thus represented almost one-third (500 000 euros) of the total budget for developing teachers' professional competence in 2020 (Eurydice, 2020[60]). Teachers can engage for free in professional development courses to enhance their digital skills in the e-environment for the use of educational technologies. The courses target a large variety of teachers and school leaders, from pre-school to vocational education and training teachers and teachers of various school subjects (e.g. languages, mathematics, and biology). Teachers can engage with the content flexibly, at their own pace (Eurydice, 2020[60]).

While low-skilled teachers tend to display similar shares of participation in open or distance education as high-skilled ones (Figure 3.2), mere participation does not guarantee that teachers are actually effective in their online learning experience. Evidence on teacher engagement in online courses, MOOCs or online communities indicates that there is a need to enhance teachers' digital competence in order to allow them to participate in and seize the benefits of online learning (Dash et al., 2014[36]; Macià and García, 2016[28]). Teachers with higher digital competence or capacity to quickly navigate online resources, and make critical uses of them, are likely to be more efficient in their learning, progress faster and achieve desired goals in less time. In addition, higher-skilled teachers may also choose their online learning sources better, targeting higher quality courses or resources, and moving into more complex uses of such resources. Once teachers engage in online learning activities, the way they use these learning sources and the type of benefits they derive from them are likely to be dependent on their skills.

Expanding access to professional learning opportunities on line is unlikely to be sufficient in reaching more teachers in need of professional learning or be effective for those who already go on line for learning activities, if teachers' skills are insufficient for them to make

the most of these new learning resources. However, little is known on teachers' ability to access and use digital tools, and while the OECD Survey of Adult Skills (PIAAC) measures proficiency in problem solving in technology-rich environments, the assessment's primary focus is on the cognitive dimensions of problem solving rather than on digital skills per se.

3.3. Supporting teachers' engagement in technology-based learning activities

The COVID-19 crisis has brought digital resources and the online provision of training to the forefront of policy solutions to ensure the continuity of teacher professional learning in the absence of face-to-face training options. Enhancing teacher engagement in technology-based learning activities can pave the way for more effective uses of digital resources by teachers for their own learning, as they become more familiar with a wealth of resources, methods and ways of learning and can make more productive uses of such resources.

There are currently many gaps in terms of data and research related to teacher enrolment, but also related to the profile of teachers engaging in online forms of professional learning, particularly from a cross-country comparison perspective. OECD surveys such as the OECD Survey of Adult Skills (PIAAC) and the Teaching and Learning International Survey (TALIS) allow providing some contributions in this area.

3.3.1. How teachers engage in open or distance education relative to other high-skilled workers

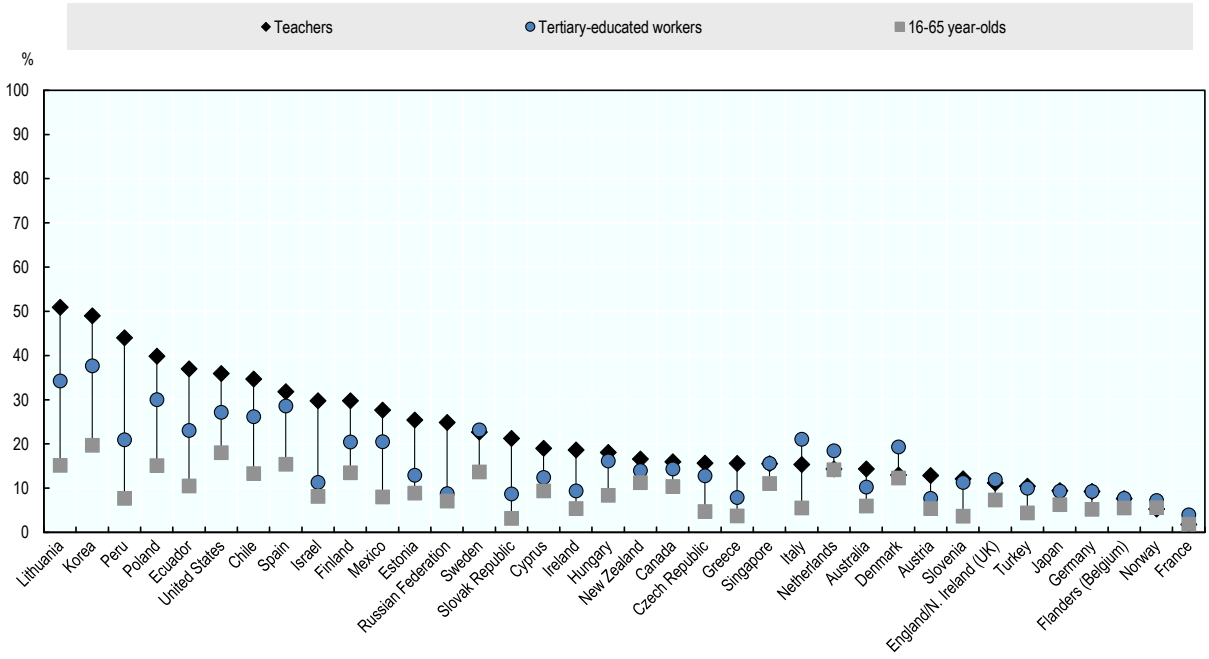
The OECD Survey of Adult Skills (PIAAC) contains questions related to adults' participation in open or distance education. Open or distance education is defined as not leading to formal qualification and covers courses that are "similar to face-to-face courses but take place via postal or correspondence or electronic media, linking together instructors, teachers and tutors or students who are not together in the classroom" (OECD Survey of Adult Skills (PIAAC), n.d.[61]). Countries participating in the Survey of Adult Skills (PIAAC) were surveyed in three rounds - 2012, 2015 and 2017. Hence, open or distance education participation is more likely to capture engagement in MOOCs rather than in more traditional forms of open education in 2015 and 2017 rather than in 2012, when MOOCs were only beginning.

When it comes to teachers' engagement in open or distance education, teachers display higher participation rates than other tertiary-educated adults (Figure 3.1) and a similar pattern is observed for MOOCs (Seaton, Coleman and Daries, 2014[23]). Among OECD countries with available data in the Survey of Adult Skills (PIAAC) around 21% of teachers had participated in open or distance education in the 12 months before the survey, in comparison to 16% among high-skilled workers and less than 10% in the entire 16-65 year-old population covered by the survey. In countries with lower levels of engagement in open or distance education, teachers are as likely and sometimes less likely than other adults to participate in such courses. In contrast, in Korea, one in two surveyed teachers reported having participated in open or distance education in the year preceding the survey.

Adults' participation in open or distance education tends to reproduce existing inequalities in participation in more standard forms of adult learning. Younger, more educated or skilled adults are more likely to engage in such forms of flexible training. In this respect, the potential of open education at reaching those adults most in need of training could be further explored (OECD, 2019[14]).

Figure 3.1. Teachers' participation in open/distance education

Percentage of each population category having participated in open or distance education in the 12 months before the survey[2]



Notes: In the PIAAC questionnaire, open or distance education is defined as not leading to formal qualification. It covers courses that are similar to face-to-face courses but take place via postal or correspondence or electronic media, linking together instructors, teachers and tutors or students who are not together in the classroom. Teachers and tertiary-educated workers are defined based on the population of adults aged 25-65 years old. Teachers are adults self-reporting working in the following two-digit occupations as classified by the International Standard Classification of Occupations (ISCO-08): Teaching Professionals (ISCO 23). Tertiary-educated workers are all adults in employment with a tertiary education as defined by 1997 International Standard Classification of Education (ISCED): Tertiary (ISCED 5B, 5A, 5A/6). Chile, Greece, Israel, Lithuania, New Zealand, Singapore, Slovenia and Turkey: Year of reference 2015. Ecuador, Hungary, Mexico, Peru and United States: Year of reference 2017. All other countries: Year of reference 2012.
Source: Adapted from the OECD (2017[17]) *Survey of Adult Skills (PIAAC) (2012, 2015, 2017)* (database), http://www.oecd.org/skills/piaac/ (accessed on 15 May 2020).

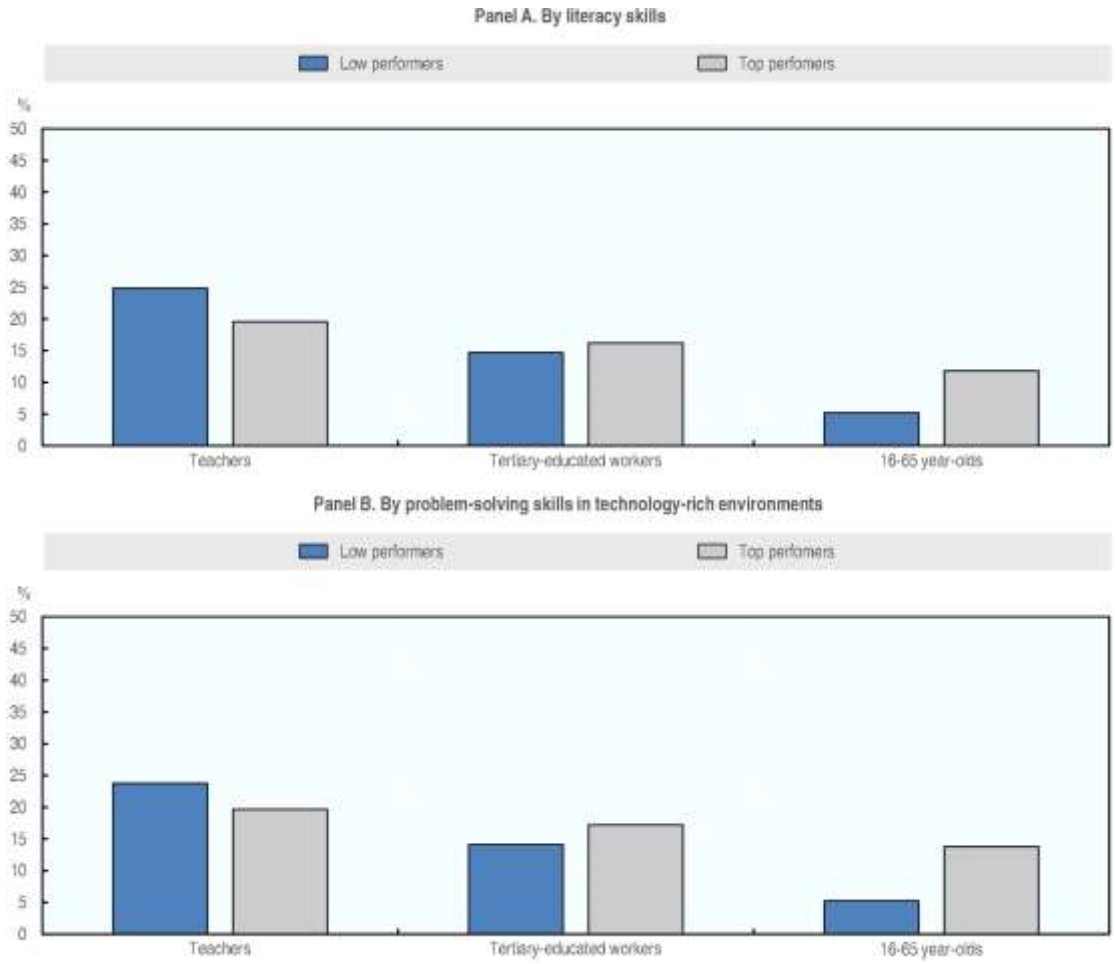
At the same time, in the teacher population, lower-skilled and higher-skilled individuals tend to display similar engagement in open or distance education. Participation rates are comparable for low-performing and top-performing teachers in literacy or problem solving in technology-rich environments (Figure 3.2): teachers want to learn, upgrade and expand on their skills, suggesting a high willingness to learn, even when they are low-skilled. Indeed, low-skilled teachers, similarly to other tertiary-educated adults, display a higher readiness to learn than other low-skilled individuals do (Figure 3.3). Low-skilled teachers may want to bridge a gap in skills by additional training and open or distance education can provide them some flexibility.

