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What Did We Learn About Massive Open Online Courses for Teachers? A Scoping Review

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Abstract

The growing interest in professional development for teachers via massive open online courses (MOOCs) raises the need for identifying the existing gaps in the literature on the topic. In this literature review, we were able to identify 68 relevant studies. They mostly used mixed methods (57%) and surveys (82%), and only reported descriptive statistics (52%). They also tended to measure participants' attitudes (41%) and engagement (40%). Based on our findings, we recommend that future researchers consider additional data collection and analysis methods (e.g., clickstream data, objective performance measures) and use correlational, longitudinal, and experimental designs.

Keywords: massive open online courses, scoping review, teacher professional development, in-service teachers

Introduction

Professional development (PD[ii]), understood as activities educators engage in to improve education in the classroom (Day, 1999), is considered a vital part of efforts to improve students' achievement (Yoon et al., 2007). Educators' need for high-quality PDs that are also flexible and accessible has led to an increase in the popularity of online PDs (Liu, 2012), particularly during and after the COVID-19 pandemic (Lockee, 2021). Such courses fit more easily into educators' busy schedules (Collins & Liang, 2015) and are received positively by teachers (Gunter & Reeves, 2017; Wasserman & Migdal, 2019), with some studies showing that they can also be effective in enhancing educators' learning and students' achievement (Dash et al., 2012; Magidin de Kramer et al., 2012).

One type of online course for educators is the massive open online course (MOOC). Unlike other online courses, they are available for free or for a very low price, making them accessible to large numbers of learners. MOOCs in general are extremely popular among educators (Carapezza, 2015; Seaton et al., 2015), showing educators' need for and willingness to take MOOCs to enhance their practice. Indeed, many studies focus on MOOCs designed specifically for educators' PD. For example, researchers have described the design and pedagogical impact of MOOCs as PDs about teaching (Butler et al., 2016; Hodges et al., 2016; Jobe et al., 2014; Kleiman & Wolf, 2015) and about specific subjects such as math (Taranto et al., 2017; Tømte, 2019), language (Ibáñez Moreno & Traxler, 2016), and science (Dikke & Faltin, 2015). Studies have also explored these MOOCs empirically, describing participants' attitudes, persistence, and changes in practices (Avineri et al., 2018; Mishra et al., 2019; Van de Poël & Verpoorten, 2019; Wang et al., 2018).

Research on MOOCs as PDs is valuable from an educational technology perspective given how educators are a large subset within the general group of MOOC learners, so these studies may help understand MOOC learners and improve MOOCs more broadly. They are also important for the field of teacher PD as they expose educators' PD needs, potentially contributing to the development of future online and offline PDs. In spite of the popularity of studies about MOOCs for PD and their significance, there are no existing reviews on the subject. A review of the current research about PD MOOCs can help researchers understand what is known and what remains to be explored, thus contributing to future studies in the field.

In order to understand what is known about topics related to MOOCs for educators, we present a brief overview of existing reviews of studies on MOOCs and online PDs. We were able to identify dozens of reviews about MOOCs published since 2013 with varying foci. Some of them summarized studies about MOOCs in general (e.g., Bozkurt et al., 2017; Despujol et al., 2022; Ebben & Murphy, 2014; Meet & Kala, 2021; Raffaghelli et al., 2015; Yousef et al., 2015; Zawacki-Richter et al., 2018; Zhu et al., 2018; 2020). These reviews largely reached similar conclusions: (a) most studies about MOOCs apply a quantitative approach, specifically using surveys; (b) most studies were conducted in North America or Europe; and (c) these studies can be generally grouped into learner-focused (e.g., retention, motivation, and experience in the MOOC), course-focused, and instructor-focused, with learner-focused studies being the most common. The reviews we identified also made suggestions for future studies, one of them being conducting more research about MOOCs for specific disciplines or subpopulations (Deng et al., 2019; Liyanagunawardena et al., 2013; Veletsianos & Shepherdson, 2016).

Other reviews were more specific, focusing on certain publication avenues (e.g., Babori et al., 2019; Gašević et al., 2014), methods (e.g., Lu et al., 2021; Montes-Rodríguez et al., 2019), theories (e.g., Alonso-Mencía et al., 2020; Jacoby, 2014), or sub-topics such as assessment methods (e.g., Alturkistani et al., 2020) and motivation (Badali et al., 2022; Hew & Cheung, 2014). A relatively small number of reviews surveyed MOOCs about certain topics (e.g., Fang et al., 2019, about MOOCs and language learning). Relevant to the current study, Paton et al. (2018) explored research about vocational education and MOOCs and identified common topics such as student perceptions and engagement in MOOCs. Gonçalves and Gonçalves (2019) reviewed studies about teachers' motivations for taking MOOCs and found that teachers were interested in expanding their digital and technological skills. However, they only explored motivation and not any empirical studies about MOOCs for PD.

