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Can online learning communities achieve the goals of traditional professional learning communities? What the literature says

Cynthia L. Blitz
Center for Effective School Practices
Rutgers University

Key findings

Studies find that online communities of educators can achieve the goals of professional learning communities (PLCs), but the research is methodologically limited—and too fragmented to offer clear prescriptions. The literature reflects current thinking and practice mainly for traditional PLCs, with discussions of online PLCs generally focused on how to move traditional PLC activities online. The aim is to expand opportunities for teachers to reflect and collaborate without the usual limitations of time, space, and pace.

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Summary

Professional learning communities (PLCs)—teams of educators who get together regularly to exchange ideas—have sprung up to meet school districts' growing interest in promoting professional development that engages teachers and administrators. PLCs meet to develop lesson plans, monitor student progress, assess instructional effectiveness, and identify professional learning needs. The ultimate goal is to raise student achievement by adapting teaching and classroom practices based on learning and interchanges during PLC meetings.

The Internet and mobile communication technologies have greatly expanded opportunities for teams of educators to reflect and collaborate with each other and experts outside their schools—and even outside their districts—for learning, joint lesson planning, and problem solving. These electronic platforms provide ready access to knowledge and resources without the usual limitations of time, space, and pace. Hybrid PLCs combine online interactions with the face-to-face interactions of traditional PLCs.

This review of the literature on online PLCs responds to a request from district and school administrators in the Regional Educational Laboratory Mid-Atlantic Region for information on using online PLCs to engage their teachers in professional development. The review looked at advantages, challenges, and emerging best practices.

What are the advantages and challenges of online and hybrid professional learning communities?

Overall, the evidence indicates that online communities of teachers can achieve the goals of PLCs. The literature finds that teachers who collaborate online are engaged with the group, develop a sense of community, improve their knowledge of subject and pedagogical content, and intend to modify their instructional practices accordingly. Flexibility is presented as the strongest advantage of online PLCs over the traditional face-to-face environment in facilitating teachers' learning. The online environment enables teachers to access and share knowledge in a timely and comprehensive manner. The online environment is also consistently found to be better at promoting self-reflection on learning and instructional practices than is the face-to-face environment, even though both models appear to contribute equally to learning and mastering subject content.

The online environment is not without challenges, however. Studies indicate that teachers' motivation to engage their peers and contribute regularly to the group was lower online than face-to-face, perhaps because of the greater isolation of teachers who collaborate in a completely online environment.

What are some emerging best practices in the design and implementation of online and hybrid professional learning communities?

Best practices recommended in the recent literature for promoting interaction in PLCs of all kinds include structuring collaboration; allowing participants to shape the goals, structure, and assessment of the collaboration; pairing experts with less experienced learners; and designing activities that promote self-reflection. In general, the literature on planning PLCs sees the key decision as determining how much freedom to allow participants in structuring and directing the group's collaboration. Regardless of how PLCs are organized,

online collaboration appears most productive when membership is diverse (in roles, areas, and levels of expertise), the group has an effective moderator, and group members have opportunities to socialize in person (as in hybrid PLCs). Creating opportunities for members to socialize is important for identification and community building, and the literature suggests that hybrid PLCs may be better suited for fostering community.

Implications and future directions

The literature on online and hybrid PLCs is methodologically limited—and too fragmented to offer clear prescriptions for designing and implementing them. Most of the research reflects current thinking and practice for traditional PLCs. Discussions of online PLCs generally focus on how to move traditional PLC activities and functions online to take advantage of the greater flexibility. The research makes the case for hybrid PLCs, which blend the online and face-to-face environments. As theory and research evolve, more consideration should be given to how the key characteristics of the online environment can transform traditional PLCs.

Contents

Why this study?

For more than a decade practitioners have promoted professional learning communities (PLCs) as an effective structure for providing teachers with professional development (Chappuis, Chappuis, & Stiggins, 2009; DuFour, Eaker, & DuFour, 2005). These collaborative networks are believed to be effective because they expose teachers to new ideas and practices and improve teaching by promoting critical reflection (Hord, 1997; Wood, 2007). Underpinning this argument is the theory of situated learning in communities of practice (Lave & Wenger, 1991), which contends that teachers who learn within a self-directed and problem-centered community of learners are more likely to find value in their learning and to apply it in their classrooms (see appendix A). When teachers disseminate this knowledge to other teachers and invite feedback, their school becomes more learning-oriented and results-focused. Ultimately, the expectation is that by cultivating PLCs, schools can improve student achievement by making teaching and classroom practices more effective.

For more than a decade practitioners have promoted professional learning communities as an effective structure for providing teachers with professional development

PLCs have proliferated as school districts have tried to promote professional development that engages teachers and administrators (Hargreaves, 2007; Talbert, 2010). One indicator of this interest is the many practitioner-oriented texts offering guidance to district and school leaders. Most texts are by practitioners (for example, DuFour, DuFour, Eaker, & Many, 2010); a smaller number are by university researchers (McLaughlin & Talbert, 2001). Despite the proliferation of PLCs, there have been few rigorous evaluations of their contribution to effective instructional practices, which is still being debated (Vescio, Ross, & Adams, 2008). Nonetheless, school administrators and policymakers strongly support expanding PLCs (see Talbert, 2010).