[2] Note by Turkey:
The Information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".
Note by all the European Union Member States of the OECD and the European Union:
The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Teachers' participation in open or distance education alone does not guarantee, however, that teachers make the most of these technologies and use them at their full potential, so that they are actually impactful. These data do not allow capturing the outcomes of participation and whether these vary by teachers' skills. Returns to such forms of training may end up being higher for those who are already high-skilled.

Figure 3.2. Participation in open/distance education by skills proficiency

As a percentage of each category



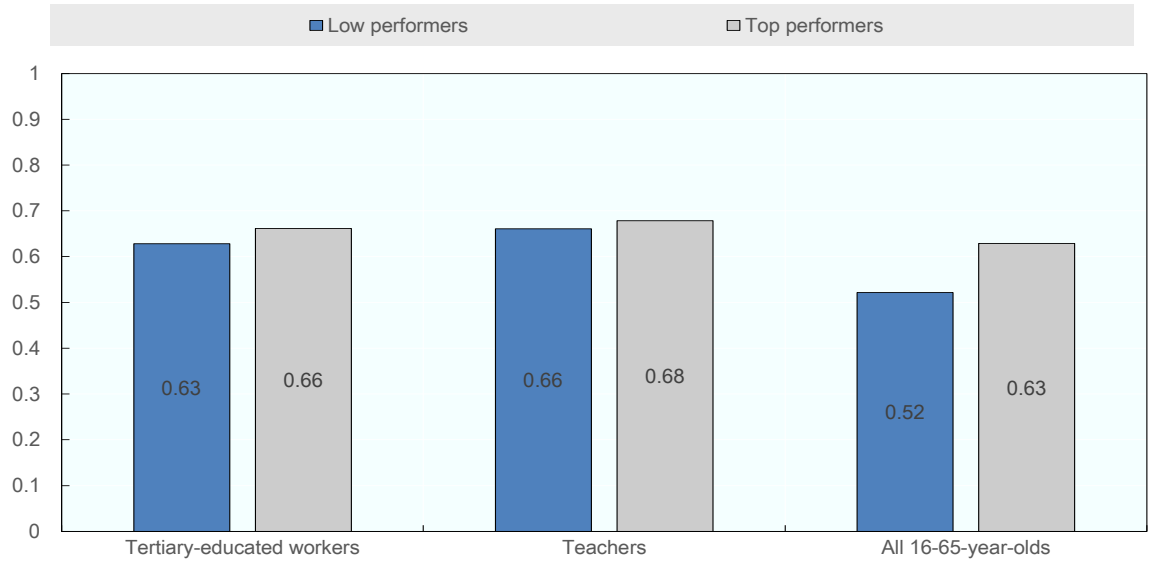
Notes: Poor performers in literacy score at most *Level 1* (inclusive), while top performers score at least *Level 3* (inclusive). Poor performers in problem solving in technology-rich environments are defined as scoring at most *Below Level 1* (inclusive) in problem solving (including failing ICT core and having no computer experience), while top performers score at least *Level 2* (inclusive).
Source: Adapted from the OECD (2017[17]) *Survey of Adult Skills (PIAAC) (2012, 2015, 2017)* (database), http://www.oecd.org/skills/piaac/ (accessed on 15 May 2020).

In addition, the similar shares of engagement in open/distance education displayed by teachers of varying skills proficiency emphasises the importance of matching online professional development materials or sources to teachers' background. The design of online professional development needs to account for teachers' previous experience with online learning and their skills. A study of teacher participation in online professional development courses in mathematics (Dash et al., 2014[62]) found that the large dropout rate from the course was mostly due to teachers who were less experienced with online

professional development. In fact, teachers' experience in online environments was the only significant difference in terms of teacher characteristics between teachers who remained engaged and those who dropped out of the course.

Figure 3.3. Readiness to learn, by literacy proficiency

Average readiness to learn



Notes: Using the methodology of (Grundke et al., 2017[16]), the index of readiness to learn is built based on the following survey items: I like to get to the bottom of difficult things; If I don't understand something, I look for additional information to make it clearer; When I come across something new, I try to relate it to what I already know; When I hear or read about new ideas, I try to relate them to real life situations to which they might apply; I like learning new things; I like to figure out how different ideas fit together. A higher score is associated with a higher readiness to learn.
Source: Adapted from the OECD (2017[17]) *Survey of Adult Skills (PIAAC) (2012, 2015, 2017)* (database), http://www.oecd.org/skills/piaac/ (accessed on 15 May 2020).

Teachers engage in open/distance education overwhelmingly for job-related reasons: 91% of them (and 81% of tertiary-educated workers) reported that their participation in open/distance education was job-related and more than half of them found it very useful for their job. Doing better at their job and/or improving career prospects is the main reason driving teachers' participation (59% of teachers), even more than for other tertiary-educated workers (49%) (Figure 3.4).

While teachers engage in open/distance education mostly for job-related reasons, these activities tend to take place outside of their working hours, in contrast to other tertiary-educated workers. More than 60% of teachers surveyed in the Survey of Adult Skills (PIAAC) reported that they had engaged in open/distance education only outside working hours and another 20% that they had done so mostly outside working hours. In contrast, for one-third of tertiary-educated workers, participation in open/distance education occurred only during working hours.

Digitalisation increasingly expands the opportunities for learning flexibility as well as for novel forms of on-the-job training. At the same time, when work-related professional learning increasingly takes place outside of school hours, there is a risk that it may add on to teachers' workload and negatively affect their well-being. For instance, the provision of professional learning activities outside of working hours as well as requirements set by

public authorities (e.g. renewal of teacher registration or re-certification programmes conditional on teachers undergoing a given number of professional learning hours) in some contexts can over-burden teachers by constraining them to use their personal time for these activities. Time devoted to training constitutes one of the main challenges for teachers' participation in professional development, and across OECD countries, more than 54% of teachers agree or strongly agree that conflicts with their work schedule are a barrier that prevents them to engage in such forms of learning (OECD, 2019[27]).

In these conditions, engagement in professional learning becomes increasingly possible only outside of teachers' working hours and similarly to in-person training, equity considerations should be integral to the design and implementation of online professional learning opportunities as well. When teachers increasingly participate in professional learning, whether online, blended or in-person, in their own time, those who hold family or caring responsibilities are likely to engage or benefit less from their learning experience.

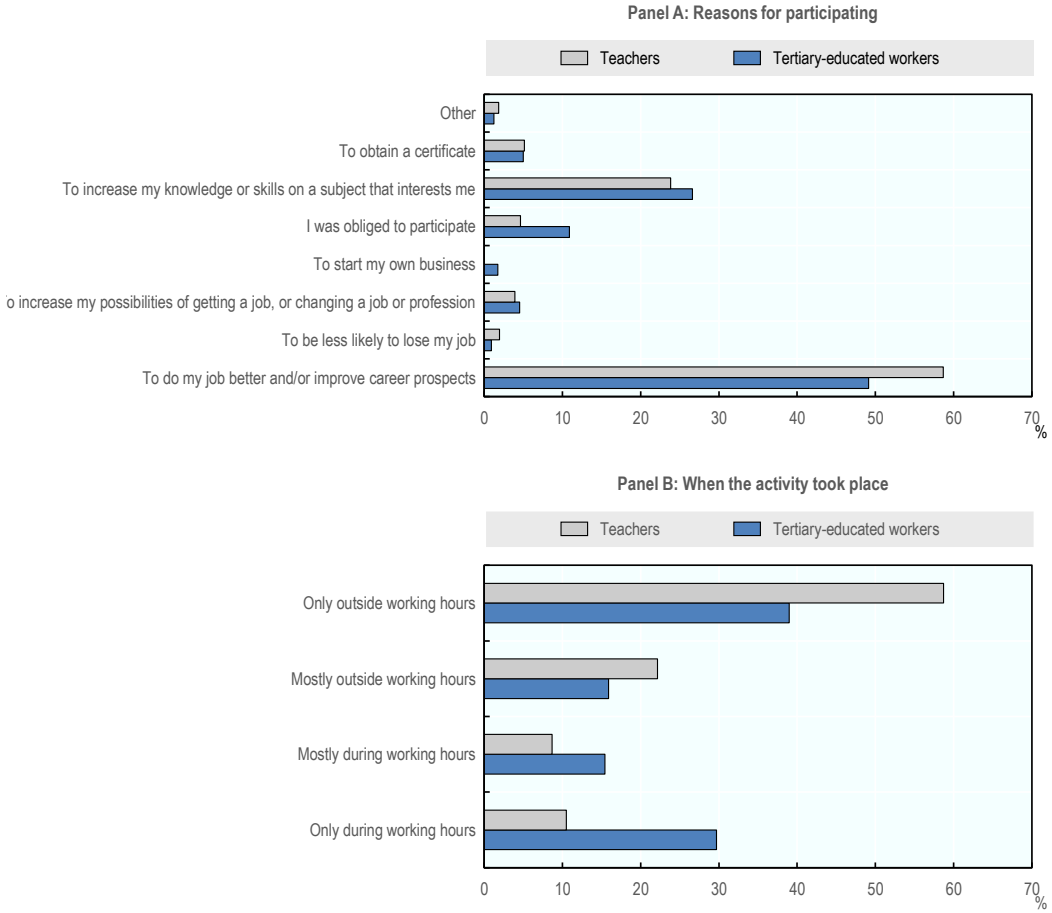
In addition, the design of online or blended learning activities needs to strike the right balance between providing teachers with valuable and sufficient resources for their professional growth and avoiding overloading them. The COVID-19 pandemic has highlighted even more this challenge as teachers have been provided with a wealth of online resources, platforms or tutorials to support them in adapting to remote teaching. Navigating the multitude of available learning and teaching resources, while balancing many activities and an extended teaching practice has often resulted in an increased sense of "COVID-19 fatigue".