Reviews about non-MOOC online PDs are also ubiquitous. Similar to the aforementioned reviews on MOOCs, we identified reviews of online PDs studies in general (Dede et al., 2009; Dillie & Røkenes, 2021; Lay et al., 2020), dividing the existing literature into effectiveness studies, design-focused, teacher-focused (e.g., their attitudes and perceptions), and interaction-focused (with peers and leaders in the course and in the school). Other reviews are more specific, for example focusing on online communities as PD (Macià & García, 2016) or the impact of online PDs on various outcomes (Bragg et al., 2021).

The existence of a large number of reviews about MOOCs and online PDs demonstrates the popularity of the topics among researchers, making the lack of reviews about MOOCs for teachers particularly striking. While one may surmise that studies about MOOCs as PDs follow the same general trends as described in the other reviews, there are several reasons why this may not be the case. Researchers of MOOCs for teachers may have different agendas than researchers of other MOOCs that are mostly aimed at college students (Olsson, 2016) because teachers have different motivations and engagement patterns compared to other learners (Brooker et al., 2018; Seaton et al., 2015). In addition, MOOCs are different from other online courses in their availability and because they are usually self-paced rather than being formally organized by school districts. Therefore, studies about MOOCs used for PD may have different emphases or findings in comparison with studies about smaller-scale online PDs. So, a review of the existing literature on MOOCs for teachers is warranted.

The current study is meant to address this gap by examining empirical studies on MOOCs as PDs using a scoping review technique (Arksey & O'Malley, 2005). Beyond simply filling a gap, we hope to identify what topics have been studied (e.g., teachers' attitudes or motivations) and what remains to be studied (e.g., specific subpopulations of teachers). By summarizing the existing literature on the topic, we hope to assist researchers and practitioners to understand what is known about PD MOOCs, how the findings were discovered, and what remains to be explored, thus potentially guiding future research. So, our research questions are:

1. What are the research methods used in the existing literature about MOOCs for educators' PDs?

2. What are the topics and findings of studies about MOOCs for educators' PD?

In order to describe the research methods used, we recorded what courses were studied, data collection methods, and data analysis methods applied in the reviewed studies. The methods as well as the main

variables at the center of the studies were used to guide the discussion of the studies' findings. We then discuss the findings in light of the existing reviews and make suggestions for future research.

Methods

Our review was guided by Arksey and O'Malley's (2005) framework for rigorous scoping reviews. We chose a scoping review approach as opposed to a systematic review because we were interested in the state of the field: the constructs being studied (or understudied), the methods used, and so on (Arksey & O'Malley, 2005). For the same reason, we did not evaluate the studies' quality or assess their biases as is generally expected in systematic reviews (e.g., the PRISMA guidelines; Page et al., 2021), but still recorded our search and analysis strategy to allow for future replication. Arksey and O'Malley's framework consists of five stages: identifying the research question, identifying relevant studies, study selection, charting the data, and collating, summarizing, and reporting the results. Note that although the stages are presented here linearly, the research process was iterative, with the search process and inclusion criteria being revised at different stages of the study.

Identifying the Research Question

This stage involved defining the research question of the review and the main variables of interest that were to be extracted from the reviewed studies. As our research questions involved MOOCs for educators' PDs, we defined MOOCs as courses given remotely and available to the public. So, we were not interested in blended courses or in online courses given privately to a small group of teachers. We also defined educators as K–12 teachers and administrators; while studies about MOOCs for higher education instructors are valuable, they were beyond the scope of the current work. Finally, we used a broad definition of PD as involving any action that could improve educational practice, so we included any relevant MOOCs and not only those formally acknowledged as PD.

Identifying Relevant Studies

This stage included the search strategies used. We looked at electronic databases, reference lists, and key journals. All of our searches were conducted throughout December 2022. We first searched the websites Web of Science, Scopus, and ERIC. Although we had used rather specific definitions in the previous stage, we wanted our search to be as broad as possible. As a result, we used relatively general terms when searching these databases: MOOC* OR "Massive open online course*", "professional development OR professional learning OR professional growth OR professional training", and "teacher* OR educator*", all connected with the Boolean AND. These were searched in each paper's title, abstract, and keywords. We also searched Google Scholar, but due to the large number of results, we limited our search to articles that had these search terms in their title. These searches yielded 214 articles, and after removing duplicates, we found 152 unique articles.

Next, we searched for publications in important journals in the field. We chose the three most impactful journals in educational technology (*Computers & Education*, *British Journal of Educational Technology*, and *Education and Information Technologies*) and teacher education (*Teaching and Teacher Education*, *International Journal of Instruction*, and *Journal of Teacher Education*) based on Google Scholar's ratings

in December 2022. Most of the results were previously identified in the database search, but we found two additional articles using this method.

After an initial round of study selection, where we narrowed down the results based on our inclusion criteria (see the Study Selection section), we hand-searched the references of the remaining 53 articles. This search yielded 15 more relevant articles, and we reviewed their references for further relevant studies. We also examined the titles of the references of key articles that were not included in this study because they did not meet our inclusion criteria (see the Study Selection section; e.g., Gonçalves & Gonçalves, 2019; Hodges et al., 2016; Jobe et al., 2014). No new references were identified.