One way to facilitate PLCs is to move them online or partially online (Beach, 2012). Online PLCs are loosely defined as teams of educators who use digital and mobile communication technologies, at least part of the time, to communicate and collaborate on learning, joint lesson planning, and problem solving. Partially online (hybrid) PLCs combine online and face-to-face interactions. The Internet and mobile technologies provide teachers with opportunities to reflect and collaborate with each other and with experts outside their schools and to access information and other resources with few limitations of time, space, or pace. Collaboration is what distinguishes online PLCs from online professional development and learning more generally, such as online courses, webinars, or online training. The U.S. Department of Education (2010b) supports online PLCs in its National Education Technology Plan, and *Connect and Inspire: Online Communities of Practice in Education* makes the case for broadening educators' participation in online PLCs (U.S. Department of Education, 2010a).

This review of the scientific literature on online PLCs responds to a request from district and school administrators in the Regional Educational Laboratory Mid-Atlantic Region to learn more about the potential of online PLCs to engage teachers in professional development inside and outside school and their routine school day. It is confined to peer-reviewed journal articles and government-sponsored research studies published during 2000–12 as they relate to two questions:

- What are the advantages and challenges of online and hybrid models of PLCs compared with traditional (exclusively face-to-face) PLCs?
- What, if any, are some emerging best practices in designing and organizing online and hybrid PLCs?

Before examining these two questions, the report describes common characteristics of PLCs and the logic model used in the analysis. Appendix A provides context for the discussion of online and hybrid PLCs by reviewing the literature on traditional, face-to-face PLCs. Appendix B details the study methodology.

Characteristics of the online professional learning communities described in the literature

The literature review yielded 74 relevant peer-reviewed journal articles published over 2000–12 (see appendix B; the source articles are identified with asterisks in the reference list). Of the 74 articles, 39 were empirical studies of aspects of online PLCs, 6 were reviews, and 29 offered conceptual or theoretical discussions based on the available evidence (table 1). Much of the empirical work on online PLCs centers on the fully online model.

Much of the empirical work on online professional learning communities centers on the fully online model; interest in the hybrid model is more recent

Table 1. Selected characteristics of online professional learning community articles reviewed

Topic and number of articles	Description	Number of articles
Article type (All articles, N = 74)	Theoretical/review	35
	Empirical	
	· Quantitative	14
	· Qualitative	16
	· Mixed methods	9
Online model referenced (Empirical articles only, *n* = 39)	Completely online	27
	Hybrid	9
	Not specified	3
Scope of collaboration (Empirical articles only, *n* = 39)	K–12	
	· Single school	3
	· Multiple schools	25
	· Regional/national collaboration	9
	· Higher education	2
Subject area of online professional learning community (PLC) (Empirical articles only, *n* = 39)	Math or science	17
	Language arts	3
	Social studies	1
	Not specified	18
Participants in online PLC (Empirical articles only, *n* = 39)	Teachers only	24
	Teachers and administrators/staff	2
	Not specified	13
Length of collaboration (Empirical articles only, *n* = 39)	Less than 6 months	15
	6 months to 1 year	3
	More than 1 year	2
	Not specified	19
Size of online PLC group (Empirical articles only, *n* = 39)	Less than 10	6
	10–20	10
	More than 20	17
	Not specified	6
Collaboration outcomes (Empirical articles only, *n* = 39)	Teacher outcomes	26
	Student outcomes	0
	Teacher and student outcomes	0
	School outcomes	0
	No outcomes reported	13

Note: A single article may fit multiple criteria, so the numbers in each category do not sum to the total for that category or to the overall total.

Source: Author's analysis based on articles identified in the literature review; see appendix A and the reference list.

Interest in the hybrid model is more recent (since 2006), deriving in part from increased interest in students' online learning (Brooks, 2010).

Features of online professional learning communities

Nearly two-thirds of the empirical reports on online PLCs involve K–12 institutions and typically describe PLCs that bring together teachers from multiple schools or districts. There has also been interest in studying regional and national online PLCs, particularly in Australia and the United Kingdom, which have vast geographically dispersed and rural areas. Online PLCs within individual schools have received much less attention. The preference for studying online PLCs involving larger jurisdictions is consistent with the interest many of the articles express in the potential of online technology to scale-up traditional PLCs (for example, Anderson & Herr, 2011; Beach, 2012; Broadley, 2010; Cady & Rearden, 2009; Chalmers & Keown, 2006; Chesbro & Boxler, 2010; Duncan-Howell, 2010; Hartnell-Young, 2009; Mackey & Evans, 2011; Reading, 2010; Taylor, 2008). The typical online PLC examined had more than 10 participants.[1]

Each source was reviewed for information on why and how online professional learning communities resemble or differ from traditional face-to-face ones

Many of the empirical studies examined online PLCs of math and science teachers, and most of the case studies included only teachers as participants. Most of the online PLCs were less than a year old. Members were convened to achieve a specific, time-bound goal and then dispersed once the task was completed. Where studies considered the outcomes of participation in online PLCs, they looked only at teacher outcomes (teachers' self-reports on satisfaction with the online PLC, perceived impact of participation on their learning, and likely impact on their students) rather than at student or school outcomes.