In this respect, finding an equilibrium between teacher autonomy and the provision of central guidance to help teachers navigate resources, particularly more in a context of changing skills requirements, has been essential. Supporting teachers in curating information, and adapting the design of learning opportunities to facilitate an efficient use by teachers is required to ensure that teachers make the most of these learning activities. The online sphere opens access to and brings possibility to diffuse an abundance of learning resources (e.g. courses, tools, articles) with enhanced flexibility and no scale limitations. However, due to the time constraints inherent to the teaching profession, teachers are likely to lack the necessary time to navigate and choose from the wealth of available information and sources (Trust and Horrocks, 2017[63]). In a study of a blended teacher community in the United States, many teachers reported feeling overwhelmed by the amount of online resources and events (Trust and Horrocks, 2017[63]).

Shorter online course formats are likely to better accommodate participants' existing workload and grant them more flexibility, even if these entail participation in several shorter courses to cover all the material associated with an area of expertise or competence. Evidence from Spain shows that completion rates were significantly higher for teacher participation in NOOCs (25%) rather than MOOCs (6%), suggesting that the format, structure and length of the training activity are likely to matter (Castaño-Muñoz et al., 2018[49]). NOOCs provided by the National Institute of Educational Technologies and Teacher Training (INTEF) enabled participants to focus on exploring and learning about a key element of a competence or knowledge area, with an estimated effort time of 3 hours (Box 1.1).

Figure 3.4. Participation in open/distance education – reasons and time

For individuals who have participated in distance/open education in the 12 months before the survey



Notes: Panel B: The question on "When the activity took place" refers to the "degree that the activity takes place during working hours meaning that the working hours are used to attend the activity instead of working. It also includes the case where a number of working hours are being replaced by the learning activity even if the activity itself takes place outside normal working time of the respondent. If the learning activity takes place outside working time and the respondent has received payment for the hours, the activity should be coded as during working hours. The answer should only reflect the participation in the course itself and not homework.".
Source: Adapted from the OECD (2017[17]) *Survey of Adult Skills (PIAAC) (2012, 2015, 2017)* (database), http://www.oecd.org/skills/piaac/ (accessed on 15 May 2020).

3.3.2. How teachers engage in online professional learning

In TALIS, professional development is defined as "activities that aim to develop an individual's skills, knowledge, expertise and other characteristics as a teacher" (OECD, 2018[64]). It can therefore cover both formal and non-formal types of activities undertaken by teachers after their initial education or training to enhance their skills. Items related to engagement in professional development activities in TALIS do not allow distinguishing whether these activities were a part of a formal programme or searched for independently by teachers. Professional development activities as defined in TALIS should be thus understood in a broad sense, as activities in which teachers engage to expand their skills after their initial education or training, whether these are formally provided to teachers by schools or public education authorities, or undertaken by teachers independently at home (e.g. MOOCs).

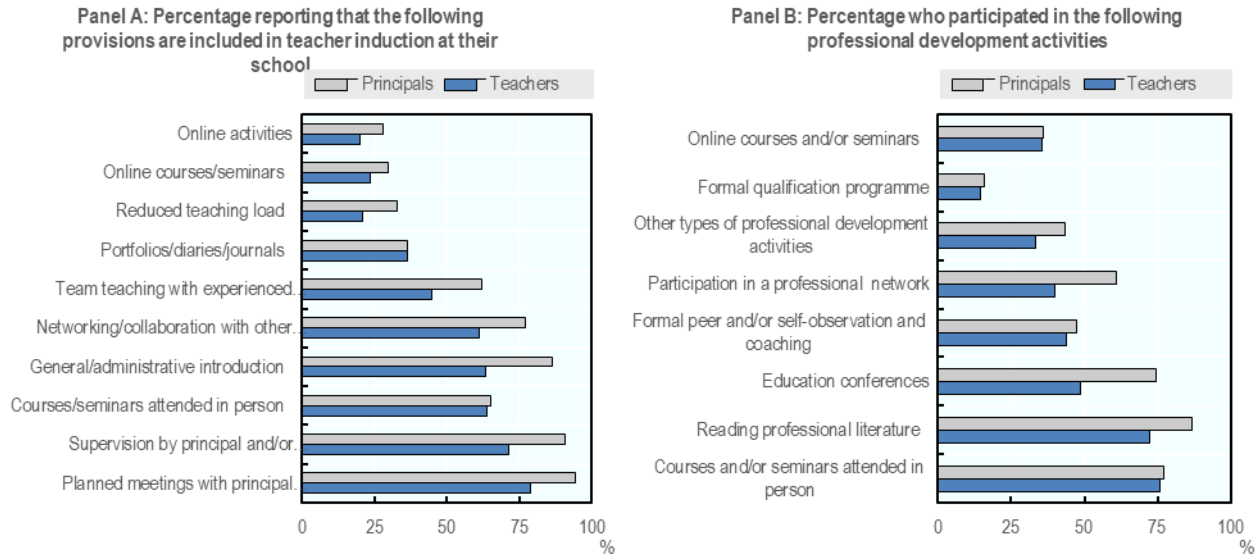
The professional development section of TALIS also comprises information on the induction activities in which teachers engaged when they joined their current school. Induction activities are "designed to support new teachers' introduction into the teaching profession and to support experienced teachers who are new to a school, and they are either organised in formal, structured programmes or informally arranged as separate activities" (OECD, 2018[64]). Such induction-related provisions can therefore be offered at the system or school-level (or both) (OECD, 2019[27]).

Patterns of teacher participation in online professional learning

Data from TALIS (2018) show that teacher engagement in online forms of professional learning is not widespread (Figure 3.5). Across OECD countries with available data, around 34% of lower-secondary teachers, and a similar share of school principals, had participated in online courses/seminars as part of their professional development activities. Online courses/ seminars are among the least recurrent forms of professional development reported by teachers in OECD countries with available data in TALIS (2018). A similar picture emerges when it comes to induction activities proposed to teachers as they joined their current school: less than one in five teachers reported having benefitted from online courses/seminars and online activities (e.g. virtual communities) as part of their induction provisions.

Figure 3.5. Teachers' engagement in learning activities delivered on line

Percentage of lower-secondary teachers



Source: OECD (2019[27]), *TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners*, https://dx.doi.org/10.1787/1d0bc92a-en (accessed on 15 May 2020).

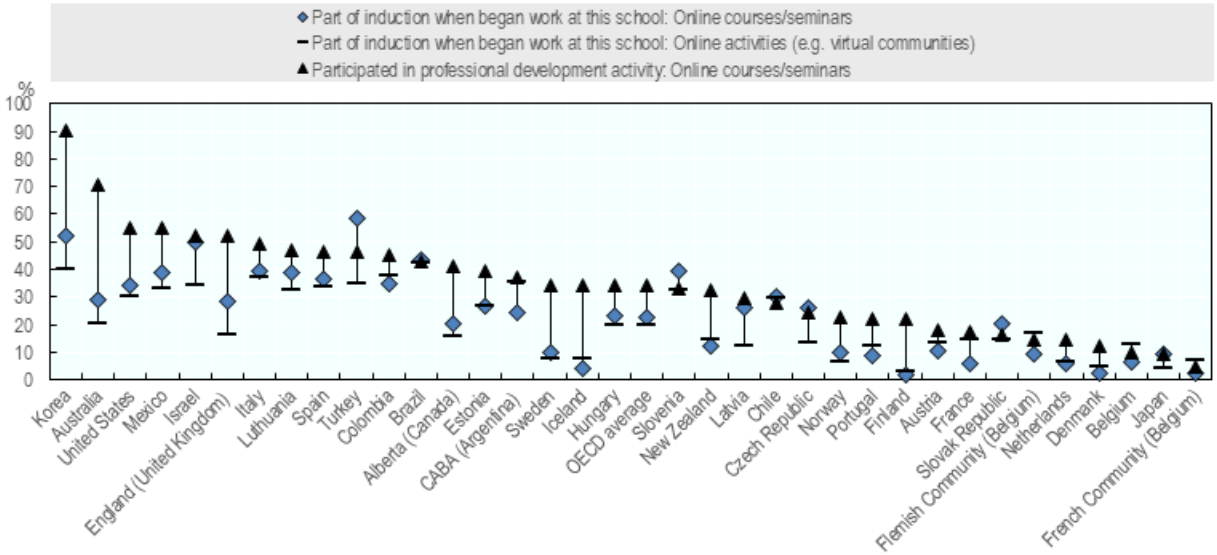
Principals are more numerous to report teacher engagement in online forms of induction activities. Indeed, the provision of online-based induction activities is likely to have increased in recent years, and hence to be reflected in principals' reports about what is currently being provided in their schools. By contrast, teachers who have been in the school for a long time already may be less likely to have benefitted from such forms of induction at the time they joined their current school. Discrepancies between teachers and principals' reports for other forms of induction activities may also stem from the fact that some

provisions may not be necessary for all teachers joining the school (e.g. reduced teaching load for more experienced teachers) or all teachers may not be encouraged to engage in them (OECD, 2019[27]).