Study Selection

Before the initial search, we developed several criteria to narrow down the results. First, we only included peer-reviewed studies from journals and conferences to ensure that studies adhered to at least some quality standards. We also focused on papers in English. Next, in order to make sure that the studies were relevant to our research questions, we focused on studies about MOOCs (namely, not blended or small-scale courses) for K–12 educators. Based on these criteria, we performed our initial reading of the studies' abstracts; if it was unclear whether a study met our inclusion criteria, we also read its methods and the results sections. Out of the 154 studies we had identified at that point, 20 studies were removed because they were not peer-reviewed journal or conference papers (e.g., book chapters and dissertations), 20 were removed because they did not center around MOOCs, 24 were removed because participants were not K–12 teachers, and six studies were removed because we were not able to find them online or via our institution's library, resulting in 84 remaining studies.

After this first reading of the manuscripts, we decided to add two exclusion criteria. As we were interested in teachers' PD and not initial training, we decided to remove studies focusing on pre-service teachers. Ten studies were removed as a result. We also noticed that many of the studies included a narrative description of a MOOC or a program's development process and pedagogical philosophy, with no or very little data reported in them (e.g., only completion rates). While such articles are valuable for those interested in course design, we were interested in empirical findings, so we decided to exclude this type of study. This resulted in the removal of 21 more papers. Following these exclusion criteria, our sample included 53 papers. Then, we searched the reference sections of these papers as described above. After applying our criteria, we identified 15 more articles, so our final sample included 68 articles.

Charting the Data

The next step was coding the identified articles for the key data to be reported. Arksey and O'Malley (2005) proposed documenting where and when each study was published as well as its aims, population, methodology, measures, and important results. We read the studies carefully several times to identify these elements with special attention given to the studies' purpose based on their research questions and reported results. We also recorded the MOOCs studied in each of those papers (their subject matter, where they were developed). In cases where the course's name was given but who developed it was not, we searched for the course online. If we found an exact match and the information was available, we recorded the country where it was developed.

Collating, Summarizing, and Reporting the Results

Finally, based on the data extracted from the selected studies, the findings were summarized and are presented in the Results section.

Results

Research Methods Used

In our first research question, we asked: What are the research methods used in the existing literature about MOOCs for educators' PDs?

The papers we identified (see Appendix) were published between 2014 and 2022, and 63% were published in journals and the rest in conference proceedings. Most of the studies focused on specific MOOCs: 76%[iii] explored one MOOC, and 19% explored several MOOCs (the rest surveyed teachers about MOOCs regardless of whether they took any, e.g., Hilali & Moubtassime, 2021). The MOOCs covered a variety of topics, most commonly general pedagogical methods (47%), but there were also subject-specific courses in math (13%), computer science (12%), language (8%), and other topics. It is noticeable that most of the courses about teaching and pedagogy (27 out of 33) were related to the use of technology in teaching or remote teaching (e.g., Castaño-Muñoz et al., 2018). The MOOCs studied were produced in 18 different countries, most commonly in the United States (18%) and China (15%). About two thirds (66%) of the courses were developed in North America and Europe. However, some of the studies involved the use of a MOOC from one country by participants from another country. For example, Chavez (2020) studied Filipino teachers who took a U.S.-based MOOC.

Looking at the studies' design, most of them (57%) used mixed methods, 35% used purely quantitative methods, and 7% were purely qualitative, with some studies also discussing the pedagogical approach behind the course they reviewed (e.g., Garreta-Domingo et al., 2015). The studies' sample sizes ranged from four (Bonafini, 2018) to over 10,000 (Chen et al., 2020), though a large proportion of the studies (32%) had fewer than 100 participants. The common data sources used in the identified studies were pre- and post-course surveys (82%), followed by the course's forum (37%) and automatically recorded engagement measures (32%): 18% were binary indicators such as course or assignment completion (e.g., Rutherford-Quach et al., 2021), and 15% were more elaborate clickstream data (e.g., Fan et al., 2022). Other, less common data sources included interviews, performance measures, and other text-based information such as social media posts.

In terms of analysis, a plurality of the quantitative and mixed-methods studies (44%) only reported descriptive statistics. The other common analysis methods applied in these studies were group comparisons using inferential statistics, for example, *t*-tests or analysis of variance or ANOVA (19%) and correlational methods including regression models and structural equation modeling (12%). Few studies used social network analysis (SNA), natural language processing (NLP), data reduction methods (factor analysis, principal component analysis), or different machine learning algorithms (19% across all of these methods). Table 1 presents a summary of these findings.

Table 1

A Summary of the Frequency of Analysis Methods

Method	%	Example
Descriptive only	44	Evaluating a MOOC's reach and impact by describing its participants, their attitudes, and achievement (Laurillard, 2016)
Group comparison (*t*-test, ANOVA)	19	Comparing the learning effects of those studying individually and those studying in groups (Li et al., 2021)
Correlational	12	Predicting course completion based on learners' motivation and grit (Davies, 2022)
Social network analysis	9	Describing patterns of peer interaction in the course (Banerjee et al., 2018)
Natural language processing	3	Exploring teachers' discussion topics in the course (Xie et al., 2021)
Data reduction	3	Constructing a scale on teachers' readiness and perceptions of MOOCs (Arnavut & Bicen, 2018)
Other	4	Using cluster analysis to detect learning strategies and changes in them among MOOC retakers (Fan et al., 2022)

Note. MOOC = massive open online course; ANOVA = analysis of variance.

