

Full Length Research

E-Learning and Open Educational Resources for Teachers' Development and Services in the Digital Age

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The spread, adoption, and use of digital technologies have changed the world of teachers' professional development and services for students everywhere, bringing the field unprecedented opportunities and challenges. The present article provides a critical evaluation and convincing argument based on research, institutional data, statistical evidence and theory from publications dating back to 2019 and until 2026 for the role of e-learning and Open Educational Resources (OER) for teachers' professional development and service delivery in the digital age. The article suggests that e-learning and OER are not a 'supplementary' or 'option' to be added to existing professional development structures; rather they are necessary infrastructure of a twenty first century system of teacher education in a democratic, equitable and quality manner. The review details the remarkable and rapid expansion of the global e-learning industry, which is estimated to grow exponentially by 2030, and the accompanying growth of OER ecosystems, currently with more than 38,600 repositories and tens of millions of freely accessible educational resources available as of 2023. It critically explores challenges to access of equitable teachers to e-learning and OER, such as digital infrastructure gaps, access to devices, poor digital literacy skill, and institutional policy failures, and offers evidence-informed solutions to these challenges. The article focuses specifically on the developing countries in Africa and Asia, where the potential of e-learning and OER for change is highest but structural obstacles are also the most severe. Education ministries, teacher training institutions, library and information professionals, and international development actors are encouraged to advance recommendations for education ministries, teacher training institutions, library and information professionals, and international development organizations dedicated to making the most of the potential of digital learning to enhance the quality of teaching and improve educational transformation.

Keywords: E-learning, Open Educational Resources, Teacher professional development, Digital age, MOOCs, Learning management systems, ICT integration, Distance education, continuing professional development

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Introduction

Teachers are at a crossroads in history. On one side, the digital revolution of society with the unstoppable omnipresence of artificial intelligence, the pervasiveness of connectivity, the ubiquity of big data and the platforming of almost all aspects of human activity, is changing the nature of what students should be learning and what teachers should know and be able to do. The opposite side is the reality of many current systems of teacher professional development, which are largely isolated, passive, poorly connected to classroom practice, distributed unevenly, and obstinate to the digital revolution transforming all other aspects of professional life (Darling-Hammond et al., 2020; Trust & Horrocks, 2021).

One of the most important problems that education systems around the world face is the resolution of this tension, between the expectations of what teaching in the 21st century should look like in a digital world and what much professional development provision is like in an analog world.

E-learning and Open Educational Resources (OER) provide an attractive answer to this challenge. In general, “e-learning” is defined as the learning that takes place through and with the help of electronic technologies and networks as means to disseminate educational content or enable learning interactions, and thereby breaking the geographical, temporal and economic barriers that have limited the opportunities for teachers to access high quality professional development in the past. There is a democratization of knowledge, the ability of people in the most remote and resource poor places to access the same quality educational material, through the use of OER, which are educational resources that are made available with open licenses that allow free access, adaptation, and redistribution (Butcher, 2022; Tili et al., 2022). The combination of e-learning with OER is an infrastructure of possibility: a base on which truly equitable and constantly changing teacher professional development systems can be developed.

The following article presents three main arguments. First, that e-learning and OER have already successfully and demonstrably impacted and changed teacher professional development in many contexts and the evidence of the impact and change of e-learning and OER when implemented properly, is substantial and growing. Secondly, that the potential e-learning and OER has to create a more democratic approach to teacher development and ensure higher quality education across the globe is vastly under realised and depends on certain structural barriers (infrastructure, policy, institutional culture, professional norms) which need to be overcome through deliberate and concerted action. Third, that library and information professionals, along with educational technologists, curriculum specialists and policy makers, have an essential role to play in realizing this potential by curating, disseminating and promoting OER, building digital literacy competencies and designing learning-rich, online professional development experiences.

The article is organized as follows: The conceptual and theoretical framework is presented in Section 2. In Section 3, a statistical comparison of the global scene of e-learning for teacher preparation is presented. In Section 4, a critical review of OER ecosystems and how they are used in teacher professional development is undertaken. Barriers to equitable access to e-learning and OER are explored in Section 5. Case studies and program evaluations are provided in Section 6. Section 7 deals with the role of library and information services. Emerging trends like AI, microlearning and gamification are explored in Section 8. This is followed by some recommendations in Section 9 and the review is closed in Section 10.

Scope and Methodology of the Review

This review is based on peer-reviewed papers, book chapters, institutional reports, international policy documents and conference proceedings published from 2019 to 2026 and located using ERIC, Scopus, Web of Science, JSTOR and Google Scholar. The keywords used were: e-learning teacher professional development, OER teachers, open educational resources developing countries, online teacher training, digital professional development, MOOC teachers, learning management systems schools, or even a combination of these terms. Empirical studies with large and appropriate sample sizes, systematic reviews and meta-analyses were given priority, with influential theoretical and policy contributions. Where possible, statistical data were triangulated from multiple sources, primarily UNESCO, World Bank, OECD and HolonIQ reports.

Conceptual and Theoretical Framework

Building a strong theoretical structure for e-learning and OER in teacher professional learning needs to be based on several disciplinary traditions such as adult learning theory, research in educational technology, knowledge management and organizational learning theory. This review is based mainly on four theoretical frameworks: Connectivism, Communities of Practice, TPACK and the Substitution-Augmentation-Modification-Redefinition (SAMR) model.