These figures hide large cross-country variations in participation levels (Figure 3.6). In Korea, professional development unfolded through online courses or seminars is the type of professional development activity reported by most lower-secondary teachers. More than 90% of teachers in Korea reported having engaged in such activities in the year prior to the survey, in contrast to fewer than 15% of lower-secondary teachers in Belgium, Denmark, Japan and the Netherlands. While Belgium, Denmark and the Netherlands, are ahead of most other OECD countries in terms of the digitalisation of their economies and societies (OECD, 2019[14]), reliance on ICT tools for teacher professional development is less recurrent. Korea also displays the highest shares of teachers reporting to have engaged in online forms of induction activities.

Figure 3.6. Teachers' engagement in induction and professional development activities on line, by country

Share of lower-secondary teachers



Source: Adapted from OECD (2018[65]), *TALIS 2018 Database*, http://www.oecd.org/education/talis/ (accessed on 15 May 2020).

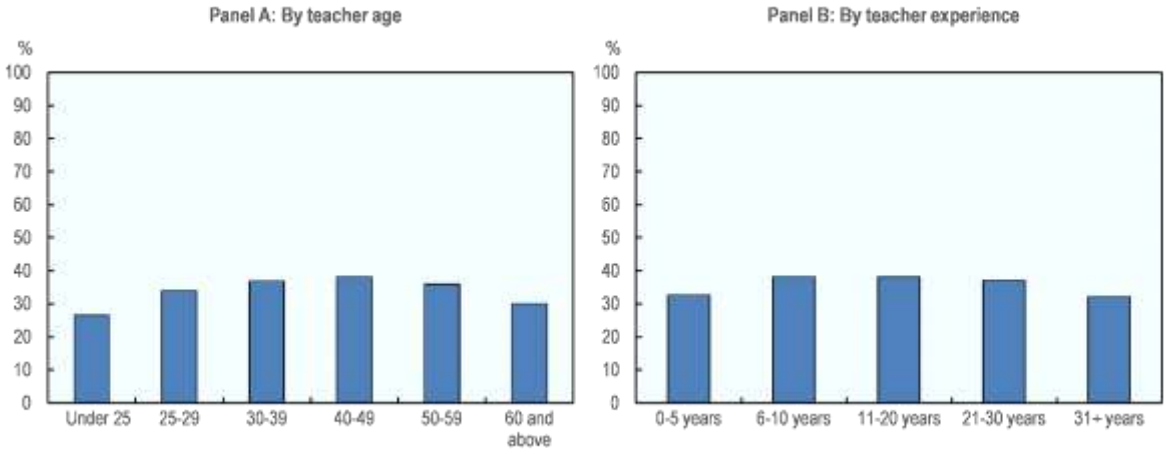
While participation in induction activities unfolded on line is likely to be determined by the level of provision of such activities at the school or system level, engagement in professional development activities may depend on a variety of factors. However, data from TALIS show that teacher participation in online professional learning is rather homogeneous across various teacher and school-level characteristics.

For instance, perhaps surprisingly, the share of lower-secondary teachers reporting to have participated in online courses or activities as part of their professional development is relatively similar at different levels of experience or teacher age (Figure 3.7). Participation is quite evenly distributed across ages and, if any, middle-aged teachers are more likely to engage. This may reflect that these teachers may be more at ease with teaching but also more likely to be curious about new forms of professional development, since they have already had the opportunity to engage in other types of professional development activities.

The contents/programmes offered online may also be more aligned to their needs in terms of deepening subject or pedagogical content knowledge. In contrast, younger teachers often need more induction-type of professional learning for classroom teaching. As such, contents and opportunities offered on line may be less suitable for inexperienced or entry-level teachers. For older teachers, while levels of participation are slightly lower, these may reflect an overall lower level of participation in teacher professional development (since these teachers are likely to have already benefitted from substantial learning opportunities before) but also potentially insufficient skills to make the most of new technologies. In addition, more experienced teachers are more likely to have higher administration workload than others, and perhaps there is no or little content aligned to administrative learning needs on line.

Figure 3.7. Teachers' participation in online courses/seminars for professional development, by age and experience

Share of lower-secondary teachers



Source: Adapted from OECD (2018[65]), *TALIS 2018 Database*, http://www.oecd.org/education/talis/ (accessed on 15 May 2020).

Participation rates in online professional development also appear to be evenly distributed across teachers working in rural and urban areas, although in Mexico, Spain and the United States – countries that also display high levels of participation in online professional development – teachers from rural schools are more likely to engage in online forms of professional development than those from cities (Figure 3.8). In these latter countries, the provision of online teacher professional learning, whether formal or informal, can bridge geography gaps that may prevent teachers from more remote areas to engage in professional development. While on average across OECD countries, similar shares of teachers from different subjects engage in online courses or seminars, participation is significantly higher among science teachers in France, Sweden and the United States, whereas modern languages teachers are significantly more likely to participate in such activities in England (United Kingdom) and New Zealand.

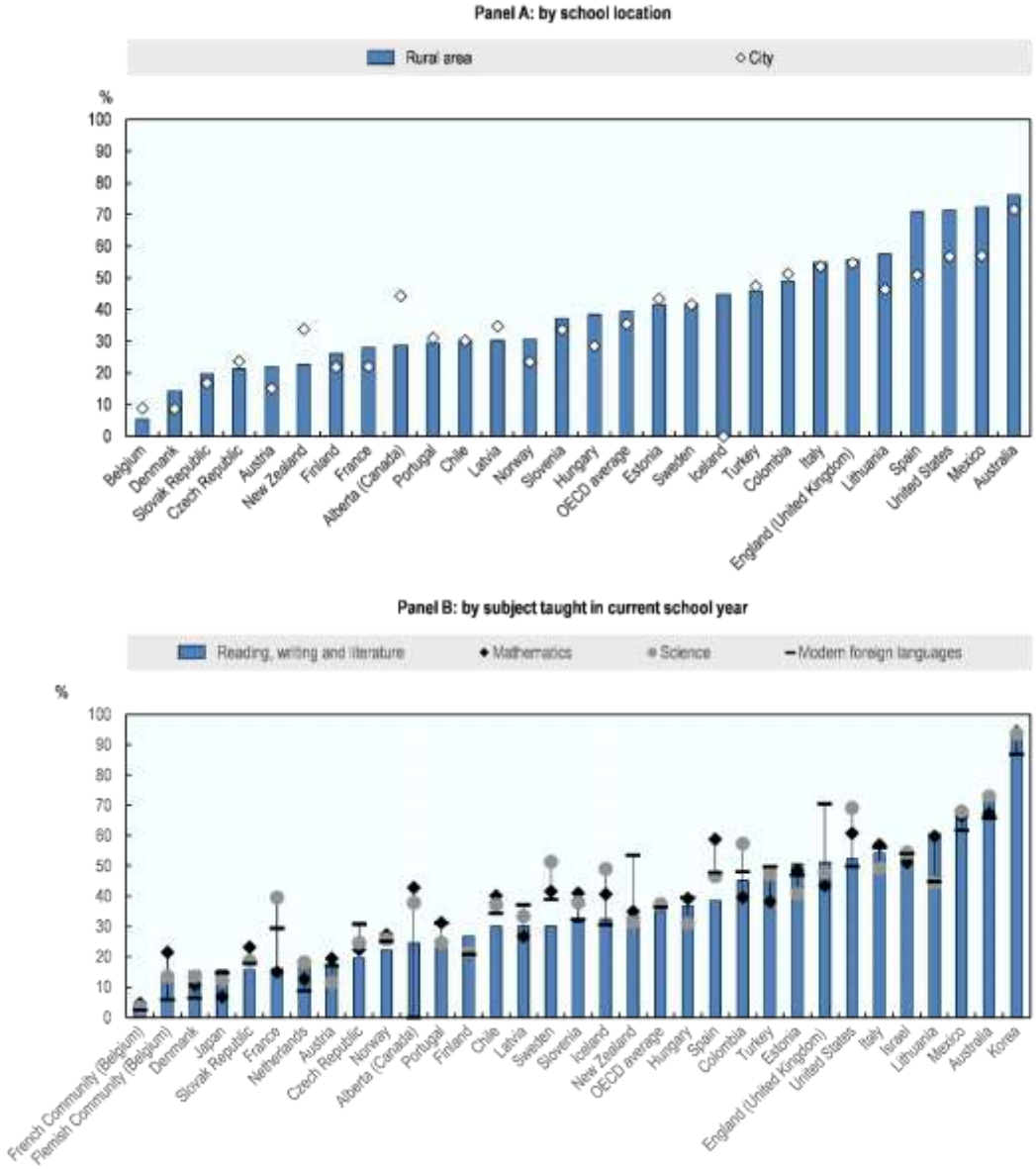
On the contrary, the share of disadvantaged students in the school or reported shortages that hinder the provision of quality instruction do not appear to shape teachers' participation in online courses or seminars. Nor is participation influenced by teachers reporting specific barriers to professional development (although it is important to note that teachers report general barriers to professional development and not barriers linked to a specific type of

professional development activity). Participation rates are also similar for primary, lower-secondary and upper-secondary teachers in countries with available data at all education levels in TALIS (2018).

While teachers are more likely to engage in online forms of learning than other high-skilled adults are, participation in online teacher professional learning remains limited within the teaching profession. There is wide variability within the teaching profession in terms of participation, and data from TALIS suggests that the vast majority of teachers do not engage in online professional development.

Figure 3.8. Teachers' participation in online courses/seminars for professional development, by school location and subject taught

Share of lower-secondary teachers



Source: Adapted from OECD (2018[65]), *TALIS 2018 Database*, http://www.oecd.org/education/talis/ (accessed on 15 May 2020).