Topics and Findings

In our second research question, we asked: What are the topics and findings of studies about MOOCs for educators' PD?

In order to discuss the studies' topics and findings, we decided to divide them based on their general methodology and the variables at their center.

A majority of the studies was purely descriptive (62%), that is, they only reported means or percentages of variables without considering the relationship among them. Many of them described a MOOC or a group of MOOCs and their pedagogical model, only providing data to demonstrate the learners' satisfaction and engagement with the MOOC. The most common variable described in these studies was participants' perceptions of and attitudes toward the course (41%). Generally, they reported high levels of satisfaction among participants in MOOCs for educators (e.g., Karlsson et al., 2014; Kennedy & Laurillard, 2019). The participants also described what contributed to their engagement and mentioned factors such as the course pedagogy, prior knowledge, and learning habits; factors that hindered engagement were challenging course content and lack of time (Falkner et al., 2018; Li & Yu, 2019; Shah et al., 2018).

Other common variables were related to course engagement (40%), ranging from binary indicators (e.g., Koukis & Jimoyiannis, 2020) to clicks and views by course unit or over time (e.g., Boltz et al., 2021). Some studies also compared the level of engagement in the target course to the engagement of learners in other

MOOCs in general or MOOCs for educators that were reported in the literature (e.g., Koukis & Jimoyiannis, 2019b; Vivian et al., 2014), suggesting that the engagement in MOOCs for educators is relatively high.

Studies also described participants' self-reported implementation of the course material when teaching (16%), quality and quantity of interaction among participants (16%), topics of posts on the forum (12%), participants' performance (12%), self-reported knowledge (9%), motivation for taking the course (4%), and prior experience with MOOCs (4%). Table 2 presents selected findings related to these variables. These findings generally show that educators taking MOOCs as PDs experience knowledge gains and apply their knowledge when teaching, though not all results were positive (e.g., Zou et al., 2020 reported a completion rate of less than 5%).

Table 2

Selected Findings in Descriptive Studies

Variable	Findings
Implementation	Interviewees described applying skills in their professional context (Kennedy & Laurillard, 2019)
	A high agreement that the learned skills were useful in practice (4/5) and that they saw improvement in students' outcomes (4.35/5; Silvia, 2015)
Interaction among participants	Participants' interactions in the forum were categorized into groups such as elaboration, opinionated elaboration, etc. (Banerjee et al., 2018)
	Teachers helped each other learn about different tools presented in the course (Koutsodimou & Jimoyiannis, 2015)
Forum topics	Teachers' discussed the link between specific subjects they teach and the MOOC topic, digital technologies (Falkner et al., 2017)
	Participants discussed pedagogical issues relevant to their practice and the use of MOOCs as PDs (Koukis & Jimoyiannis, 2017)
Performance	Reported mean scores on each of the MOOCs' units, amounting to about 90% (Huang et al., 2020)
	4.34% of enrollees passed the course (Zou et al., 2020)
Knowledge	Over 50% of the participants felt they gained knowledge about teaching the course material (Burbaitė et al., 2022)
	Increase in self-reported knowledge of digital skills (Vázquez & Montoya, 2015[a])
Motivations	Most teachers enrolled to learn about innovative practices and to find useful resources (Cinganotto & Cuccurullo, 2019)
	Teachers took the MOOC to develop professionally and experience online learning (Wambugu, 2018)
Prior MOOCs experience	Learners in MOOCs for teachers had significantly higher rates of first-time MOOC users than learners in other MOOCs (Castaño-Muñoz et al., 2018)
	76% of participants had not taken a MOOC before (Spradling et al., 2015)

Note. In (a), the authors only use descriptive statistics and do not report whether the increase is significant or substantial

A special group within the descriptive studies did not focus on teachers who took a MOOC but rather on teachers in general (10%). These studies explored variables such as MOOC readiness (e.g., Arnavut & Bicen, 2018) or attitudes towards MOOCs (e.g., Vlachou et al., 2020) among teachers, and found that while most teachers viewed MOOCs positively, they were concerned about barriers such as access to the Internet and maintaining motivation over time (Kennedy & Laurillard, 2019; Yıldırım, 2020).

Next, we turn to discuss studies that went beyond describing their target variables. One such group of studies explored the associations among two or more variables (18%). One tenth of the studies tried to predict performance or course completion. The most common variable associated with course completion was engagement with the course content, for example, watching more videos and taking more assessments (Bonafini, 2017; Fan et al., 2022; Ma et al., 2022; Tang, 2021). Another common variable was interaction with other learners, though there is some disagreement about the role of this variable in predicting course performance. After controlling for engagement with content, Ma et al. (2022) and Bonafini (2017) found that interactions with peers (e.g., number of forum posts) predicted course performance, while Tang (2021) found that they did not. Other studies looked at learner factors that were associated with higher performance such as grit (Davies, 2022) and digital competence (Ramirez-Montoya et al., 2017). Finally, Rutherford-Quach et al. (2021) found that support at the school level, particularly structural support (dedicating time to learning, offering monetary incentives) was associated with better performance in the course.