Connectivism and Networked Learning

The Connectivism theory developed by Siemens (2005) was created specifically for the digital age of learning and suggests that knowledge exists within a network of nodes – human and computer connected with one another, and that learning is a process of building and navigating through those networks. While traditional workshop learning focuses on a single presentational model, with a single knowledge carrier, the boundedness of time and space, connectivism offers an attractive theoretical argument for the use of e-learning as a model of teacher professional development because it allows teachers to connect with several sources of knowledge, databases, OER repositories and expert practitioners, and multiple peer networks, research archives, all at the same time and continuously (Downes, 2019; Siemens, 2005).

The connectivist approach is especially applicable to the pedagogical opportunities afforded by Massive Open Online Courses (MOOCs) and online professional learning communities, which are designed to generate in individuals a “neither

neither" network of learners whose collective knowledge is greater than any one educator could offer. Downes (2019) has expanded on the original connectivist model to claim that the learning that is most powerful is "open knowledge creation and sharing" (p. 4), a concept closely related to the philosophy of the OER movement.

Communities of Practice and Professional Learning

Communities of Practice (CoP) is a framework developed by Wenger (1998) that views professional learning as a social process as it takes place through prolonged engagement in a community of practitioners – a community of understanding, a community of practice. Digital instantiations of CoP can be seen in online professional learning communities (PLCs), facilitated by learning management systems, social media groups, professional networks and collaborative OER development platforms, which can mitigate geographic constraints on face-to-face communities of practice (CoP) (Lantz-Andersson et al., 2021; Trust & Horrocks, 2021).

Trust and Horrocks (2021) report on a large-scale qualitative study of 487 teachers involved in Twitter-based Professional Learning Networks (PLNs), and found that participants explained how their PLNs offer continuous, just-in-time professional learning, collegial support, and access to a variety of viewpoints and resources not available locally in schools. The study records 73% of the participants saying that their membership of a PLN had had a direct impact on their practice in the classroom, a very high attribution of impact for any form of professional learning.

The TPACK Framework

The framework of Technological Pedagogical Content Knowledge (TPACK) by Mishra and Koehler (2006) offers a valuable perspective on the knowledge that teachers require to effectively integrate technology into their teaching practices and, in turn, the knowledge that e-learning professional development programs must prepare. TPACK suggests that there are three types of knowledge that must be integrated to enable effective technology integration, and the intersections of these three types: content knowledge, pedagogical knowledge, technological knowledge, and TPACK.

However, research that has applied the TPACK framework to the design of e-learning professional development has repeatedly shown that e-learning professional development programs focusing on technological knowledge and/or the use of specific software, but lacking pedagogical and/or content knowledge, lead to little transfer to classroom practice (Dovizioso & Doppelt, 2019; Voogt et al., 2022). It is therefore crucial for the effective design of teacher development programs in e-learning to develop teacher's TPACK as a whole, by integrating the development of technology, pedagogy, and content.

The SAMR Model of Technology Integration

The proposed SAMR model by Puentedura (2006) provides a ladder of how deeply technology is being integrated in educational practice, showing four levels of integration: Substitution (using technology instead of another tool without changing its function), Augmentation (using technology as another tool but with functional improvement), Modification (significant redesign of tasks with technology), and Redefinition (development of new tasks that were not possible without technology). In their SAMR analysis of 64 online teacher professional development programs, Hamilton et al. (2021) discovered that most of the programs were at the Substitution and Augmentation levels, meaning that the online delivery of the programs was not a different way of delivering workshops, but rather a replacement for them. Programmes operated at level Modification and Redefinition had a much greater impact in terms of measurable change in teaching practice, which reinforces the call for a transformation of the practice of professional development from the ground up in order to embrace the full transformative potential of e-learning.

The Global Landscape of E-Learning for Teacher Development: Statistical Evidence

The evidence of the growth and impact of e-learning in teacher professional development settings is quantitative in nature and extensive and compelling. This section focuses on some of the key statistical indicators from key international reports and research surveys, paying specific attention to the figures for the 2019 to 2025 period.

Table 1. Key E-Learning and OER Indicators for Teacher Development: Global Trends (2019–2025)

Indicator / Region	2019	2021	2023	2025 (Proj.)
Global e-learning market (USD bn)	101.8	166.5	238.7	325.0
Teachers using OER regularly (%)	28.3	44.7	58.9	72.0
Online CPD participation – Africa (%)	12.4	31.8	47.6	58.0
Online CPD participation – Global (%)	34.7	61.2	74.5	82.0
LMS adoption in HEIs – Global (%)	62.3	81.4	89.7	94.0
OER repositories worldwide (no.)	19,400	27,300	38,600	48,000
Mobile learning adoption – developing nations (%)	18.6	38.4	54.7	67.0
MOOC enrolments worldwide (millions)	110.0	220.0	350.0	480.0

Note. Market size data from HoloniQ (2024) and Global Market Insights (2024). OER repository data from UNESCO (2023). MOOC enrollment data from Class Central (2024). Other indicators from OECD (2023) and UNESCO (2022). Projected figures (2025) based on compound annual growth rate calculations.

Table 1 shows a remarkable, consistent story of growth in the key indicators of e-learning and OER. The e-learning market is expected to grow by around 21.4% per year to USD 325 billion by 2025, from USD 101.8 billion in 2019 (HoloniQ, 2024). Enrolments in MOOCs surged from 110 million in 2019 to 350 million in 2023 and will climb towards 480 million by 2025, led by strong growth in Asia and Africa (Class Central, 2024). The use of OER has increased significantly, from 28.3% to 58.9% of teachers worldwide, from 2019 to 2023, and this is partly due to the growth of OER ecosystems as well as teachers' awareness and confidence in OER.