Balancing system-level provision of online professional learning with teacher-led, bottom-up initiatives

Figures from the previous section reflect that engagement in online forms of professional development is likely to be a combination of teachers' own motivation and curiosity as well as of the wider provision or spread at the system-level of such forms of learning. Data from TALIS (2018) show that teachers who participate in online courses/seminars are more likely to engage in other types of professional development activities as well (Figure 3.9), suggesting a potentially higher readiness to learn and in particular, with new technologies, than teachers who do not engage in these forms of training. In addition, teachers who participate in online courses/ seminars are particularly more likely to have also participated in networks of teachers as part of their professional development, perhaps through online communities. Around 54% of lower-secondary teachers who had engaged in online professional development had participated in networks of teachers, in contrast to 40% among those who had not participated in online professional development. Participation in teacher networks has been found to be more effective for teacher learning than for more traditional forms of professional development (courses or seminars) and digitalisation offers novel opportunities for teachers to engage in such impactful forms of learning.

Teachers who engage in online professional learning are thus potentially more motivated, display higher readiness to learn, or are more curious about learning activities unfolded using digital technologies. Evidence from Spain, on a MOOC initiative supported by the government for teacher professional development, supports these hypotheses (Castaño-Muñoz et al., 2018[49]). In Spain, teachers generally found information on MOOCs while going on line for their own purposes or based on their personal contexts. Few reported to obtain information about MOOCs from their colleagues, in a professional context.

At the same time, in countries with higher levels of engagement in online forms of professional learning, the provision of online professional learning activities may also be organised more systematically or teachers may receive more incentives and/or support to engage. Evidence from European countries on participation in ICT-related professional development shows that most teachers learn about ICT in their personal time, while engagement in compulsory ICT training is less widespread (European Commission, 2019[66]). Differences in participation levels most likely also reflect the extent to which teachers are supported and incentivised in engaging in professional learning using new technologies.

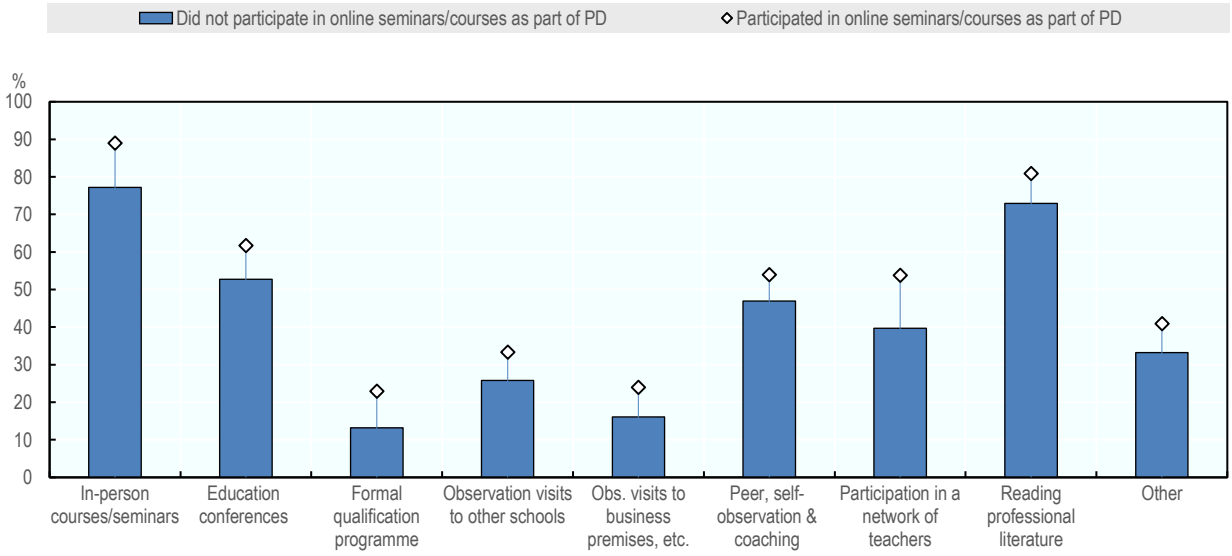
The level of provision of ICT-based professional learning activities stemming from the formal teacher-training system, their formats, frequency and design are important drivers of teachers' potential participation in such forms of learning. Simultaneously, as many teachers undergo such learning activities in their own time outside of working hours, stimulating teachers' intrinsic motivation and engagement in self-initiated autonomous learning practices is critical. In this context, a major challenge for continuous professional development systems relates to how countries can organise the provision of ICT-based teacher professional learning but also develop strategies to facilitate a more systematic teacher engagement in such forms of learning.

Indeed, a number of online professional learning activities are likely to be initiated by teachers themselves, beyond mere engagement in online courses or seminars (Box 3.2). *KlasCement*, the educational resources network managed by the Flemish Department of Education and Training, provides an interesting example. This online network was initiated as a teacher-led initiative and was run by a non-profit organisation on a voluntary basis for over a decade. It continues to rely on a support team composed of teachers, functioning as a community for and by the teachers (Minea-Pic, 2020[67]). Other similar initiatives can,

however, easily go undocumented when they originate from the "bottom" rather than through "top-down" approaches.

Figure 3.9. Participation in other professional development activities, by engagement in online courses/seminars

Share of lower-secondary teachers having participated in each type of professional development (PD), among those who engaged or not in online courses/seminars



Source: Adapted from OECD (2018[65]), *TALIS 2018 Database*, http://www.oecd.org/education/talis/ (accessed on 15 May 2020).

Research on teacher communities for professional development (not necessarily online) shows that some top-down influence or involvement in the implementation of such initiatives (e.g. to facilitate the establishment of the community, provide funding or professional support) can be beneficial (Vangrieken et al., 2017[68]). Teacher communities can lie on a continuum from top-down, governmental initiatives to teacher-led ones, with a number of communities in between, depending on the level of top-down influence and involvement. While some purely top-down approaches have been associated with positive outcomes as reported by teachers, they have not always resulted in long-lived communities. In contrast, a balance between top-down and bottom-up influence appears desirable to ensure the community reaches its goals, while continuing to be driven by its members' desire to learn and thereby achieve some form of sustainability (Vangrieken et al., 2017[68]). Online communities can experience similar challenges. In Korea, the Community of 10 000 Representative Teachers (Box 1.1), initiated by the government to address challenges associated with the COVID-19 crisis, faced difficulties in drawing active participation at its start. In addition, as the challenges associated with the COVID-19 disruption were progressively addressed, teacher participation in the community decreased significantly, emphasising the need to potentially rethink the role of the community in order to ensure its sustainability beyond the COVID-19 emergency context.

Box 3.2. Online teacher-led professional learning: bottom-up initiatives for teacher professional learning

While education systems around the world have adopted a series of measures (e.g. provision of professional development, enhanced access to ICT resources or teaching content) to support teachers in the transition to remote schooling during the COVID-19 crisis, teachers have equally taken an active role in developing their skills to adapt to the new context. From following online tutorials to exchanging questions and solutions with other teachers in teacher forums or platforms, teachers have found new ways to learn and support each other in their professional learning during the COVID-19 crisis.

Teacher-led initiatives for professional learning using digital technologies are however not new, although such bottom-up initiatives are more likely to go undocumented than governmental or top-down ones. There is scope for further investigating how to create the framework environment for the development and sustainability of such bottom-up initiatives as well as to identify and spread good practices or successful local initiatives (Vuorikari, 2018[13]; Boeskens, Nusche and Yurita, 2020[2]).

In the **Flemish Community of Belgium**, **KlasCement** is an educational resources network that was initiated in 1998 from a teacher-led initiative (Minea-Pic, 2020[67]). It was subsequently run for more than a decade by a non-profit organisation before being incorporated in 2013 in the Flemish Agency for Educational Communication. KlasCement has put trust in teachers and the materials they share at the core of its functioning and a team composed of teachers manages the network. Before the COVID-19 disruption, more than 200 000 members were using KlasCement, including teachers from the Netherlands. Between mid-March and end of April 2020, around 22 000 new members joined the platform and around 500 new learning resources were shared every week. The newly redesigned teacher forum also enabled more than 50 discussions to be initiated and teachers supported each other by exchanging with other teachers or experts around relevant questions for the COVID-19 context (engaging children from socio-economically disadvantaged backgrounds facing difficulties during the school closure, using specific online tools, etc.).

In **Lithuania**, **iKlasė** is a teacher network that began as an online blog of a Lithuanian teacher on smart technology for education and that has progressively evolved in the last decade towards a teacher community with more than 2 000 members on a social networking platform (Vuorikari, 2018[13]). The iKlasė informal network allows teachers to share on topics or subjects they are interested in and has also attracted teachers from the other Baltic States**.** iKlasė has provided a starting point for other teacher initiatives (e.g. a provision of workshops or seminars by a small group of teachers) and for partnerships with the private sector (Vuorikari, 2018[13]). More recently, the founder of iKlasė has also taken the role of community administrator for the **iMokytojai!** (iTeachers!) virtual community of teachers (iMokytojai!, n.d.[69]). On iMokytojai!, teachers share innovative ideas for enhancing learning activities with digital technologies and creating meaningful learning environments in classrooms, including ideas and IT tools for organising distance education, newly discovered educational methods and ways to apply them, descriptions of successfully implemented lessons or projects (local or international), etc.