The rest of the associational studies (6%) compared different groups of learners. Chen et al. (2020) looked at the motivations and engagement patterns of MOOC retakers and one-time takers. They found that retakers were more likely to want to earn a course certificate and had higher scores relative to one-time takers. Li et al. (2021) and Wollscheid et al. (2016) looked at the interactions and performance of learners taking the course alone vs. in groups. They found that working in groups in schools had a better sense of community within the school (Wollscheid et al., 2016) and had higher performance and more interactions with other learners within the MOOC (Li et al., 2021).

The last group of studies focused on MOOCs' impact (16%). Most of these studies compared the levels of a target outcome before and after the course. The studies' most common target outcome was self-reported knowledge (e.g., Taranto et al., 2021), but other outcomes included awareness of and attitudes toward the course's subject (Falkner et al., 2018; Garreta-Domingo et al., 2015). They generally found that the MOOC at their center had the expected impact and improved participants' knowledge of and about the course's topic. Notably, few studies looked at changes in knowledge or learning using objective measures (i.e., exams; Gordillo et al., 2019; Shemy & Al-Habsi, 2021; Xie et al., 2021). In addition, although these studies generally aimed to demonstrate the course's effectiveness, almost none used an appropriate study design: only Luo et al. (2022), Tzovla, Kendraka, Karalis, et al. (2021), and Xie et al. (2021) used a quasi-experimental design, and only Shemy and Al-Habsi (2021) used a true experimental design, finding that a MOOC designed to train teachers to use open educational resources resulted in an increase in the teachers' knowledge and a positive attitude towards the use of open educational resources in schools.

Discussion

In spite of the popularity of studies about MOOCs for teachers in recent years, there are no existing reviews of these studies. This scoping review summarized the literature about MOOCs as PDs with an emphasis on commonly used methods and topics. We found that the existing works mostly focused on a single MOOC, about technology in education, that was created in North America or Europe. Most studies used mixed methods and were descriptive, with few predictive or longitudinal studies. They often measured variables such as teachers' perceptions of the MOOC and their engagement; perhaps as a result, they almost always used surveys as a data source.

When considering commonly identified topics in prior literature reviews on MOOCs and online PDs (impact, design, instructors, and learners), we found that most studies focused on the learners and very few focused on the instructors, as was also reported in prior reviews. The courses' impacts were also of interest in the reviewed studies, although most of their designs could be improved to truly detect course impact. However, many of our studies described course design elements. Since we removed some studies whose focus was course design, it is clear that PD design was a more attractive subject to PD MOOCs researchers in comparison with researchers in similar fields (Alturkistani et al., 2020; Babori et al., 2019; Dede et al., 2009; Despujol et al., 2022).

In terms of methods, many of these studies used mixed methods, a suggestion endorsed in prior reviews as a way to expand on the existing knowledge in the field (Alturkistani et al., 2020). On the other hand, most of the studies used surveys, were conducted in Western countries, and were learner-focused, looking at learners' perceptions and engagement. All of these points resemble the findings of past reviews.

This brings us to some suggestions for future studies based on our findings:

1. Target MOOCs: As online PDs require many resources to develop (Hollands & Tirthali, 2014), it seems unsurprising that most studies about MOOCs as PDs were conducted in the West. This is the case in studies about MOOCs more generally as well. Multiple authors have suggested conducting more studies about MOOCs in other countries to learn how they design MOOCs and what their learners value (van de Oudeweetering & Agirdag, 2018). Although there has been an increase in the number of studies from nations such as China (Meet & Kala, 2021), as seen in this review as well, there is still room for improvement.

   Another interesting point is that many studies focused on courses about technology in education. This is probably the case because PD designers familiar with MOOCs are likely to also be interested in educational technology more generally and more likely to want to teach the topic. While it is certainly positive that the use of technology is being taught to teachers at a large scale, more studies are needed about MOOCs focusing on other topics such as science and social science teaching.

2. Data collection and analysis: Most of the reported studies used traditional data collection methods, namely surveys and interviews. As such, they did not take advantage of the wealth of data available from MOOCs platforms. Even studies that do use automatically collected data mostly use rather simple binary indicators of engagement, making their results almost obvious (e.g., course completion is often

conditioned on completing assignments and watching videos, so the association between these engagement measures and completion is not very surprising).

Existing studies have rarely used the complex data available on what pages or videos learners viewed, when they viewed them, and for how long. This is also a problem in other studies about MOOCs and online PDs (Alturkistani et al., 2020; Dede et al., 2009; Raffaghelli et al., 2015), but the fact that it exists in studies about MOOCs for teachers is somewhat surprising. Education researchers who usually design MOOCs as well as the studies about them are often interested in understanding and improving teaching and learning processes, which are best measured by looking at participants' actions in the course. Therefore, it would seem the use of automatically collected data would be particularly relevant in research on MOOCs for teachers.