The professional learning community logic model

Notably missing from current work on online PLCs are logic models that can bridge the gap between the abstract theorizing that is characteristic of current work on online PLCs and the clear operationalization of their inputs, outputs, and outcomes. The absence of logic models impedes not only the translation of ideas and goals into practice but also the ability of researchers and practitioners to rigorously evaluate online PLCs and their impacts on teachers' development and students' learning and achievement.

Because the literature is so fragmented and because the theoretical and practical approach to developing and implementing online PLCs draws heavily on the studies of traditional PLCs (see appendix A), this study organizes and evaluates the insights from the online PLC literature using a logic model that describes how traditional PLCs are expected to influence participating teachers and their schools and students (box 1). Accordingly, this literature review sought evidence applying directly or indirectly to specific components of the general PLC logic model. Each source was reviewed for information on why and how online PLCs resemble or differ from traditional face-to-face ones, as well as for insights on factors and practices that can be modified to help online PLCs work as intended. The logic model is meant as a starting point for discussion among stakeholders interested in creating PLCs in their districts or schools, not as a definitive how-to guide.

Box 1. Logic model for professional learning communities

The logic model created for this study describes how professional learning communities (PLCs) are expected to positively affect participating teachers and their schools and students (see table). It shows how elements of PLCs commonly discussed in the literature (as evident in the six reviews of PLCs examined for this study; see box B1 in appendix B) might be linked to outcomes. The model bridges the abstract theorizing characteristic of the work on online PLCs and the clear operationalization of inputs, outputs, and outcomes of all PLCs—traditional, hybrid, and online.

Inputs are the resources typically invested in PLCs: members' time, content knowledge, teaching experience, expertise, and other contributions (Darling-Hammond, Wei, Andee, Richardson, & Orphanos, 2009; Feger & Arruda, 2008; Hord, 1997; Lomos, Hofman, & Bosker, 2011; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006; Vescio et al., 2008). Other inputs discussed in the literature include training PLC members in working in teams and on technology (for online or hybrid PLCs), preparing PLC protocols (specific charges to the team), and scheduling time and space to meet. Online and hybrid PLCs need additional inputs, such as access to online collaboration tools and technical support. PLCs may also benefit from having a specialized staff member (a coach or a lead teacher), and members may be offered incentives to participate. Less commonly, the literature discusses sources of funding and the benefits of partnerships and networks of educators.

Outputs are the typical activities of PLC members as they collaborate to evaluate and refine the curriculum, instruction, and classroom assessments in a subject area. In general, the literature has reported on small groups of teachers who meet (face-to-face or online) for at least one hour a week to discuss ways to improve instruction and student learning. Teachers typically use this forum to develop lesson plans, examine student work, monitor student progress, assess the effectiveness of instruction, and identify professional learning needs. The tangible products of this collaboration include essential learning targets, lesson plans, and common assessments that teachers can implement and evaluate using comparative assessment data. While PLC teams typically include subject-area teachers, and sometimes a coach or school administrators, the composition of teams (within-grade, across grades, or across schools) may vary with the team's charge. For example, single-grade teams might focus on aligning learning targets, the curriculum, and assessments within a specific grade level; multigrade teams might focus on aligning the curriculum and ensuring coherent learning pathways across grades; and multischool teams might share ideas on curricula and assessments (Darling-Hammond et al., 2009; Feger & Arruda, 2008; Hord, 1997; Lomos et al., 2011; Stoll et al., 2006; Vescio et al., 2008).

Outcomes are divided into short-, medium-, and long-term effects for teachers, the PLC team, and students. There are also potential long-term outcomes for schools and districts. For teachers, short-term outcomes include changes in knowledge and cognition (beliefs, attitudes, focus); medium-term outcomes reflect changes in teachers' behavior (for example, using novel or revised instructional practices); and long-term outcomes reflect the typical professional development goals of PLCs, such as increased job satisfaction and commitment to the school's education mission.

Outcomes for PLC teams reflect the common notion in the literature that PLCs progress through phases, from "starter" learning communities (short-term outcomes) to "developing" (medium-term outcomes) and finally to "mature" (long-term outcomes; Darling-Hammond et al., 2009; Feger & Arruda, 2008; Hord, 1997; Lomos et al., 2011; Stoll et al., 2006; Vescio et al., 2008). During the early stages PLCs often organize internally, defining roles and

(continued)

Box 1. Logic model for professional learning communities *(continued)*

responsibilities, articulating goals, and moving toward collaborative knowledge-sharing and data-driven decisions. This process may be guided by formal PLC protocols produced by the school or district that outline tasks, tools, activities, and other charges to the team (DuFour et al., 2010). As teams mature, they turn to issues related to learning results and best practices for effective PLCs, such as shared values and visions of learning, shared norms, and shared (or distributed) leadership. They shift from sharing and exchanging knowledge and ideas to critically examining practices and assuming mutual accountability for student growth and success. There is an expectation that PLCs will transform the school culture from a focus on instruction to a focus on learning (DuFour, 2004). The intended long-term outcome is sustainability as a community of learners focused on critical inquiry and action.

Finally, favorable outcomes for students are expected as a result of these changes in teachers and schools. As teachers collaborate to improve instruction, use assessment data, and employ more differentiated instruction and targeted interventions for low-performing students, students are expected to respond with greater engagement and improved performance on statewide, school, and classroom assessments.