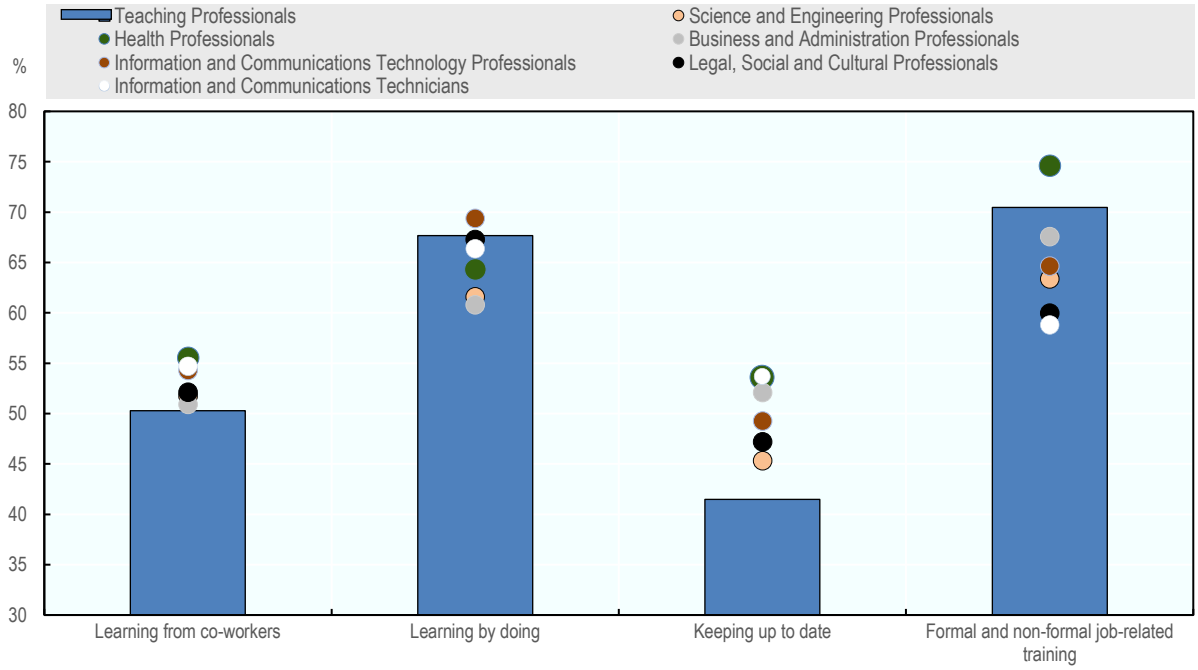
At the same time, while a number of online learning initiatives may stem from teachers themselves, teachers appear to be less likely than other professionals to learn new things by keeping up to date with new products and services (Figure 3.10). In increasingly digital

work and school environments, and particularly in the context of the COVID-19 crisis that has triggered a rise in online or hybrid teaching, teachers are likely to experience stronger challenges than other professionals are if they are less required or used to keeping up the pace with new tools and products. While a large share of teachers engage in formal and non-formal job-related learning and learn informally by doing, fewer teachers report that their jobs require them to keep up to date on a regular basis in contrast to other high-skilled workers, whether health, administration of ICT professionals (Figure 3.10). In addition, teachers are also less likely to learn from co-workers than other high-skilled professionals are.

Evidence from the adult learning literature shows that high performance work-organisation practices combining worker autonomy, teamwork and regular exchanges with peers can enhance informal learning and amplify its returns (Fialho, Quintini and Vandeweyer, 2019[70]). There is a need to further investigate the types of policies or initiatives that can foster collaborative professional cultures in and beyond schools, and support teachers in becoming active learners. OECD education systems have adopted different strategies to promote teachers' engagement in collaborative professional learning formats (investments in school-level personnel to facilitate teamwork opportunities, recognition of teachers' participation in such continuous professional learning, etc.) and effective school leadership and facilitation hold great potential in this respect (Boeskens, Nusche and Yurita, 2020[2]).

Figure 3.10. Incidence of formal, non-formal and informal job-related learning among teachers, ICT professionals and other high-skilled workers

Share of workers engaging in each learning type



Notes: Informal job-related learning refers to learning from others, learning by doing, or keeping up to date with new products or services at least once per week. Formal and non-formal job-related training refers to having participated in formal or non-formal adult education and training for job-related reasons in the 12 months preceding the survey.
Source: Adapted from the OECD (2017[17]) *Survey of Adult Skills (PIAAC) (2012, 2015, 2017)* (database), http://www.oecd.org/skills/piaac/ (accessed on 15 May 2020).

Monitoring and recognising teachers' professional learning using digital technologies

Teachers' participation in online forms of professional development also raises the question of monitoring, recognising and certifying teachers' skills acquired using digital technologies and in a variety of online formats or settings (e.g. online communities, MOOCs). While transforming the way teachers and individuals learn, digitalisation has also brought about many new forms of certification (e.g. open badges, micro-credentials) that allow covering a broader range of skills than formal qualification frameworks (OECD, 2019[14]).

Technology-based solutions can enable easier monitoring and recognition of teachers' online and offline learning experiences. In Wales, the Professional Learning Passport (PLP), a digital tool funded by the government, enables recording and supporting teachers' active engagement in continuous professional learning, in line with the new Professional Standards for Teaching and Leadership (Education Workforce Council, n.d.[71]). Teachers can upload materials, lesson plans or other resources to showcase their professional learning to leadership or their peers on the PLP, but also use the app to engage in collaborative work or dialogue with colleagues or the PLP. Using the PLP is mandatory for newly qualified teachers who can provide evidence in the PLP about how they are meeting the Professional Standards (Education Workforce Council, n.d.[71]).

In addition, some education systems are already relying on emerging technology-based forms of recognising and certifying teachers' skills acquired on line, through online courses provided by Education Ministries and authorities (e.g. micro-credentials in Spain - Box 1.1), or engagement in networks of teachers (e.g. badges provided by Education Plaza in Iceland or the National Science Teaching Association Learning Centre in the United States) (Vuorikari, 2018[13]; Dede et al., 2016[20]). Such technology-enabled recognition tools can be useful not only for credentialing learning experiences, but also stimulating teachers' motivation to learn and further personalising teachers' learning experiences (as digital badges can provide meta-data for learning analytics) (Dede et al., 2016[20]).

At the same time, while digital technologies offer new opportunities for recognising teachers' skills acquired through online professional learning, emerging forms of certification may not be acknowledged as part of formal qualifications or official professional development. Providing teachers with the appropriate incentives to engage in online professional learning also requires reflecting on how emerging forms of certification can be recognised as part of official teacher professional development schemes, but also for teachers' career progression (Box 3.3) and compensation (Vuorikari, 2018[13]; Diamond and Gonzalez, 2014[72]). While open badges or MOOC certificates may stimulate teachers' motivation to begin engaging in such forms, they may not be sufficient for maintaining sustained and effective teacher participation in online professional learning if teachers do not acquire a more formal recognition of their invested time and efforts.

Box 3.3. Recognising teachers' skills acquired on line: Micro-credentials and teacher professional learning in the United States

Digitalisation has enabled the emergence of new forms of skill certification, among which micro-credentials are providing novel opportunities for supporting teacher professional learning. While definitions of micro-credentials differ across OECD countries, they generally tend to present micro-credentials as sub-units or learning activities that are smaller than a degree and thereby imply the existence of a connected, wider, credential (Kato, Galán-Muros and Weko, 2020[73]). In this respect, they can be seen as digital certifications that recognise an individual or teacher's specific skill or competence (Digital Promise, 2020[74]).

The fact that micro-credentials allow dividing learning activities and eventually competences into smaller parts has been perceived as one of their core advantages relative to more standard forms of skills certification (DeMonte, 2017[75]). For teachers, they bring about personalised learning opportunities that can fit each teacher's specific needs, recognise their agency in their own professional learning and can be subsequently shared (e.g. through open badges). Teachers can choose a specific skill they have developed or choose to develop, gather the evidence that supports their mastery of that specific skill (e.g. student materials, instruction videos), upload that evidence into the credentialing platform and have it scored by a reviewer. As each micro-credential corresponds to a narrowly defined skill or competence, teachers can earn several micro-credentials to certify their mastery of an area of teaching.

In this respect, micro-credentials could help address some of the shortcomings of traditional teacher professional development formats that are less content-focused or are based on one-shot learning activities (DeMonte, 2017[75]; Crow and Pipkin, 2017[76]). While research on the effectiveness and conditions for success of micro-credentials remains in its infancy, existing evidence based on teacher surveys in the United States suggests that teachers value these learning opportunities and consider they have a positive impact on their students' learning (DeMonte, 2017[75]).

Digital Promise: Building an eco-system of micro-credentials for teacher skills

In the United States, Digital Promise, an independent organisation authorised by the United States Congress as the National Centre for Research in Advanced Information and Digital Technologies, has developed an eco-system of more than 400 micro-credentials for educator skills based on research evidence and that are provided by more than 50 organisations (e.g. higher education institutions, non-profit organisations, school districts) (Brown, 2019[77]). For instance, in the area of deeper learning, the platform offers 40 micro-credentials to demonstrate teachers' ability of engaging students in deeper learning. Micro-credential topics on deeper learning include "Mapping concepts", "Kind critiquing" or "Active Listening" that feed into each of the six wider indicators used by the platform to define deeper learning (e.g. Think critically and solve complex problems, Work collaboratively, Communicate effectively) (Digital Promise, 2018[78]). Digital Promise offers micro-credentials directly to teachers but also collaborates with schools and districts on the design of teacher professional learning structures based on micro-credentials. During the COVID-19 disruption, Digital Promise put forward a list of micro-credentials that did not require student work or interactions and was equally relevant for a remote teaching context in order to support the continuity of teacher professional learning.

Micro-credentials and teacher policies

Developing and promoting micro-credentials among teachers is intrinsically linked to the extent to which such new forms of certification matter for teachers' career and professional learning (e.g. licensing renewal, further qualifications or professional development, salary increases). Micro-credentials are digital certifications that recognise teachers' acquired skills and can thereby serve as a basis for a variety of teacher-related policies (Brown, 2019[77]). In the United States, 29 states have micro-credential policies through legislation of their Department of Education (Digital Promise, n.d.[79]). In 2017, eight states enabled teachers to rely on micro-credentials for fulfilling their continuing education requirements (DeMonte, 2017[75]). Other states (e.g. Tennessee, Louisiana) have experimented or are experimenting with the use of micro-credentials in the context of teacher licensure, while Virginia passed a bill to introduce a micro-credential programs allowing teachers to complete new training in areas that need more qualified teachers (e.g. science, technology, engineering, and mathematics). In the context of its efforts to promote teacher leadership, Tennessee has also developed a Teacher Leader Network whose members have access to relevant leadership micro-credentials and in a number of states, micro-credentials allow the identification of teachers for more advanced leadership activities (Brown, 2019[77]).

Evidence from states that have adopted micro-credentials at different levels emphasises the importance of several factors for a successful implementation of such certifications (DeMonte, 2017[75]):

- establishing a clear goal for micro-credentials use (e.g. expanding and personalising the professional development offer, providing a new approach for teacher licensure)
- starting with pilot programmes
- selecting relevant micro-credential topics depending on their intended goal
- designing quality assurance mechanisms (e.g. training the scorer who reviews teachers' evidence portfolio to ensure the quality of the scoring process)
- communicating with and involving relevant stakeholders.