Another underused form of data is performance data. While we did identify studies interested in learners' performance, many of them used self-reported knowledge rather than an objective measure. Self-reported knowledge is important in order to understand whether teachers felt the course is helpful, but it is not enough in order to see if teachers' objective knowledge has improved (Raffaghelli et al., 2015; Reich, 2015). Even studies that did use objective performance measures such as the course's assessment rarely report on these assessments' development and validation processes. More use of valid assessments as well as transparency concerning their quality is important for MOOC evaluation.

Related to teachers' performance is the course's impact on practice. While several studies asked teachers whether taking a MOOC affected their practice, no studies measured actual pedagogical changes or effects on students. Self-reported data are limited, measuring only teachers' perspectives rather than true changes. So, to understand whether the course actually had the desired effect, studies should follow teachers in schools via observations or student-level assessments (Dede et al., 2009).

Regarding data analysis, the most popular methods were traditional, mostly descriptive and some inferential statistics. This may be attributed to the use of surveys administered once or twice rather than the more complex data available from MOOC platforms. While traditional statistics are valuable when the research question requires them, researchers in the field should also consider more complex methods that allow for answering other types of research questions. For example, studies using SNA, NLP, or machine learning techniques (Chen et al., 2020; Fan et al., 2022; Kellogg et al., 2014; Xie et al., 2021) can be used to describe learners' interactions with each other or with the course in ways that are impossible using inferential statistics alone (Lu et al., 2021; Moreno-Marcos et al., 2018; Sangrà et al., 2015; Zhu et al., 2018; 2020). Considering alternative data analysis techniques may potentially expand the research topics available to scholars.

3. Study design: Most of the studies we reviewed were purely descriptive, although some of them used descriptive analyses to make claims about the course's effectiveness (e.g., show that the participants were satisfied with it). Describing learners' experiences is important, but there is also room for other types of studies. As an example, to show that a course was successful in causing the desired change, one must measure the learners' status before taking it. Ideally, impact studies should also have a control group. A simple description of learners' status at the end of the course is not enough to show that the course was effective. This is also an issue in studies about other MOOCs and online PDs (Joksimović et

al., 2017; Yousef et al., 2015). For example, Reich (2015) argued that existing MOOC studies are rarely experimental. Even the experimental ones tend to take a simple A/B testing form, checking whether changing a course component (e.g., introducing badges) has an impact on performance or engagement. He suggests going beyond such simple interventions and conducting experiments to check whether specific pedagogical methods have an impact on learning. Alternatively, Alturkistani et al. (2020) suggested using longitudinal designs with several measures throughout the course in order to track participants' learning over time. Again, given how those who create MOOCs for teachers are often interested in course impact, these suggestions seem to be pertinent.

Although the need for experiments is urgent, there is also room for more correlational studies, describing the relationships among variables (Deng et al., 2019; Moreno-Marcos et al., 2018). For example, there is a clear interest in predicting learners' performance in MOOCs for teachers. However, few studies used variables other than engagement to do so. Studies using variables such as pre-course knowledge about the content and about MOOCs, reasons for enrolling, and interactions with other participants in order to predict performance have the potential to contribute to the field. Of course, there is also value in predicting or finding the correlations among other constructs such as engagement, knowledge, or implementation of what was learned.

4. Target variables: Related to the other points above, there are several understudied topics on MOOCs for teachers. We were able to identify only a handful of studies about participants' objective performance, motivations, previous experience with MOOCs, expectations, and barriers and supports at the school level. All of these topics are important; for instance, understanding whether a teacher took the MOOC because they were made to or because they were interested in the course topic might be important in understanding their performance and engagement (Meet & Kala, 2021; Sprague, 2006).

   Of course, many topics were not studied at all in the articles we reviewed. We already mentioned the implementation of the course content in class, student-level impact, and the impact of certain design elements. Other topics were suggested by other authors, for example, engagement in specific parts of the course (Moreno-Marcos et al., 2018), comparisons of subpopulations' engagement, performance, and so forth by culture or teaching subject (Reich, 2015; Zhu et al., 2018), MOOCs-specific instruments and assessments (Deng et al., 2019), learners' support in the course (Bozkurt et al., 2017; Bragg et al., 2021), MOOCs designers and instructors (Dillie & Røkenes, 2021; Meet & Kala, 2021; Veletsianos & Shepherdson, 2016), MOOCs in comparison with blended courses (Sprague, 2006), business models of MOOCs for teachers (Kennedy, 2014), and social issues such as equity in access to the courses (Bozkurt et al., 2017; Despujol et al., 2022).