(continued)

Box 1. Logic model for professional learning communities *(continued)*

Logic model for professional learning communities

	Outputs		Outcomes/impact		
Inputs/investments	**Activities/products**	**Participation**	**Short-term**	**Medium-term**	**Long-term**
Staff time and expertise Support services • Teamwork-related training (working collaboratively, managing conflict) • Training and technology troubleshooting for online collaboration tools (for online and hybrid models) • PLC protocols or guides • Incentives for participation • Logistics (meeting time and place; for online and hybrid models, online collaboration tools, tech support, and laptops) • Facilitation by coaches or lead teachers • Pairing of expert learners with less experienced learners Funding • School professional development funding • District professional development funding • External sources of funding (grants, awards) Partnerships and networks • Other schools and districts • Government offices • Parents and community • Higher education institutions	Meet (face-to-face or online) at least an hour a week in small groups to work collaboratively on improving instruction and student learning: • Discuss and shape goals, structure, and assessment of collaboration • Design activities that promote self-reflection • Discuss and delineate challenges (ideally, based on assessment data) • Set learning goals and objectives aligned with national or state standards • Compare and share instructional strategies and identify effective approaches for meeting challenges • Revise or create common formative assessment instruments and protocols • Implement selected approaches • Collaboratively analyze assessment data for each learning target and identify nonproficient students; develop and implement differentiated instruction modules to assist nonproficient students and extend and enrich learning for proficient students • Continually revise plan and curriculum	• Content-area teachers • School administrators • Other school staff (instructional coaches) Organizational models • Single-grade teams (aligning learning targets, curriculum, and assessments within a single grade) • Multigrade teams (aligning curriculum and ensuring coherent learning pathways across grades) • Multischool teams	Teacher outcomes • Greater focus on collaboration and openness to feedback • Greater focus on results (rather than instruction) • Enhanced knowledge of subject content • Enhanced skills in examining and analyzing data • Enhanced efficacy to teach effectively in content area • Positive attitude toward improving student learning outcomes Team outcomes • Defined roles and responsibilities • Defined goals and objectives of collaboration • Effective communication channels • Collaborative knowledge sharing • Collaborative data analysis and interpretation	Teacher outcomes • Mastery of subject content • Adoption of effective instructional practices, including increased use of differentiated instruction • Self-reflection and critical evaluation of the effectiveness of instructional practices • Personal commitment to collaborative learning Team outcomes • Shared values and vision emphasizing learning and research-based standards • Shared norms of collaboration • Mutual trust • Shared (distributed) leadership • Shift from sharing and exchanging knowledge and ideas to critically examining practice • Mutual accountability for student growth and success	Teacher outcomes • Professional growth, including increased ability to lead and respond to learning challenges • Increased job satisfaction • Stronger commitment to school's mission and goals Team outcomes • Institutionalization (integration of PLCs into teachers' daily work routine) • Knowledge dissemination School/district outcomes • Improve results for all students through collective, consistent, and context-specific professional learning • Culture of collaboration • Continued critical reflection on goals and practices Student outcomes • Highly engaged learning • Continued improvement on statewide, school, and classroom assessments

External factors found to facilitate or hinder successful PLCs
- Presence or absence of supportive school/district leadership and community support
- Structural/logistical support (blocked time and space to meet regularly, availability and access to comparative assessment data, dedicated staff support)
- Degree of agreement or conflict with current school norms or teacher resistance

Source: Author's analysis based on a review of the literature on traditional PLCs; see appendix A.

Comparing the advantages and challenges of online and hybrid professional learning communities with those of traditional professional learning communities

The literature on online and hybrid PLCs reflects much of the current thinking and practice concerning traditional PLCs. The general thrust seems to be finding ways to transfer the activities and functions of traditional PLCs online to take advantage of the greater flexibility. As theory and research on this topic evolve, more attention may turn to how the characteristics of the online environment can transform PLCs. For now, the literature suggests that the built-in flexibility of the online environment is its greatest advantage in facilitating teachers' learning of subject and pedagogical content. The online environment frees teachers to collaborate without the typical time, space, and pace constraints of traditional PLCs and lets teachers access and share knowledge rapidly and comprehensively. However, there is no compelling evidence that the online environment improves collaboration among teachers. In fact, the evidence suggests that the online environment decreases teachers' motivation to collaborate with colleagues while promoting teachers' self-reflection on learning and instructional practices.

The online environment frees teachers of the typical time, space, and pace constraints of traditional professional learning communities, but there is no compelling evidence that the online environment improves collaboration

The evidence, though not strong, supports many of the claims made for online professional learning communities

Advantages commonly asserted for online PLCs over traditional PLCs are that online PLCs:

- Provide more time and space for teachers to learn and collaborate (Reading, 2010; Tsai, Laffey, & Hanuscin, 2010).
- Lower the cost and time demands that traditional professional development activities place on busy teachers (Beach, 2012; Cirillo & Shay, 2007; Duncan-Howell, 2010; Hodes, Foster, Pritz, & Kelley, 2011).
- Create opportunities to better satisfy personal learning interests and goals, because participants have more freedom than in a face-to-face group meeting to connect closely with members who share the same interests without disturbing the group dynamics (Chalmers & Keown, 2006; Curwood, 2011; Fasso, 2010; Forsyth & Schaverien, 2005).
- Can serve a broad range of education improvement goals (content-, skill-, or student-focused), which can be pursued individually or together (Lieberman & Mace, 2010).
- Provide opportunities to scale educators' interactions broadly and efficiently, because online PLCs place no limits on group size and afford busy educators the flexibility to participate and contribute meaningfully to the group when they can (Lieberman & Mace, 2010; Sorensen, Takle, & Moser, 2006).
- Enable comprehensive and timely access to valuable internal resources, such as archival data, and to resources not available locally, such as expert knowledge (Nistor, Baltes, & Schustek, 2012; Pijanowski, 2010).
- Can provide daily guidance for teachers in applying novel curricula or pedagogies (Vavasseur & MacGregor, 2008).
- Can provide professional mentoring for entry-level teachers (Dorner & Karpati, 2010).
- Enable PLC designers to collect rich, real-time assessment data on participants' engagement and learning, including longitudinal data (Schlager, Farooq, Fusco, Schank, & Dwyer, 2009).

Although these claims appear plausible, they are based on agreement among some scholars about the *potential* of online technology to promote effective professional development for teachers, not on direct, unequivocal evidence. Absent rigorous evaluations this survey of the evidence on the performance of online and hybrid PLCs follows the rationale of the general PLC logic model developed for this review (see box 1).

The logic model indicates that effective PLCs will have a positive impact on participating teachers, contribute to productive team collaboration, and improve student achievement through collaboration and teachers' professional development. As noted, however, the literature is mute on the impact of online PLCs on student achievement and largely silent on the impact of collaborative teamwork.

In fact, much of the literature merely describes the experiences of teachers in online PLCs, usually based on teachers' self-reports. Thus, the performance of online and hybrid PLCs could be compared with that of traditional PLCs only for teacher outcomes. This was done by examining the evidence on teachers' motivation and cognition (attitudes, beliefs, and perceptions) concerning learning, collaboration, and commitment to improving student learning outcomes; teachers' knowledge of subject content; and teachers' instructional practices. Only a handful of studies compared online and traditional teachers' collaborative learning on any of these outcomes. Although none of the studies constituted an authoritative investigation of this difference, in the aggregate they offer a valuable (and remarkably consistent) insight into the similarities and differences of online and traditional PLCs.

Although claims for the advantages of online professional learning communities appear plausible, they are based on agreement among some scholars about the potential of online technology, not on direct, unequivocal evidence

One study explored the online and offline versions of the *TryScience* course for science teachers, which had a built-in collaboration module (Harlen & Doubler, 2004). Participants in both groups first completed their science investigations at home and then reported their results in the group forums, read each other's reports, considered the ideas and findings of their colleagues, and negotiated collective explanations. Participants were assessed before and after the completion of the course according to the time invested in collaborative work, understanding of the science content, and confidence in teaching science. Collaboration was assessed by analyzing participant messages posted in the online course and through direct observation and video recording of interactions in the face-to-face module.

Online participants invested two more hours a week on course-related learning activities, and their understanding of the science content (measured by a pre-post thought experiment) and confidence in their ability to teach science through inquiry increased statistically significantly more than did that of the offline participants. The researchers concluded that online participants were more reflective about their learning and about the inquiry process (a target goal of PLCs) than their offline counterparts were, despite finding no statistically significant difference between the groups in participants' perceived benefit from engaging with their working groups.

Another study used data collection tools, including a teacher survey, classroom observations, teacher interviews, and analyses of web server log files, to examine whether a hybrid PLC improved teachers' capacity for developing problem-based learning curricula (Hawkes & Good, 2000). Overall, teachers rated the face-to-face discourse more favorably for interactivity but considered the online discourse to be considerably more reflective. Teachers recognized the convenience and potential of online technology for communication, yet

most believed that online exchanges could not replace in-person communication entirely. A follow-up study explored the professional development experience of 28 teachers in 10 suburban Chicago schools in a two-year program of technology-supported, problem-based learning curriculum development (Hawkes & Romiszowski, 2001). The online discourse produced using asynchronous computer-mediated tools, such as forums, emails, and blogs (rather than synchronous communications, such as live chat or web-based conferencing) was compared with the discourse produced by teachers in face-to-face meetings. Discourse analysis and archival data analysis found that although the online dialogue was less interactive, it was statistically significantly more reflective than the face-to-face discourse.

An examination of the impact of two one-year hybrid PLCs found that they positively affected teacher attitudes and content knowledge in math and science/technology and motivated many teachers to transform their classroom practices (Sinclair & Owston, 2006). At the same time the study noted a lack of cohesion in online groups and a dropoff in participation as the frequency of face-to-face interaction decreased. Teachers reported greater satisfaction in the face-to-face component of the collaboration.

Overall, there is good (but not strong) evidence that online communities of teachers can achieve the professional development goals of professional learning communities

Finally, an evaluation of an online professional development program for math teachers in a rural school district found that the program improved teachers' knowledge of pedagogy but not their knowledge of math content (Cady & Rearden, 2009). The study attributed this outcome to the design of the collaborative activities, which fostered a community of practice among the teachers.