4. Conclusion

New technologies have brought about countless opportunities for teacher professional learning but also many challenges. Low retention and completion rates have characterised not only general MOOCs but also those dedicated to teachers. Designing content that is appropriate for teacher needs, aligned to curricula or that teachers can link to their own practice has not been straightforward. In addition, while online communities have provided new opportunities for teacher collaboration, many teachers have acted as passive consumers.

While relying on a variety of methodological approaches and displaying many remaining gaps, evidence from the research literature has put forward a number of key features that can inform the design of effective online teacher professional learning. The principles that enhance the effectiveness of professional learning outside of the digital sphere (e.g. content focus, active learning, sustained duration, embeddedness in collective practice, coherence with teachers' knowledge) can also guide online teacher professional learning. When it

comes to features specific to digital learning, behavioural and motivational interventions have provided successful solutions for enhancing engagement and completion rates. In addition, blended (learning) environments (whether for courses or communities) appear to be more beneficial to but also preferred by teacher learners than purely virtual ones. Such blended formats help foster higher levels of trust and thereby participation and sociability between members of online communities. The effectiveness of the latter is, however, also dependent on community moderators whose skills, expertise and time are instrumental in encouraging and guiding members' participation and ensuring the continuity of the community.

Several preconditions need to be met to support teachers in seizing the potential of digital tools for their learning, from ensuring teachers have access to high-quality ICT and are digitally competent, to enhancing their participation in online forms of professional learning. While a number of countries have organised a more systematic provision of teacher professional learning in online forms, evidence from OECD surveys shows that teacher participation in online professional development has remained limited across OECD countries.

In this respect, the COVID-19 disruption has brought renewed attention to the provision of online professional learning for teachers, acting as a catalyst for policy reforms in this area as well as regarding the development of teachers' digital literacy. Indeed, as countries have turned to digital tools to ensure the continuity of learning, teaching and teacher professional development, policies that can support a more effective and/or systematic reliance on ICT resources for teacher professional learning have benefitted from novel interest.

A series of policy questions and gaps emerge in this context. Given the relatively moderate levels of teacher engagement in online professional development on average across OECD countries, the way in which countries organise and support the provision of ICT-based teacher professional learning (e.g. formats, actors, main providers) could be further explored. The reaction of professional learning systems to emerging needs for teacher distance learning during the recent COVID-19 crisis has triggered novel interest in strategies to more systematically provide teacher professional learning in online formats. Investigating how to design such strategies, but also effective measures and initiatives to facilitate teachers' engagement in online teacher professional learning (e.g. access to high-quality ICT, development of teachers' digital competence, funding, incentives) is critical as countries prepare for more hybrid models of education and training. The design itself of policies that can support blended models of teacher professional learning is equally an area of enhanced interest. At the same time, supporting teacher engagement is also largely dependent on stimulating teachers' intrinsic and extrinsic motivation to participate in such learning activities. How to recognise and certify teacher skills and knowledge acquired as part of online-based learning becomes therefore a critical question to address.

Finally, as many resources and tools have been developed to support the continuity of teacher professional learning during the COVID-19 disruption (e.g. MOOCs, open education resources, online platforms), monitoring the quality of online teacher professional learning is ever more important. How to ensure the quality of online forms of professional learning, when teachers can engage in individual or collective learning, in formal or informal ways, and through a variety of formats (e.g. MOOCs, online communities) remains a core challenge for continuous professional development systems. The role of data collection and evaluations can be further investigated, especially as novel technologies and tools (e.g. learning analytics, big data) provide increased opportunities for refining analyses regarding the effectiveness of teachers' online learning practices and for supporting the personalisation of their professional learning.

References

Alpert, W., K. Couch and O. Harmon (2016), "A Randomized Assessment of Online Learning", *American Economic Review: Papers & Proceedings*, Vol. 106/5, pp. 378-382, http://dx.doi.org/10.1257/aer.p20161057. [44]

Beach, P. (2017), "Self-directed online learning: A theoretical model for understanding elementary teachers' online learning experiences", *Teaching and Teacher Education*, Vol. 61, pp. 60-72, http://dx.doi.org/10.1016/j.tate.2016.10.007. [39]

Bettinger, E. et al. (2017), "Virtual Classrooms: How Online College Courses Affect Student Success †", *American Economic Review*, Vol. 107/9, pp. 2855-2875, http://dx.doi.org/10.1257/aer.20151193. [43]

Boeskens, L., D. Nusche and M. Yurita (2020), "Policies to support teachers' continuing professional learning: A conceptual framework and mapping of OECD data", *OECD Education Working Papers*, No. 235, OECD Publishing, Paris, https://dx.doi.org/10.1787/247b7c4d-en. [2]

Brown, D. (2019), *Research and Educator Micro-credentials.* [77]

Bulman, G. and R. Fairlie (2016), "Technology and Education: Computers, Software, and the Internet", in *Handbook of the Economics of Education*, http://dx.doi.org/10.1016/B978-0-444-63459-7.00005-1. [41]

Castaño-Muñoz, J. et al. (2018), "Who is taking MOOCs for teachers' professional development on the use of ICT? A cross-sectional study from Spain", *Technology, Pedagogy and Education*, Vol. 27/5, pp. 607-624, http://dx.doi.org/10.1080/1475939X.2018.1528997. [49]

Choi, D. and P. Morrison (2014), "Learning to get it right: understanding change processes in professional development for teachers of English learners", *Professional Development in Education*, Vol. 40/3, pp. 416-435, http://dx.doi.org/10.1080/19415257.2013.806948. [37]

Class Central (2019), *By The Numbers: MOOCs in 2019 — Class Central*, https://www.classcentral.com/report/mooc-stats-2019/ (accessed on 13 December 2019). [47]

CPEIP (2020), *BOLETÍN DOCENTE: Recursos y apoyo para la enseñanza*, https://www.cpeip.cl/wp-content/uploads/2020/06/Boleti%CC%81n_Mineduc_CPEIP.pdf (accessed on 27 July 2020). [3]

Cranefield, J. and P. Yoong (2009), "Crossings: Embedding personal professional knowledge in a complex online community environment", *Online Information Review*, Vol. 33/2, pp. 257-275, http://dx.doi.org/10.1108/14684520910951203. [29]

Crow, T. and H. Pipkin (2017), *Micro-credentials for Impact: Holding Professional Learning to High Standards*, Learning Forward and Digital Promise, http://www.learningforward.org (accessed on 12 October 2020). [76]

Darling-Hammond, L., M. Hyler and M. Gardner (2017), *Effective Teacher Professional Development*. [21]

Dash, S. et al. (2014), "Impact of Online Professional Development or Teacher Quality and Student Achievement in Fifth Grade Mathematics", *Journal of Research on Technology in Education*, Vol. 45/1, pp. 1-26, http://dx.doi.org/10.1080/15391523.2012.10782595. [36]

Dash, S. et al. (2014), "Online Professional Development or Teacher Quality and Student Achievement in Fifth Grade Mathematics", *Journal of Research on Technology in Education*, Vol. 45/1, pp. 1-26, http://dx.doi.org/10.1080/15391523.2012.10782595. [62]

Davis, D. et al. (2017), "Follow the Successful Crowd: Raising MOOC Completion Rates through Social Comparison at Scale *", http://dx.doi.org/10.1145/3027385.3027411. [50]

Dede, C. et al. (2016), *Teacher Learning in the Digital Age: Online Professional Development in STEM Education*, https://www.hepg.org/hep-home/books/teacher-learning-in-the-digital-age (accessed on 30 July 2020). [20]

DeMonte, J. (2017), *Micro-credentials for Teachers: What Three Early Adopter States Have Learned So Far*, American Institute for Research, https://openbadges.org/about/. (accessed on 12 October 2020). [75]

Diamond, J. and P. Gonzalez (2014), *Digital badges for teacher mastery: an exploratory study of a competency-based professional development badge system*, Education Development Center, Inc.| Center for Children & Technology, https://files.eric.ed.gov/fulltext/ED561894.pdf (accessed on 13 August 2020). [72]

Digital Promise (2020), *Micro-credentials*, https://digitalpromise.org/initiative/educator-micro-credentials/ (accessed on 12 October 2020). [74]

Digital Promise (2018), *Developing a System of Micro-credentials: Supporting Deeper Learning in the Classroom*. [78]

Digital Promise (n.d.), *Micro-credential Policy Map - Digital Promise*, https://digitalpromise.org/initiative/educator-micro-credentials/micro-credential-policy-map/ (accessed on 13 October 2020). [79]

Dooner, A., D. Mandzuk and R. Clifton (2008), "Stages of collaboration and the realities of professional learning communities", *Teaching and Teacher Education*, Vol. 24/3, pp. 564-574, http://dx.doi.org/10.1016/j.tate.2007.09.009. [32]

Education Workforce Council (n.d.), *Professional Learning Passport*, https://www.ewc.wales/site/index.php/en/professional-development/professional-learning-passport.html#capturing-your-experiences (accessed on 10 November 2020). [71]

Ericson, B. et al. (2016), *Identifying Design Principles for CS Teacher Ebooks through Design-Based Research*, http://dx.doi.org/10.1145/2960310.2960335. [48]

Escueta, M. et al. (2017), "Education Technology: An Evidence-Based Review", http://www.nber.org/papers/w23744. [40]

European Commission (2019), *2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools*, Luxembourg: Publications Office of the European Union, http://dx.doi.org/10.2759/23401. [66]

Eurydice (2020), *National Reforms related to Transversal Skills and Employability | Eurydice*, https://eacea.ec.europa.eu/national-policies/eurydice/content/national-reforms-related-transversal-skills-and-employability-34_en (accessed on 18 November 2020). [60]

Eurydice (2019), *National Reforms in School Education - Latvia*, https://eacea.ec.europa.eu/national-policies/eurydice/content/national-reforms-school-education-34_en (accessed on 28 July 2020). [59]

Fialho, P., G. Quintini and M. Vandeweyer (2019), "Returns to different forms of job related training: Factoring in informal learning", *OECD Social, Employment and Migration Working Papers*, No. 231, OECD Publishing, Paris, https://dx.doi.org/10.1787/b21807e9-en. [70]

Goodman, J., J. Melkers and A. Pallais (2019), "Can online delivery increase access to education?", *Journal of Labor Economics*, Vol. 37/1, pp. 1-34, http://dx.doi.org/10.1086/698895. [46]