In spite of the potential contribution of our findings to the literature, this study has several limitations. First, in terms of inclusion criteria, we only reviewed English-language studies published in conference proceedings or journals. As a result, we might have missed relevant studies published in other languages or venues. Second, as we focused solely on MOOCs for in-service K–12 teachers, we did not survey studies about related topics that might be of interest to the reader such as blended courses or pre-service training. Future studies could expand the scope of this research by including other types of MOOCs for teachers. Finally, as we conducted a scoping review, we did not evaluate the studies' quality. Although all of the studies were published in peer-reviewed venues, some of them may not meet some formal quality standards

(e.g., a detailed description of the measures used in the study; see the PRISMA guidelines, Page et al., 2021). Therefore, they could be less valuable than the rest of the studies. Future reviews should explore the studies' quality or focus on high-quality studies only.

Conclusion

This study provides a scoping review of the literature on MOOCs for teachers' PD. Based on our findings, we suggested that future research diversify studies' (a) target MOOCs, (b) data collection and analysis methods, (c) study designs, and (d) target variables. These suggestions will help enrich future studies about MOOCs for teachers. In addition, this review might inform research about MOOCs or PDs in general, as some of our findings and suggestions may apply to other fields, as well. We hope our review will help improve and expand our knowledge of how to better educate teachers, thus contributing to education as a whole.

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Appendix

Studies Included in the Review

Authors	Course topic	Purpose	Type	Data sources
Arnavut & Bicen (2018)	Unspecified	Develop a MOOC readiness scale	QN	Survey
Bakogianni et al. (2020)	Unspecified	Measure MOOC readiness and perceptions of MOOCs among teachers	QN	Survey
Banerjee et al. (2018)	Pedagogy (technology)	Measure course effectiveness in enhancing learners' interactions	MM	Survey, forum
Boltz et al. (2021)	Pedagogy	Describe engagement and learners' challenges	MM	Survey
Bonafini (2017)	Math	Identify demographic engagement variables that predict course completion	QN	Course data
Bonafini (2018)	Math	Describe the learners who posted the most on the course's forum	MM	Course data, survey, forum
Brennan et al. (2018)	Computer science	Describe what teachers value in the course	QL	Interview
Burbaitė et al. (2022)	STEM	Describe teachers' perceptions of the course and what they learned	QN	Survey
Castaño-Muñoz et al. (2018)	Pedagogy (technology)	Describe Spanish teachers taking MOOC in comparison with non-MOOC taking teachers and non-teachers MOOC participants from Spain	QN	Survey
Chavez (2020)	Language	Describe participants' attitudes towards the course	MM	Survey, interview
Chen et al. (2020)	Pedagogy	Compare the motivation and engagement of one-time and multiple-times takers of a MOOC	MM	Survey, course data, interview
Cinganotto & Cuccurullo (2019)	Pedagogy	Describe participants' engagement, motivation, and interactions	MM	Survey, course data, forum, social media posts
Davies (2022)	Computer science	Predict course completion based on participants' grit, motivation, and intentions	QN	Survey

Falkner et al. (2018)	Computer science	Describe MOOC participants' engagement and perceived challenges	MM	Survey, course data, forum
Falkner et al. (2017)	Computer science	Describe MOOC participants' engagement	MM	Survey, course data, forum
Fan et al. (2022)	Pedagogy	Compare the learning strategies in the first and following MOOC attempts and their effect on performance	QN	Course data
Garreta-Domingo et al. (2015)	Pedagogy (technology)	Describe teachers' experiences over time	QN	Survey
Gonçalves & Osório (2018)	Pedagogy (technology)	Describe the course's impact on teachers' knowledge	MM	Survey, interview, observations
Gordillo et al. (2019)	Pedagogy (technology)	Describe the course's impact on teachers' knowledge	QN	Survey, artefacts
Griffiths et al. (2022)	Physical education	Describe teachers' experiences in the course	MM	Survey, interview
Herranen et al. (2021)	STEM	Describe teachers' perceptions of the course	QN	Survey
Hilali & Moubtassime (2021)	Unspecified	Describe teachers' MOOC readiness, use, and attitudes	QN	Survey
Hollebrands & Lee (2020)	Math	Describe teachers' experiences and attitudes towards the course	MM	Survey, course data, forum
Huang et al. (2020)	Pedagogy (technology)	Describe learners' engagement and performance	QN	Course data, forum
Johnston (2016)	Math	Describe MOOC enrollment after an intervention	QN	Course data
Karlsson et al. (2014)	Pedagogy (technology)	Describe participants' attitudes and interactions	MM	Survey, social media posts
Kellogg et al. (2014)	Pedagogy (technology)	Describe participants' interactions	MM	Survey, forum
Kennedy & Laurillard (2019)	Pedagogy (technology)	Describe learners' engagement and attitudes towards the course, describe teachers' perceptions of MOOCs potential	MM	Survey, course data, forum, interviews
Koukis & Jimoyiannis (2017)	Language	Describe learners' engagement and attitudes	MM	Survey, course data, forum, interviews