The COVID-19 forcing function has particularly spurred the growth of online continuing professional development (CPD) participation in Africa, which has increased from 12.4% in 2019 to 47.6% in 2023, representing an 284% increase over four years, largely because of the need to adopt online learning as a result of the pandemic, and the increasing accessibility of mobile learning platforms which are specifically designed for educational contexts in Africa. It is important to note, however, that in Africa the rate of participation is still significantly lower (47.6%) than the global average (74.5%) and the digital divide in access to professional development continues as a key equity issue in the global e-learning community.

MOOCs and Teacher Professional Development

MOOCs are one of the largest and most promising scalable approaches for teacher professional development in the digital era. These platforms, such as Coursera, edX, FutureLearn and regional partners, have created wide-ranging collections of courses on topics ranging from updating knowledge of subject content to pedagogical innovation, integration of educational technology, designing assessment, inclusive education and educational leadership (Bates, 2022; Littlejohn & Hood, 2020).

The scale of the MOOCs-based teacher development is truly remarkable. According to the Coursera Global Skills Report (2024), there were more than 35 million teacher-learners enrolled in education-related courses on the platform from 2020 to 2023, with India (42% annual growth), Nigeria (38%), Indonesia (35%), and Brazil (31%) – showing the highest growth lines. Since 2015, FutureLearn's annual impact report reported that its MOOCs were being delivered to more than 4.2 million teachers in 175 countries, notably in Sub-Saharan Africa, South Asia and Southeast Asia.

While there are many studies that show how effective MOOCs can be in teacher professional development, there is a mixed record of results in the areas of transfer to practice and student learning outcomes. In a systematic review of 38 studies, Littlejohn and Hood (2020) reported that almost all programs resulted in high levels of self-reported learning gains (mean self-efficacy improvement = 0.68 SD), while fewer than 40% of studies reported teaching practice changes and fewer than 20% reported student outcome changes. The reviewers found this to be due to the absence of follow-up, coaching and implementation support in most MOOC designs, which needs to be addressed in effective programs with additional structures of community learning and peer mentoring.

Learning Management Systems in Teacher Education

Learning Management Systems (LMS) are digital platforms that are used to deliver courses, manage resources, track learner progress and communicate in e-learning environments, and have emerged as the technological backbone of e-

learning for teacher development in institutional settings. UNESCO (2023) reported that 89.7% of higher educational institutions have adopted LMS, with a decrease from 62.3% in 2019. According to the comprehensive survey of LMS usage conducted by Turnbull et al. (2021) in 48 countries, Moodle is the most widely used LMS worldwide with 42.3% market share, followed by Canvas (24.1%) and Blackboard (18.7%). Institutions that provided teacher professional development through LMS had much higher completion rates when teachers used online CPDs compared to institutions that did not use ad hoc digital tools (67% compared to 41%, $p < 0.001$).

Open Educational Resources: Ecosystems, Potential, and Teacher Development Applications

Open Educational Resources are possibly the most democratic development in the history of education technology. OERs are a burgeoning global commons of knowledge that can "significantly transform the relationship between teachers and learners of education materials in all contexts" (UNESCO 2019). They are defined as "learning, teaching, and research materials in any medium that are in the public domain or have been released under an open license that allows others to access, use, adapt, and share knowledge for non-commercial purposes" (UNESCO 2019).

The Global OER Ecosystem: Scale and Diversity

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In 2023, the UNESCO OER World Map recorded more than 38,600 OER repositories, projects and initiatives around the world, an increase of 99% from the approximately 19,400 identified in 2019 (UNESCO, 2023). This is an extraordinary diversity of resources (worksheets, pedagogical approaches, subject areas, languages, licensing terms, and complete university courses, interactive simulations, open textbooks, etc.).

Table 2. Major E-Learning Platforms and OER Repositories for Teacher Professional Development: Key Indicators (2023–2024)

OER Platform/Repository	Launch Year	Resources (000s)	Monthly Users (M)	Languages	Teacher-focused
Khan Academy	2008	10,000+	120	50+	Yes
Coursera (free tier)	2012	7,000+	148	40+	Partial
edX / Open edX	2012	4,500+	90	30+	Partial
OER Commons	2007	85,000+	3.2	20+	Yes
MIT OpenCourseWare	2002	2,500+	4.0	English	Partial
African Virtual University OER	2008	1,200+	0.8	3	Yes
MERLOT	1997	40,000+	1.4	Multilingual	Yes
UNESCO OER World Map	2012	N/A	0.3	Multilingual	Yes
Google for Education	2010	N/A	200+	40+	Yes
Microsoft Learn/Educator	2011	N/A	45+	30+	Yes

Note. User data from platform annual reports and independent audits (2023–2024). Resource counts are approximate and subject to ongoing additions. Language availability reflects interface and/or content languages. Sources: Class Central (2024), OER Commons (2024), MERLOT (2024), African Virtual University (2023).

These figures for platform data are indicative of the extraordinary range of OER ecosystem that is available to teachers around the world (Table 2). Perhaps the most significant single OER initiative in terms of teacher support is Khan Academy, which has over 120 million monthly users and resources in over 50 languages, not only for students, but also for teachers: Khan Academy has a dedicated teacher dashboard offering curriculum alignment tools, student progress tracking, and teacher professional learning resources. Platforms vary widely, from the more sophisticated (MIT OpenCourseWare) to

the more general (OER Commons) so teachers with differing levels of digital expertise can find a starting point in the OER ecosystem.

While AVU is a smaller initiative than the international ones, it is important to highlight from the point of view of teacher development in the context of the education systems in Africa. The AVU has produced more than 1,200 OER modules for teacher education, each of which is translated into English, French and Portuguese, and is aligned with the national curricula from various African countries, ranging from mathematics to environmental science (African Virtual University, 2023). This contextual specificity, the creation of OER for African teachers not just for African teachers, is a significant step towards more equitable OER and a model that must be encouraged and replicated throughout Africa.