Overall, then, there is good (but not strong) evidence that online communities of teachers can achieve the professional development goals of PLCs. The literature demonstrates that teachers who collaborate online tend to be engaged with the group, develop a sense of community, strengthen their content knowledge of pedagogy and subject area, and expect to modify their instructional practices to match what they learned. Flexibility appears to be the online environment's greatest advantage over the traditional face-to-face environment in facilitating teacher learning of pedagogical and subject area content. The online environment frees teachers to collaborate without the usual time, space, and pace constraints and enables them to access and share knowledge comprehensively and as they need it. This environment was consistently found to promote teachers' self-reflection about learning and instructional practices much more than the face-to-face environment did, even though both environments appeared to contribute equally to learning and mastering subject content. The reflective properties of asynchronous, text-based online learning appear to be well-adapted to deep learning (Garrison & Cleveland-Innes, 2005).

The online environment presents important challenges as well

Across the studies reviewed there were multiple indications that teachers' motivation to engage with their peers and contribute regularly to the group was lower online than face to face. This may be explained by the greater isolation of teachers who collaborate in a completely online environment (Sinclair & Owston, 2006), in much the same way that teachers in rural areas experience professional isolation (Hawkes & Good, 2000). The collaborative learning intended to take place in PLCs appears to be facilitated by face-to-face interactions, which enable teachers to better relate to one another (Berger, Eylon, & Bagno, 2008). This seems to support the case for hybrid PLCs, which blend the two environments. A recent review of experimental and quasi-experimental studies contrasting

blends of online and face-to-face instruction with conventional face-to-face classes found that blended instruction was more likely to increase student engagement and performance on assessments (Means, Toyama, Murphy, Bakia, & Jones, 2009). Much of the observed effect of hybrid models on learning is likely the result of the online component affording learners more learning time, materials, and opportunities for sharing and exchanging information and views.

Shifting from face-to-face PLCs to an online environment raises concerns about teachers' access to online technology and their grasp of the skills needed to take full advantage of it. Although several studies reported that teachers experienced technical difficulties interacting with each other over an online portal (Baek & Barab, 2005; Yang & Liu, 2004) or were reluctant to use the online technology because they had not received proper training or were overwhelmed by the amount of information (Moore & Barab, 2002; Vrasidas & Zembylas, 2004), such challenges were less frequently reported in the more recent literature (since 2006). National and local investments in building schools' information technology infrastructure may gradually close access gaps for most teachers in the United States, but there is still a documented need for training teachers to use this technology and providing ongoing technical support to PLCs (Beach, 2012).

A recent review of experimental and quasi-experimental studies contrasting blends of online and face-to-face instruction with conventional face-to-face classes found that blended instruction was more likely to increase student engagement and performance

Emerging best practices for the design and setup of online and hybrid professional learning communities

The literature provides scant guidance on the design and setup of online and hybrid PLCs, and recommendations are based on researchers' or practitioners' experience rather than on systematic comparisons of how well various practices and tools perform on similar, well-defined tasks. Practices recommended in the recent literature include promoting interaction by structuring collaboration; providing opportunities for participants to shape the goals, structure, and assessment of the collaboration; pairing expert learners with less experienced learners; and designing activities that promote self-reflection (Duncan-Howell, 2010; Lloyd & Duncan-Howell, 2010; Vrasidas & Zembylas, 2004; Whitehouse, McClosky, & Ketelhut, 2010). However, these are the same recommendations as for traditional PLCs, and they do not clearly specify how to adapt them to online and hybrid PLCs. Box 2 lists a selection of publicly available resources that offer practical recommendations for designing, implementing, and evaluating online PLCs.

Box 2. Selected online resources on best practices for online professional learning communities

The following list of online resources on procedures and tools for online professional learning communities (PLCs) includes links to practical guides for planning and implementing PLCs and useful online collaboration tools:

- All Things PLC
- CONNECT AND INSPIRE: Online Communities of Practice in Education
- Online Communities for Educators: Guidelines for Planning and Implementation
- Technology for Online Communities of Practice
- Collaborative Professional Learning in School and Beyond: Tool Kit for New Jersey Educators

One extensive review and synthesis of the literature on PLCs recommends best practices that are echoed in several of the individual studies reviewed for this report (Lai, Pratt, Anderson, & Stigter, 2006). In particular, effective online PLCs have a clear purpose, boast strong leadership (or, at a minimum, benefit from facilitation), draw on a diverse group of members for a meaningful exchange of ideas and instructional philosophies, have a strong community-building component, and help all members acquire skills in the use of collaborative technology.

The studies reviewed for this report emphasize design elements that are aligned with these principles. Several studies suggested that having experienced facilitators moderate group activities is a key factor in cultivating and sustaining a virtual knowledge-sharing environment focused on learning (Baek & Barab, 2005; Chalmers & Keown, 2006; Curwood, 2011; Eddy Spicer & Dede, 2006; Gairin-Sallan, Rodriguez-Gomez, & Armengol-Asparo, 2010; Gray & Smyth, 2012). Moreover, facilitation is often tied to leadership: recognized leaders (whether formal or informal) are typically a good choice as facilitators.