Koukis & Jimoyiannis (2018)	Language	Describe learners' engagement and attitudes	MM	Survey, course data
Koukis & Jimoyiannis (2019a)	Language	Describe learners' engagement and attitudes	MM	Survey, forum
Koukis & Jimoyiannis (2019b)	Language	Describe learners' engagement and attitudes	MM	Survey, forum
Koukis & Jimoyiannis (2020)	Language	Describe learners' engagement and attitudes	MM	Survey, course data, forum
Koutsodimou & Jimoyiannis (2015)	Language	Describe learners' engagement and attitudes	QN	Survey, course data, forum
Laurillard (2016)	Pedagogy (technology)	Describe learners' engagement and attitudes	MM	Survey, course data
Laurillard et al. (2018)	Pedagogy (technology)	Describe a tool and its use within a MOOC	MM	Survey, forum
Li & Yu (2019)	Pedagogy (technology)	Describe course engagement and teachers' perceptions of what affects use	MM	Survey, course data, forum
Li et al. (2021)	Unspecified	Compare the performance and interactions of individual learners vs. learners in groups	MM	Course data, forum
Luo et al. (2022)	Pedagogy (technology)	Test the effectiveness of an intervention on learners' engagement and interactions	MM	Course data, forum
Ma et al. (2022)	Pedagogy (technology)	Predict course performance based on interactions with content and peers and learners' traits	QN	Survey, course data
Ostashewski et al. (2018)	Pedagogy (technology)	Describe participants' perceptions of MOOC-related benefits and challenges	QL	Response to prompt
Panero et al. (2017)	Math	Describe participants' attitudes towards the course's evaluation criteria	QL	Survey, learner-provided texts
Rahimi et al. (2018)	Computer science	Describe changes in knowledge and attitudes over time	MM	Survey
Ramírez-Montoya (2017)	Pedagogy (technology)	Predict teachers' knowledge and its application from teachers' traits, teachers' perceptions of course-	MM	Survey, course data, observation

		related opportunities and challenges		
Rivera Vázquez & Ramirez Montoya (2015)	Pedagogy (technology)	Describe changes in knowledge and attitudes towards the course	MM	Survey, interview
Rutherford-Quach et al. (2021)	Language	Test the effects of school-level supports on course completion and knowledge	MM	Survey, course data, interview
Salmon et al. (2015)	Pedagogy	Describe participants attitudes towards the course	MM	Survey
Shah et al. (2018)	Pedagogy (technology)	Describe participants attitudes towards the course and factors that made the engage	MM	Survey
Shangying & Jing (2017)	Pedagogy	Describe engagement patterns	QN	Course data
Shemy & Al-Habsi (2021)	Unspecified	Test the MOOCs' impact on knowledge and learners' attitudes	QN	Survey, achievement test
Silvia (2015)	Pedagogy	Describe participants attitudes towards the course	QN	Survey
Spradling et al. (2015)	Computer science	Describe learners' motivation, engagement, and attitudes	QN	Survey, course data
Tang (2021)	Pedagogy (technology)	Predict completion from learners' interactions with the content, the instructor, and other learners	MM	Course data, interview
Taranto & Arzarello (2020)	Math	Describe participants attitudes towards the course	MM	Survey, forum
Taranto et al. (2017)	Math	Describe the forum content	MM	Forum, learner-provided texts
Taranto et al. (2021)	Math	Describe changes in knowledge and participants' attitudes towards the course	MM	Survey, forum
Tzovla, Kendraka, & Kaltsidis (2021)	STEM	Describe participants attitudes towards the course	MM	Survey
Tzovla, Kendraka,	STEM	Track changes in learners' self-efficacy throughout the course	QN	Survey

Karalis et al. (2021)				
Vivian et al. (2014)	Computer science	Describe learners' engagement and attitudes towards the course	MM	Survey, course data, social media posts
Vlachou et al. (2020)		Describe teachers' use and attitudes towards MOOCs	QN	Survey
Wambugu (2018)	Pedagogy (technology)	Describe participants attitudes towards the course	MM	Survey, focus group
Wollscheid et al. (2016)	Math	Compare participants' interactions by the course's format	MM	Interviews
Xiao et al. (2020)	Pedagogy (technology)	Predict course achievement and satisfaction from variables related to technology acceptance	QN	Survey
Xie et al. (2021)	Pedagogy	Test course impact on performance and engagement	QN	Course data, forum
Yıldırım (2020)	STEM	Describe attitudes towards MOOC	QL	Interview
Yoon et al. (2020)	STEM	Describe attitudes towards MOOC and forum interactions	MM	Survey, forum, interview
Yurkofsky et al. (2019)	Computer science	Describe what teachers view as valuable in the course	QL	Interview
Zou et al. (2020)	Pedagogy (technology)	Describe engagement and content of the forum	QL	Course data, forum

Note: Course data refers to any data automatically collected by the platform such as engagement and performance. QN = quantitative; QL = qualitative; MM = mixed methods.

[i] Joshua Littenberg-Tobias was affiliated with the Teaching Systems Lab in the Massachusetts Institute of Technology while doing some of the work on this project.

[ii] Note that throughout the paper, we sometimes use the abbreviation "PDs," meaning "professional development courses," as opposed to using the general term "professional development."

[iii] The percentages throughout the paper are out of the full sample of 68 studies. The percentages may not sum up to 100 because of rounding.