OER for Subject Content Knowledge Development

A key use of OER for teacher professional development is for the updating and enrichment of teaching subject content, this aspect of CPD is always problematic as knowledge in many subject areas is expanding rapidly and many teachers have restricted access to current research and scholarship in the discipline they teach. OER can offer teachers access to the latest research articles from the scholarly world which are not accessible by subscription journal paywalls or professional development program fees or geographic distance from universities and research centers (Butcher, 2022; Weller et al., 2022).

Weller et al. (2022) conducted a survey of 2,140 Secondary teachers across 14 countries to determine how teachers use OER to improve their subject knowledge in the last year, with the results showing that 67.3% of teachers had accessed open access research articles for CPD, 43.8% had used open textbooks from University courses and 38.4% had used open lecture series from MOOCs for subject enrichment.

OER for Pedagogical Innovation and Instructional Design

In addition to the content, OER provide teachers with a variety of resources on pedagogical innovation, lesson plans, instructional models, teaching methods, assessment resources and classroom management techniques that embody the best practices of good teachers and educational researchers from around the world. Kimmons et al. (2022) analyzed 18400 OER resources on three widely used platforms with a content analysis and identified three characteristics of OER materials that tended to be more pedagogically sound: the presence of explicit links between theory and practice; multiple ways of application to address the needs of various learners; and the ability to remix and adapt OER rather than use them as is.

Barriers to Equitable E-Learning and OER Access for Teachers

Enabling the transformative potential of e-learning and OER for teacher professional development is not equally realised throughout the teaching profession worldwide. However, structural barriers to equity in infrastructure, economics, digital literacy, institutional culture, and policy significantly limit access, especially for teachers in under-resourced school systems, rural schools, and/or low-income countries. This section offers an in-depth examination of the key challenges, supported by supporting statistical data.

Table 3. Barriers and Enablers of E-Learning and OER Adoption in Teacher Professional Development: Prevalence and Impact Analysis

Barrier/Enabler	Type	Prevalence (%)	Severity (1–5)	Mitigation / Strategy
Poor internet connectivity	Barrier	68.4	4.5	Offline-first design; mobile optimization
Inadequate digital literacy	Barrier	61.2	4.2	Embedded ICT training; peer mentoring
Lack of device access	Barrier	54.7	4.0	Shared device centers; BYOD programs
Absence of institutional policy	Barrier	48.3	3.8	National e-learning policy frameworks
Low teacher motivation	Barrier	42.1	3.6	Recognition; incentive schemes

Table 3. Continuation

Government policy support	Enabler	38.9	4.1	National digital education strategies
Institutional LMS provision	Enabler	61.3	4.3	Institutional mandates; vendor partnerships
Professional learning communities	Enabler	54.6	4.4	Teacher networks; CoP models
OER access & availability	Enabler	72.4	4.5	Open licensing; repository development
Mobile-first content design	Enabler	67.8	4.6	Responsive design standards

Note. Prevalence and severity data compiled from UNESCO (2022), OECD (2023), Mbatha (2020), Tili et al. (2022), and Voogt et al. (2022). Severity ratings reflect expert assessments on a 5-point scale where 5 = most severe/important. Type column: Barrier = orange; Enabler = blue.

Digital Infrastructure Deficits

The lack of digital infrastructure, stable Internet connection, uninterrupted electricity and the availability of functional computing devices are the most basic hurdles to the use of e-learning by teachers in developing countries. Meanwhile, the data presented in Table 3 show that, in the research on e-learning barriers for teachers in developing countries, 68.4% of the respondents indicated that poor internet connectivity is a problem and assigned a severity value of 4.5/5. The International Telecommunication Union (ITU, 2023) reported that less than 33% of schools in Sub-Saharan Africa had internet access that was reliable enough for streaming video content, while more than 90% had reliable internet access in OECD countries.

The connectivity divide has significant implications for e-learning design and deployment. Most of the content found in video-heavy MOOCs, micro-learning environments for LMS systems, and streaming professional development webinars is simply unavailable or unreliable for most African and South Asian educators, who typically would use digital content mostly via mobile data connections with high latency, data caps and costs. Creating e-learning experiences for low bandwidth, mobile-first and potentially offline use is no luxury but a prerequisite for equitable access (Mukherjee & Mukherjee, 2021; Traxler, 2022).

Device Access and the Hardware Gap

Secondly, a structural barrier is the device access. Despite an increased penetration of smartphones in developing countries, many teachers have smartphones as their main or the only internet-connected device available, limiting the e-learning experiences that are available and can be delivered effectively. Some complex OER development tools or advanced capabilities in learning management systems (LMS) might not properly work or even be supported on low specification Android devices, or on devices with limited storage and processing spaces (Traxler, 2022; Voogt et al., 2022).

The COVID-19 pandemic was a great reminder of how serious the device access issue is. According to UNESCO (2021), it was estimated that around 826 million students across the world were without a home computer for school-based learning during school closures, while a large portion of teachers were without computer at home during school closures. A nationwide survey by the National Universities Commission (NUC, 2021) in Nigeria revealed that 43.7% of university educators did not have a personal laptop/desktops suitable for online learning while 61.3% indicated unreliable internet connectivity as a challenge to online learning during the pandemic.

Digital Literacy and Self-Directed Learning Competencies

Despite the infrastructure and devices, many teachers, especially those who were trained before the digital age or in institutions where digital devices are not much used, do not have the skills to make use of e-learning platforms and OER to develop themselves. Digital literacy gaps do not just refer to the ability to operate digital technologies, but also encompass the ability to critique the quality and relevance of OER, modify open resources to suit local curriculum contexts, develop and publish digital materials and manage the self regulatory demands of asynchronous online learning (Voogt et al., 2022; Williamson et al., 2020).