The literature provides scant guidance on the design and setup of online and hybrid professional learning communities, and recommendations are based on researchers' or practitioners' experience rather than on systematic comparisons of how well various practices and tools perform

The key decision discussed in the literature concerns how much freedom participants should have to structure and direct the group's collaborative efforts. Practitioners, in particular, are divided on this issue. Some advocate a top-down process in which school leaders formulate the goals and procedures in consultation with teachers and experts (DuFour, 2007; Graham, 2007; Hord, 1997; King, 2011). Others promote a bottom-up process in which teachers take full responsibility for their professional development while aligning the goals of their collaboration with the school's mission and goals (Hargreaves & Fink, 2006; Stoll & Louis, 2007; Thompson et al., 2004; Wood, 2007). Definitive conclusions about which approach is more effective or how to optimally balance the two cannot be drawn from the current literature. Regardless of how PLCs are organized, however, online collaborations appear most productive when the group is diverse, has an effective moderator, and offers members opportunities to socialize in person (as with hybrid PLCs).

More than size of membership, diversity was often identified as an important catalyst of opportunities to share knowledge, expertise, experience, and perspectives among PLC members (Baran & Cagiltay, 2010; Farooq, Schank, Harris, Fusco, & Schlager, 2007; Fasso, 2010; Gray & Smyth, 2012; Hew, 2009; Riverin & Stacey, 2008). Diversity can mean members who occupy different roles in the school (teachers, principals, professional support staff), have different levels of experience (novice and veteran teachers), or have complementary sets of expertise.

Finally, the sociability aspect of online technology is clearly important to teachers and to the sustainability of online PLCs (Beach, 2012; Cornelius & Macdonald, 2008; Duncan-Howell, 2010; Eddy Spicer & Dede, 2006; Fasso, 2010). Creating opportunities for teachers to socialize is important for community building, and while this may (or should) guide the design of effective online collaboration tools, the literature suggests that hybrid PLCs may be best suited to foster a sense of community (Brooks, 2010).

Key assumptions and limitations of the study

The literature has many limitations that affect interpretations of the findings and recommendations. Some spring from underlying assumptions and others from gaps in the research.

Key underlying assumptions weaken the implications that can be drawn from the literature

Much of the literature assumes that the online environment is optimal for successful and sustainable PLCs, but that assumption has not been rigorously tested or, with few exceptions, even challenged (for example, Schlager & Fusco, 2003). An online environment is assumed to be ideal for sharing the expertise of PLC members (Lieberman, 2000; Lloyd & Duncan-Howell, 2010). Commonly invoked in support of this argument is the theory of situated learning in communities of practice (Lave & Wenger, 1991): when teachers learn within a community of learners, their learning is richer and more meaningful (see appendix A). As a theoretical paradigm the community of practice is easily applied to online or hybrid PLCs because different aspects of online communities and their practical implementation present parallels to the notion of effective PLCs. These include using collaborative tools and a collaborative platform (such as social media and online discussion boards) to facilitate situated learning, promoting collective responsibility and accountability for student learning through distributed leadership, and setting up the appropriate infrastructure (time and space) for supporting the work of PLCs.

Much of the literature assumes that traditional professional learning community activities can be moved online without first adapting them to the altered parameters of interaction

A second assumption is that traditional (co-located) PLC activities can be moved online without first adapting them to the altered parameters of interaction. In the literature on online PLCs the modus operandi is often to build online communities of teachers by mapping existing professional development strategies onto the Internet. This is done without first understanding the unique characteristics of social interaction in online-based systems, such as asynchronous communication, the lack of nonverbal feedback, and the absence of natural means for regulating interactions (such as taking turns) that exist in face-to-face interaction (Baek & Barab, 2005). As a consequence, while online PLCs can facilitate individual learning and reflection (because teachers can learn at their own pace and are free to reflect on what they learn without being distracted by comments from their peers), it is not clear whether online PLCs facilitate collaboration among teachers unless moderators and facilitators are included (Whitehouse et al., 2010).

Finally, there appears to be a disconnect between the theoretical assumptions about the structure of online PLCs and actual practice. A recent scan of more than 400 research articles on online professional development for teachers (Whitehouse, Breit, McCloskey, Ketelhut, & Dede, 2006) found that the predominant model guiding online professional development programs for teachers advocates learning through active collaboration (Lave & Wenger, 1991). This social constructivist model articulates the expectation that teachers will be in charge of creating, leading, and sustaining online collaborations for learning and professional development. Meanwhile, most of the online PLCs described in the empirical studies were established through a top-down mandate (see also Talbert, 2010), with online collaboration platforms frequently designed for teachers rather than by them or with their consultation (for an exception, see Eddy Spicer & Dede, 2006).

Several limitations of the research imply caution in interpreting the findings

Limitations of both the theoretical and the practical literature on online PLCs—much of it similar to the limitations of research on traditional PLCs—weaken the findings and recommendations reported in the studies reviewed here. Much of the literature focuses on the theory of online PLCs—no surprise considering that online PLCs are still fairly new (see Dede, 2006, for different models). There are two main limitations to the theoretical literature on online PLCs. The first is that it draws heavily on the same theoretical foundations that inform

scholarly work on traditional PLCs. As a consequence, it considers technology narrowly—as a tool for collaboration rather than as a new type of collaborative space that requires rethinking and redesigning teacher collaboration (see Baek & Barab, 2005; Eddy Spicer & Dede, 2006; Zygouris-Coe & Swan, 2010). The typical research question in the literature on online PLCs concerns the ability of online technology to facilitate (or hamper) the collaborative work of traditional PLCs. The link between technology and teacher learning has received less attention, although research is moving in that direction (for example, Whitehouse et al., 2010).