Grundke, R. et al. (2017), "Skills and global value chains: A characterisation", *OECD Science, Technology and Industry Working Papers*, No. 2017/05, https://dx.doi.org/10.1787/cdb5de9b-en. [16]

Hanushek, E., M. Piopiunik and S. Wiederhold (2014), "The value of smarter teachers: International evidence on teacher cognitive skills and student", *NBER Working Paper Series*, No. 20727, http://www.nber.org/papers/w20727 (accessed on 13 April 2018). [58]

iMokytojai! (n.d.), *iMokytojai! – Inovatyvių, išradingų ir iniciatyvių mokytojų bendruomenė.*, https://imokytojai.lt/ (accessed on 10 November 2020). [69]

INTEF (2019), *Informe anual de indicadores 2019*, https://intef.es/wp-content/uploads/2020/02/2019_ANUAL_Infografia_INTEF_05.pdf (accessed on 24 July 2020). [11]

INTEF (n.d.), *Aprendizaje en línea - INTEF*, https://intef.es/formacion-y-colaboracion/aprendizaje-en-linea/ (accessed on 27 July 2020). [12]

Joyce, T. et al. (2015), "Does classroom time matter?", *Economics of Education Review*, Vol. 46, pp. 64-77, http://dx.doi.org/10.1016/j.econedurev.2015.02.007. [45]

Kang, M. (2016), *A Korean Model for Using ICT in Education: Human Resources Development*. [6]

Karlsson, N. and A. Godhe (2016), "Creating a Community Rather than a Course--Possibilities and Dilemmas in a MOOC.", *Education Sciences*, Vol. 6. [26]

Kato, S., V. Galán-Muros and T. Weko (2020), "The emergence of alternative credentials", *OECD Publishing, Paris*, No. 216, OECD Publishing, Paris, https://www.oecd-ilibrary.org/education/the-emergence-of-alternative-credentials_b741f39e-en (accessed on 12 October 2020). [73]

KERIS (2020), *COVID-19 Response by South Korea and KERIS Through Online Distance Learning for K-12 (Q&A)*. [8]

KERIS (2018), *White Paper on ICT in Education, Korea*. [7]

KERIS (2015), *Features - Policies to Promote e-Learning Teacher Training: Korean case*, https://www.keris.or.kr/eng/na/ntt/selectNttInfo.do?mi=1186&nttSn=35651&bbsId=1066 (accessed on 29 July 2020). [5]

Lantz-Andersson, A., M. Lundin and N. Selwyn (2018), "Twenty years of online teacher communities: A systematic review offormally-organized and informally-developed professional learning groups", *Teaching and Teacher Education*, Vol. 75, pp. 302-315. [30]

Lee, D. (2019), *A Study on the International Comparison of Teachers, Principals, and Teaching and Learning -Results from TALIS 2018*, https://www.kedi.re.kr/eng/kedi/bbs/B0000006/list.do?menuNo=200014. [9]

Littenberg-Tobias, J., R. Slama and J. Reich (2020), "Large-Scale Learning for Local Change: The Challenge of MOOCs as Educator Professional Learning", http://dx.doi.org/10.35542/OSF.IO/QRWBE. [25]

Macià, M. and I. García (2016), *Informal online communities and networks as a source of teacher professional development: A review*, Elsevier Ltd, http://dx.doi.org/10.1016/j.tate.2016.01.021. [28]

Marcolin, L., S. Miroudot and M. Squicciarini (2016), "Routine jobs, employment and technological innovation in global value chains", *OECD Science, Technology and Industry Working Papers*, No. 2016/1, OECD Publishing, Paris, https://dx.doi.org/10.1787/5jm5dcz2d26j-en. [15]

Matzat, U. (2013), "Do blended virtual learning communities enhance teachers' professional development more than purely virtual ones? A large scale empirical comparison", *Computers and Education*, Vol. 60/1, pp. 40-51, http://dx.doi.org/10.1016/j.compedu.2012.08.006. [35]

Matzat, U. (2010), "Reducing Problems of Sociability in Online Communities: Integrating Online Communication With Offline Interaction", *American Behavioral Scientist*, Vol. 53/8, pp. 1170-1193, http://dx.doi.org/10.1177/0002764209356249. [34]

McConnell, T. et al. (2013), "Virtual Professional Learning Communities: Teachers' Perceptions of Virtual Versus Face-to-Face Professional Development", *Journal of Science Education and Technology*, Vol. 22/3, pp. 267-277, http://dx.doi.org/10.1007/s10956-012-9391-y. [33]

Minea-Pic, A. (2020), *Flemish Community of Belgium: KlasCement*, Education continuity stories series, OECD Publishing, Paris, https://oecdedutoday.com/wp-content/uploads/2020/11/Flemish-Community-Belgium-KlasCement.pdf. [67]

Ministry of Education (2020), *Responding to COVID-19 : Online Classes in Korea*, http://www.mofa.go.kr/eng/brd/m_22747/view.do?seq=15&srchFr=&srchTo=&srchWord=&srchTp=&multi_itm_seq=0&itm_seq_1=0&itm_seq_2=0&company_cd=&company_nm=&page=1&titleNm= (accessed on 30 July 2020). [10]

Ministry of Education, R. (2020), *Teacher Education and Finance*, http://english.moe.go.kr/sub/info.do?m=020109&s=english (accessed on 29 July 2020). [4]

OECD (2020), *ICT Access and Usage by Households and Individuals database*, https://stats.oecd.org/Index.aspx?DataSetCode=ICT_HH2. [56]

OECD (2019), *Education at a Glance 2019: OECD Indicators*. [57]

OECD (2019), *Going Digital: Shaping Policies, Improving Lives*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264312012-en. [53]

OECD (2019), *OECD Skills Outlook 2019 : Thriving in a Digital World*, OECD Publishing, Paris, https://dx.doi.org/10.1787/df80bc12-en. [14]

OECD (2019), *TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners*, TALIS, OECD Publishing, Paris, https://dx.doi.org/10.1787/1d0bc92a-en. [27]

OECD (2018), *TALIS 2018 Database*, http://TALIS 2018 Database. [65]

OECD (2018), *TALIS Teacher Questionnaire*. [64]

OECD (2017), *Survey of Adults Skills (PIAAC) (2012, 2015, 2017), (database)*, http://www.oecd.org/skills/piaac/. [17]

OECD Survey of Adult Skills (PIAAC) (n.d.), *International Master Questionnaire*, http://www.oecd.org/skills/piaac/BQ_MASTER.HTM (accessed on 17 November 2020). [61]

Patterson, R. (2018), "Can behavioral tools improve online student outcomes? Experimental evidence from a massive open online course", *Journal of Economic Behavior and Organization*, Vol. 153, pp. 293-321, http://dx.doi.org/10.1016/j.jebo.2018.06.017. [51]

Philipsen, B. et al. (2019), "Improving teacher professional development for online and blended learning: a systematic meta-aggregative review", *Educational Technology Research and Development*, Vol. 67/5, pp. 1145-1174, http://dx.doi.org/10.1007/s11423-019-09645-8. [19]

Prestridge, S. and J. Tondeur (2015), "Exploring Elements That Support Teachers Engagement in Online Professional Development", *Educ. Sci.*, Vol. 5, pp. 199-219, http://dx.doi.org/10.3390/educsci5030199. [18]

Qian, Y. et al. (2018), "Who Needs What: Recommendations for Designing Effective Online Professional Development for Computer Science Teachers", *Journal of Research on Technology in Education*, Vol. 50/2, pp. 164-181, http://dx.doi.org/10.1080/15391523.2018.1433565. [22]

Reich, J. and J. Ruipérez-Valiente (2019), *The MOOC pivot*, American Association for the Advancement of Science, http://dx.doi.org/10.1126/science.aav7958. [24]

Reimers, F. and A. Schleicher (2020), *Schooling disrupted, schooling rethought. How the Covid-19 pandemic is changing education*. [1]

School Education Gateway (2020), *Survey on online and distance learning – Results*, https://www.schooleducationgateway.eu/en/pub/viewpoints/surveys/survey-on-online-teaching.htm (accessed on 24 July 2020). [54]

Seaton, D., C. Coleman and J. Daries (2014), "Teacher Enrollment in MIT MOOCs: Are We Educating Educators?", *SSRN Electronic Journal*, http://dx.doi.org/10.2139/ssrn.2515385. [23]

Seo, K. and Y. Han (2013), "Online teacher collaboration: A case study of voluntary collaboration in a teacher-created online community", *KEDI journal of educational policy*, Vol. 10/2, pp. 221-242, https://www.researchgate.net/publication/287315935_Online_teacher_collaboration_A_case_study_of_voluntary_collaboration_in_a_teacher-created_online_community (accessed on 3 June 2020). [31]

Trust, T. and B. Horrocks (2017), "'I never feel alone in my classroom': teacher professional growth within a blended community of practice", *Professional Development in Education*, Vol. 43/4, pp. 645-665, http://dx.doi.org/10.1080/19415257.2016.1233507. [63]

UNICEF (2020), *What have we learnt? Overview of findings from a survey of ministries of education on national responses to COVID-19*. [55]

Vangrieken, K. et al. (2017), *Teacher communities as a context for professional development: A systematic review*, Elsevier Ltd, http://dx.doi.org/10.1016/j.tate.2016.10.001. [68]

Vuorikari, R. (2018), "Innovating Professional Development in Compulsory Education Examples and cases of emerging practices for teacher professional development", *JRC Technical Reports*, http://dx.doi.org/10.2760/734136. [13]

Xu, D. and S. Jaggars (2016), "The Journal of Higher Education Performance Gaps between Online and Face-to-Face Courses: Differences across Types of Students and Academic Subject Areas", http://dx.doi.org/10.1080/00221546.2014.11777343. [42]

Yeomans, M. and J. Reich (2017), "Planning Prompts Increase and Forecast Course Completion in Massive Open Online Courses", http://dx.doi.org/10.1145/3027385.3027416. [52]

Yurkofsky, M., S. Blum-Smith and K. Brennan (2019), "Expanding outcomes: Exploring varied conceptions of teacher learning in an online professional development experience", *Teaching and Teacher Education*, Vol. 82, pp. 1-13, http://dx.doi.org/10.1016/j.tate.2019.03.002. [38]