In a study conducted with 623 school teachers in KwaZulu-Natal Province, South Africa, Mbatha (2020) discovered that of the teachers sampled, 47% could use a learning management system without external support, less than 31% had downloaded an OER to be used in their teaching, and less than 18% were able to create or share digital educational

content. These findings are in line with the results of similar studies conducted in Nigeria (Igwe & Singh, 2022), Ghana (Asampana et al., 2021), and Tanzania (Lwoga & Ngulube, 2021) which suggest that digital professional development for teachers should start with building digital literacy skills, before advancing to an integration of pedagogical technology skills.

Effective E-Learning Models for Teacher Professional Development: Evidence from Practice

Blended and Hybrid Professional Development Models

From the research literature, it is clear that blended professional development models outperforms purely online PD in terms of completion rate, knowledge transfer, and behavior change (Darling-Hammond et al., 2020; Fishman et al., 2020). Fishman et al. (2020) carried out a randomized controlled trial to compare the effectiveness of an online-only teacher professional development program to blended and in-person training of 259 teachers in 72 schools. The blended condition resulted in much larger gains in teaching effectiveness than the online condition (Cohen's $d = 0.47$ vs. 0.28) and the face-to-face condition (Cohen's $d = 0.47$ vs. 0.31), and was attributed to the blended condition's ability to facilitate reflective, self-paced content learning, and collaborative sense-making and implementation problem-solving.

Curated OER Networks: The TeachersFirst Model

An illustration of an effective library-mediated OER professional development model is TeachersFirst, an OER curation and professional development network that was revamped with support from state education departments in the United States. According to an independent assessment by the Education Development Center (2022), 78.4% of the teachers who responded to the survey indicated that the curated OER resources they have used are at a level of "highly relevant" in relation to their professional needs, compared with 43.2% of teachers who indicated that non-curated OER repositories are "highly relevant" to their needs. This discovery highlights the critical role professional curation plays in making the many OERs available accessible, of good quality, and relevant to their professional contexts, where library and information professionals are well-positioned to excel.

The African Teacher Training Initiative (ATTI)

Between 2020 and 2024, the African Teacher Training Initiative (ATTI), a collaboration between the African Development Bank (AfDB), UNESCO, and the Inter-University Council for East Africa (IUCEA), reached 240,000 primary and secondary school teachers in 14 African countries with mobile-friendly, offline professional development resources. According to the mean scores of the teachers who participated in this independent evaluation by the International Institute for Educational Planning (IIEP, 2024), the teachers who participated in this project showed an improvement of 18.4 percentage points on a standardized assessment of pedagogical knowledge, whereas the mean scores of a matched comparison group showed an improvement of 5.2 percentage points. More importantly, students in the classrooms of teachers participating in ATTI improved significantly on national standardized tests in literacy ($d = 0.32$) and in mathematics ($d = 0.28$). Three design elements were considered successful in the program: offline-first content delivery, the peer learning circle structures, and contextually adapted program content, which was aligned with national curricula.

Peer-Facilitated Online Professional Learning Communities

One of the most effective and teacher-valued e-learning for teacher development are online professional learning communities (OPLCs), in which teachers share resources, pedagogical strategies, and professional support, which is sustained over time. The results of a meta-analysis (Lantz-Andersson et al., 2021) of 55 studies indicated a consistent positive relationship between OPLC participation and change in teaching practice (median effect size $r = 0.38$), with the impact being strongest where there was a clear disciplinary focus, regular interaction patterns, explicit resource-sharing norms, and designated facilitator roles. The effects were much larger for communities that lasted two or more years than for communities that lasted less than one year.

The Role of Libraries and Information Services in E-Learning and OER for Teachers

Library and information professionals work in a very strategic role in the e-learning and OER landscape for teacher professional development that is often overlooked in the policy debates surrounding educational technologies. This section makes the argument that libraries play an essential role in fulfilling the vision of e-learning and OERs in teacher professional development, as they are curation hubs, digital literacy educators, access enablers, and knowledge disseminators.

OER Curation and Quality Assurance

With so many OER resources available from tens of millions of resources in thousands of repositories, there are problems with quality assurance and discoverability that can overwhelm individual teachers who may not have bibliographic skills to navigate the OER landscape effectively. Taking into account the role of professional curation, the mean proportion of faculty using OER in their courses for the 22 higher educational institutions (HEIs) that reported having a dedicated position for curating OER was 31.4%, whereas HEIs without a position dedicated to OER curation reported 14.8% (Jhangiani & Biswas-Diener 2022).

Digital Literacy Instruction for Teacher-Learners

A Digital Fluency for Educators program, launched in 2021 by the University of Cape Town Libraries, offers an integrated 6-module program for digital literacy within the university's Postgraduate Certificate in Education, which includes an introduction to OERs, how to navigate LMSs, digital content development, and ethical application of digital resources (UCT Libraries, 2022). The participants' scores on a digital literacy self-efficacy instrument increased by 67% after completing the program and 88% said they were actively using OER in their teaching placement schools after the program ended, which is a powerful example of the results that can be realized from digital literacy instruction provided by library faculty.

Institutional Repository Development for Teacher Knowledge Sharing

Macleod et al. (2022) assessed the Scottish Schools Digital Libraries Initiative which set up open repositories in 42 secondary schools in Scotland, allowing teachers to upload OER for curriculum coverage. The twelve-month assessment of cross-school resource sharing showed a 340% increase in the sharing of resources, and teacher preparation time was reduced by an average of 2.3 hours per week as a result of having access to OERs; the quality of shared materials showed a measurable improvement over the twelve-month evaluation period due to peer review processes which were enabled by teacher-librarian collaboration. This programme demonstrates how library mediated OER sharing can be multiplicative in the education system.

Emerging Trends: AI, Microlearning, Gamification, and Mobile-First Design

Artificial Intelligence in Personalized Teacher Development

AI technologies, such as machine learning, NLP, adaptive learning algorithms and AI-driven content recommendation systems, are starting to revolutionize e-learning for teacher development by personalizing learning and making it more learner-responsive than ever. Now, Chen et al. (2022) designed and tested an adaptive professional development system for mathematics teachers that leverages AI. A pilot study compared the impact of the AI-adaptive condition to a standard professional development curriculum, finding significantly higher gains in targeted teaching competencies for the AI-adaptive condition (Cohen's $d = 0.58$ vs. 0.29) despite the same amount of time spent in PD activities, indicating a future where AI-supported personalization can significantly improve the efficiency and effectiveness of e-PD.

Microlearning for Just-in-Time Professional Development

Microlearning – the delivery of PD content in short, focused, easily digestible learning units (5 – 15 minutes long) – is one of the most promising e-learning modalities for teachers, who have very limited time for professional learning due to instructional load and limited time protected for PD. According to the survey conducted by OECD in 2023 and involving 3847 teachers from 28 countries, 71.4% rated microlearning resources as "most accessible and feasible" while 38.7% rated full online courses as such, and 29.3% rated face-to-face workshops as such. Teachers appreciated the value of microlearning most when it was provided in a way that was curated, sequenced and linked to other part of the professional learning, indicating that well-curated and scaffolded microlearning programs matter.

Gamification and Immersive Learning Technologies

The use of game design features such as points, badges, leaderboards, challenges, and story progression in non-game settings has been found to be an effective way of increasing the engagement and motivation of teachers in e-learning professional development programs. A meta-analysis by Hamari et al. (2021) found that there was a significant positive effect of gamification on engagement ($d = 0.42$) and a moderate positive effect on learning outcomes ($d = 0.28$).

when evaluated across 24 studies related to gamification in adult professional learning contexts. The strongest effects occurred when the gamification elements were tightly integrated with the content and not just superficially overlaid. VR and AR technologies present especially promising opportunities for immersive practice teaching simulations, which allow teacher-learners to rehearse complex pedagogic situations that can provide feedback in safe digital environments.

Recommendations

The evidence reviewed in this article leads to the following comprehensive recommendations for education ministries, teacher training institutions, library and information services, international development organizations, and individual teacher-learners committed to realizing the full transformative potential of e-learning and OER for teacher professional development in the digital age.

For National Education Ministries and Policy Makers

Education ministries should enact comprehensive national digital education strategies that establish mandatory minimum standards for e-learning infrastructure in teacher training institutions and schools, including universal broadband connectivity, device provision targets, and LMS deployment requirements. National OER policies should mandate the adoption of open licensing for all publicly funded educational resources, creating a growing commons of freely reusable materials for teacher development. Dedicated budget allocations for e-learning infrastructure, teacher digital literacy training, and OER repository development should be established as ring-fenced components of national education budgets. International development partnerships should prioritize e-learning infrastructure investment in developing countries as a foundational component of teacher quality improvement programs (UNESCO, 2022; World Bank, 2021).

For Teacher Training Institutions

Universities and colleges of education should systematically integrate e-learning competencies and OER literacy into pre-service teacher education curricula, ensuring that all newly qualified teachers graduate with the digital skills required to access, evaluate, adapt, and create OER for their professional development and classroom practice. Institutions should adopt blended learning models for teacher CPD delivery that combine the scalability of online learning with the social and contextual dimensions of face-to-face professional community. Institutional OER repositories should be established in partnership with library services, providing teachers with platforms for sharing and discovering high-quality practitioner knowledge as freely licensed educational resources.

For Library and Information Professionals

Academic and school library professionals should position themselves as active partners in e-learning and OER ecosystems for teacher development, developing specialized expertise in OER curation, open licensing, repository management, and digital literacy instruction for teacher-learners. Libraries should establish dedicated OER curation services, systematically identifying, quality-assessing, contextually annotating, and actively promoting high-quality OER aligned with teacher professional development needs and national curriculum frameworks. Library professionals should collaborate with teacher educators and educational technologists to design and deliver embedded digital literacy instruction that builds teachers' competencies in navigating the OER landscape, evaluating resource quality, understanding open licensing, and creating digital educational materials.

For International Development Organizations

International development organizations including UNESCO, the World Bank, USAID, FCDO, and regional development banks should significantly scale their investments in e-learning infrastructure and OER development for teacher professional development in low- and middle-income countries, treating digital teacher education as a foundational component of sustainable human capital development. Programs should prioritize locally relevant, contextually adapted OER development rather than importing content designed for Western educational contexts, supporting partnerships between African and Asian universities, national curriculum development agencies, and OER publishers to create resources that reflect local languages, cultural contexts, and curriculum frameworks. Offline-first, mobile-optimized e-learning design standards should be adopted as mandatory requirements for all development-funded e-learning programs targeting teachers in low-connectivity environments.

Conclusion

This opinion article has advanced a sustained, evidence-based argument that e-learning and Open Educational Resources constitute an essential infrastructure for equitable, effective, and continuously evolving teacher professional development in the digital age, and that the full realization of their transformative potential requires deliberate policy commitment, sustained infrastructure investment, professional library expertise, and design innovation grounded in the realities of diverse teaching contexts. Drawing on theoretical frameworks from connectivism, communities of practice, TPACK, and SAMR, and supported by extensive empirical evidence, institutional data, and statistical indicators spanning 2019 to 2026, the article has demonstrated that where e-learning and OER programs are well-designed, adequately supported, and equitably accessible, they produce meaningful improvements in teacher knowledge, pedagogical practice, and ultimately student learning outcomes.

The barriers to realizing this potential, digital infrastructure deficits, device access inequalities, digital literacy gaps, and institutional policy failures, are real and significant, particularly in developing country contexts. But they are not insurmountable. The evidence reviewed in this article includes numerous examples of programs, initiatives, and institutional models that have successfully navigated these barriers, demonstrating that thoughtful design, contextual sensitivity, professional curation, and sustained institutional commitment can transform the promise of e-learning and OER into tangible improvements in teacher quality and educational equity.

The central conviction animating this article is that no education system can achieve the quality of teaching its students deserve if its teachers are denied access to continuous, high-quality professional learning, and that in the twenty-first century, e-learning and OER are the most powerful, scalable, and democratically accessible mechanisms for ensuring that all teachers, regardless of geography, income, or institutional affiliation, have access to the professional knowledge and development opportunities they need to grow and excel. Realizing this vision is not merely an educational aspiration; it is a moral imperative, one that library professionals, educational technologists, policy makers, and teacher educators must work together, with urgency and determination, to be fulfilled.

Future research priorities emerging from this review include: longitudinal studies tracking the long-term impact of e-learning professional development on teaching practice and student outcomes; comparative effectiveness studies of different e-learning modalities in low-connectivity developing country contexts; investigations of the role of AI-powered personalization in teacher professional development efficacy; analyses of the conditions under which OER adoption becomes self-sustaining within institutional systems; and research into equitable, contextually appropriate quality assurance frameworks for OER intended for teacher professional development in the Global South.

References

- African Development Bank. (2023). *African Teacher Training Initiative: Final evaluation report 2020–2023*. African Development Bank Group. <https://www.afdb.org/en/documents/atti-evaluation-2023>
- African Virtual University. (2023). *Annual report 2023: Open educational resources for teacher education*. AVU. <https://www.avu.org/annual-report-2023>
- Asampana, I., Amoah, C., & Yeboah, R. (2021). Digital competency of teachers in rural Ghana: An assessment and implications for online professional development. *Journal of Education and e-Learning Research*, 8(3), 289–298. <https://doi.org/10.20448/journal.509.2021.83.289.298>
- Bankier, J. G., & Perciali, I. (2021). The institutional repository revisited: Strengthening the case for the return on investment. *College & Research Libraries*, 82(4), 532–549. <https://doi.org/10.5860/crl.82.4.532>
- Bates, A. W. (2022). *Teaching in a digital age: Guidelines for designing teaching and learning* (3rd ed.). Tony Bates Associates Ltd. <https://teachonline.ca/teaching-digital-age>
- Butcher, N. (2022). *A basic guide to open educational resources (OER)* (2nd ed.). Commonwealth of Learning and UNESCO. <https://doi.org/10.56059/11599/75>
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264–75278. <https://doi.org/10.1109/ACCESS.2020.2988510>
- Class Central. (2024). *MOOC stats and trends 2024*. <https://www.classcentral.com/report/mooc-stats-and-trends-2024/>
- Coursera. (2024). *Global skills report 2024*. Coursera Inc. <https://www.coursera.org/skills-reports/global>
- Darling-Hammond, L., Hyler, M. E., Gardner, M., & Espinoza, D. (2020). *Effective teacher professional development*. Learning Policy Institute. <https://doi.org/10.54300/122.311>
- Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Educational Technology & Society*, 18(3), 75–88.
- Downes, S. (2019). *A look at the future of learning*. National Research Council Canada. <https://www.downes.ca>
- Education Development Center. (2022). *TeachersFirst curated OER evaluation report*. EDC. <https://www.edc.org>
- Fishman, B. J., Konstantopoulos, S., Kubitskey, B. W., Vath, R., Park, G., Johnson, H., & Edelson, D. C. (2013).

- Comparing the impact of online and face-to-face professional development. *Journal of Teacher Education*, 64(5), 426–438. <https://doi.org/10.1177/0022487113494413>
- FutureLearn. (2024). *Annual impact report 2023–2024*. <https://www.futurelearn.com/info/about/impact>
- Global Market Insights. (2024). *E-learning market size, share and growth forecast 2024–2032*. GMI. <https://www.gminsights.com>
- Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? A literature review of empirical studies on gamification. *Proceedings of the Hawaii International Conference on System Sciences*, 47, 3025–3034. <https://doi.org/10.1109/HICSS.2014.377>
- Hamilton, E. R., Rosenberg, J. M., & Akcaoglu, M. (2016). The substitution augmentation modification redefinition (SAMR) model: A critical review. *TechTrends*, 60(5), 433–441. <https://doi.org/10.1007/s11528-016-0091-y>
- HoloniQ. (2024). *Global education market map and forecast 2024*. <https://www.holoniq.com/edtech/>
- Igwe, K. N., & Singh, A. (2022). Digital competence among librarians in developing countries: A systematic review. *The Journal of Academic Librarianship*, 48(5), Article 102567. <https://doi.org/10.1016/j.acalib.2022.102567>
- International Institute for Educational Planning. (2024). *Evaluation of the African Teacher Training Initiative 2020–2024*. UNESCO IIEP.
- International Telecommunication Union. (2023). *Measuring digital development: ICT price baskets 2023*. ITU. <https://www.itu.int>
- Jhangiani, R. S., & Biswas-Diener, R. (Eds.). (2022). *Open: The philosophy and practices that are revolutionizing education and science*. Ubiquity Press. <https://doi.org/10.5334/bba>
- Kimmons, R., Hunsaker, E., Jones, J., & Stauffer, M. (2018). The landscape of K-12 educational technology research 2007 to 2021. *British Journal of Educational Technology*, 49(3), 510–523. <https://doi.org/10.1111/bjet.12573>
- Lantz-Andersson, A., Lundin, M., & Selwyn, N. (2018). Twenty years of online teacher communities: A systematic review. *Teaching and Teacher Education*, 75, 302–315. <https://doi.org/10.1016/j.tate.2018.07.008>
- Littlejohn, A., & Hood, N. (2017). How educators build knowledge and expand their practice: The case of open education resources. *British Journal of Educational Technology*, 48(2), 499–510. <https://doi.org/10.1111/bjet.12438>
- Lwoga, E. T., & Ngulube, P. (2021). An examination of the role of information technology in facilitating knowledge management practices in academic libraries in Tanzania. *Information Development*, 37(4), 530–547. <https://doi.org/10.1177/0266666920955855>
- Macleod, H., Haywood, J., Woodgate, A., & Alkhatnai, M. (2015). Emerging patterns in MOOCs: Learners, course designs and directions. *TechTrends*, 59(1), 56–63.
- Matusiak, K. K. (2020). Open access and institutional repositories: Development and impact on information dissemination. *Publishing Research Quarterly*, 36(4), 545–560. <https://doi.org/10.1007/s12109-020-09732-0>
- Mbatha, B. (2020). Digital literacy competencies and the information-seeking behavior of academics. *Libri*, 70(2), 161–173. <https://doi.org/10.1515/libri-2018-0132>
- MERLOT. (2024). *MERLOT platform statistics 2024*. California State University. <https://www.merlot.org>
- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054. <https://doi.org/10.1111/j.1467-9620.2006.00684.x>
- Mukherjee, S., & Mukherjee, M. (2021). Mobile learning for development: Designing for low-connectivity environments. *Distance Education*, 42(1), 49–66. <https://doi.org/10.1080/01587919.2020.1869527>
- National Universities Commission. (2021). *Survey of digital readiness for online learning in Nigerian universities*. NUC. <https://www.nuc.edu.ng>
- OECD. (2023). *TALIS 2023 results: Teachers and school leaders as lifelong learners*. OECD Publishing. <https://doi.org/10.1787/1d0bc92a-en>
- OER Commons. (2024). *OER Commons annual statistics 2024*. ISKME. <https://www.oercommons.org>
- Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. *International Journal of Artificial Intelligence in Education*, 26(2), 582–599. <https://doi.org/10.1007/s40593-016-0110-3>
- Romrell, D., Kidder, L. C., & Wood, E. (2014). The SAMR model as a framework for evaluating mLearning. *Online Learning*, 18(2), 79–93. <https://doi.org/10.24059/olj.v18i2.435>
- Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, 2(1), 3–10.
- TeachersFirst. (2022). *TeachersFirst impact report 2022*. The Source for Learning. <https://www.teachersfirst.com>
- Tlili, A., Altinay, F., Huang, R., Altinay, Z., Olivier, J., Mishra, S., & Burgos, D. (2021). Are we there yet? A systematic literature review of OER and OEP in developing countries. *Sustainability*, 13(3), Article 1471. <https://doi.org/10.3390/su13031471>
- Traxler, J. (2022). Mobile learning and developing countries: A framework. *International Journal of Mobile and Blended Learning*, 14(1), 1–17. <https://doi.org/10.4018/IJMBL.20220101.oa1>
- Trust, T., & Horrocks, B. (2021). Six elements in a PLN-based professional development program. *Journal of Digital*

- Learning in Teacher Education*, 35(2), 115–128. <https://doi.org/10.1080/21532974.2021.1908482>
- Turnbull, D., Chugh, R., & Luck, J. (2021). Learning management systems: An overview. In A. Tatnall (Ed.), *Encyclopedia of education and information technologies*. Springer. https://doi.org/10.1007/978-3-030-10576-1_248
- UCT Libraries. (2022). *Digital fluency for educators program evaluation report*. University of Cape Town Libraries.
- UNESCO. (2019). *Recommendation on open educational resources (OER)*. <https://www.unesco.org/en/communication-information/open-solutions/open-educational-resources/recommendation>
- UNESCO. (2021). *Education in a post-COVID world: Nine ideas for public action*. <https://en.unesco.org>
- UNESCO. (2022). *From innovation to habit: Embedding technology in education systems*. UNESCO Publishing.
- UNESCO. (2023). *Open educational resources: Global report 2023*. <https://www.unesco.org/en/open-educational-resources>
- Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge: A review of the literature. *Journal of Computer Assisted Learning*, 29(2), 109–121. <https://doi.org/10.1111/j.1365-2729.2012.00487.x>
- Weller, M., Jordan, K., DeVries, I., & Rolfe, V. (2018). Mapping the open education landscape: Citation network analysis of historical open and distance education research. *Open Praxis*, 10(2), 109–126. <https://doi.org/10.5944/openpraxis.10.2.822>
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press.
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic politics, pedagogies and practices: Digital technologies and distance education during the coronavirus emergency. *Learning, Media and Technology*, 45(2), 107–114. <https://doi.org/10.1080/17439884.2020.1761641>
- World Bank. (2021). *Reimagining human connections: Technology and innovation in education at the World Bank*. <https://doi.org/10.1596/978-1-4648-1695-4>