The second important limitation of the theoretical work on online PLCs is its abstractness. It never fully defines what key constructs, such as "shared values and vision" and "engagement," would look like in practice. The literature gives a sense of what should happen but not of why and how. Notably missing are logic models of the type developed for this report (see the table in box 1) that connect abstract theorizing on online PLCs with clear operationalization of inputs, outputs, and outcomes. The absence of logic models impedes not only the translation of ideas and goals into practice but also the ability of researchers and practitioners to rigorously evaluate online PLCs and their impact on teachers' development and students' learning.

Perhaps the most important limitation of the empirical research on online professional learning communities is its fragmentation

The empirical work on online PLCs also has important limitations, two of which affect the research on traditional PLCs as well. First, the bulk of the research consists of case studies. Some of these case studies describe national or regional programs, but most describe a specific, typically short-term program involving teachers in a particular subject area from multiple schools. Many of these studies observed outcomes of interest only after the program's implementation, without looking at the same outcomes before implementation. Consequently, the impact on participating teachers cannot be reliably assessed (Whitehouse et al., 2006). A few studies compared participants in traditional PLCs to participants in online PLCs. In general, this type of research is better suited to assessing the impact of online PLCs, and the comparisons they offer are instructive.

A second important limitation of the empirical research on online PLCs concerns the measurement of key constructs. Whether quantitative or qualitative, the measures used were frequently limited in number (for example, one or two items for measuring multidimensional constructs, such as satisfaction or perceived learning gain) and were not backed by common validity and reliability standards. In many cases researchers developed their own measures rather than using more comprehensive and previously validated PLC-related measures (see Killion, 2006, for a compendium of validated measurement instruments). Outcome measures did not include student outcomes but were limited to teacher outcomes (degree of satisfaction with the online PLC, perceived impact on their learning, intention to modify or adapt their instructional practices, likely impact on their students). In addition, they were based exclusively on teachers' self-reports, without corroboration.

But perhaps the most important limitation of the empirical research on online PLCs is its fragmentation. While enthusiasm for online PLCs is consistent across theorists in the field, the body of empirical work on the topic is neither focused nor fully coherent. Researchers who study online PLCs ask a range of questions about the scope of specific dimensions and apply a wide range of mostly qualitative methodologies and data analysis strategies to answer these questions. But theories are typically noted in passing rather than tested. As a result, the field has not yet produced a critical mass of work in any particular area of investigation that can be used to compare findings and derive informed conclusions.

Appendix A. What the literature says about traditional professional learning communities

The term "professional learning communities" (PLCs) has been used loosely to describe many different ways of bringing together people who share a common interest in education (Talbert, 2010). Collaboration distinguishes online PLCs from online professional development and learning more generally, such as online courses, webinars, or training. Some examples of online tools are email, discussion boards, knowledge-sharing platforms (such as Jing), chat (instant messaging), video conferencing (LiveMeeting, GlobalMeet), and blogs and wikis.

Operationally, PLCs are teams of educators (commonly teachers) who meet regularly, often during scheduled school time, to develop lesson plans, examine student work, monitor student progress, assess the effectiveness of instruction, and identify needs for professional learning. These teams are committed to refining the daily work of members by engaging them in continual improvement and experimentation that advance district and school goals for student learning (National Staff Development Council, 2001). The ideal PLC has such attributes as shared beliefs, values, and vision; shared and supportive leadership; supportive structural conditions; supportive relational conditions; collective learning; and peer sharing (DuFour, 2004; Hord, 1997). Strong PLCs are generally acknowledged not only as sharing new knowledge of content and pedagogy but also as challenging and critiquing assumptions about teaching and learning (Little, 2003).

What makes professional learning communities effective?

Much of the literature on PLCs is grounded in theories of the social nature of learning and details practices through which teachers share and build their work (Blankenship & Ruona, 2007). The literature frequently cites the theory of situated learning in communities of practice (Lave & Wenger, 1991), which proposes a vital link between learning and practice so that teachers' learning is richer and more meaningful when it occurs within a community of learners. Moreover, as suggested by theories of adult learning, teachers who learn within a self-directed and problem-centered community of learners are more likely to find value in their learning and to apply this newly acquired knowledge in their classrooms. Teachers collaborate to create knowledge and then adapt their instructional practice for a greater positive impact on their students. When teachers disseminate this knowledge to other teachers and invite feedback, their school becomes a learning-oriented and results-focused organization.

What evidence is there about the impact of professional learning communities?

A common perception in the literature and among practitioners is that PLCs generally achieve their goals. Reviews of the literature typically draw that conclusion from case studies (see Hord, 1997; Stoll & Louis, 2007; Wood, 2007). Education stakeholders' growing interest in PLCs also reflects a belief in their effectiveness. Believing in the value of building systems for peer-to-peer professional learning among teachers and other education leaders, the U.S. Department of Education is supporting PLCs as part of several key initiatives, including Investing in Innovation, the Office of Special Education Programs' technical assistance centers, Promise Neighborhoods, and Race to the Top.

To demonstrate impact, however, PLCs must be able to marshal data that indicate changed teaching practices and improved student learning outcomes. Few rigorous research and evaluation studies of PLCs do this. A recent review identified just 11 studies that examined the effectiveness of PLCs (Vescio et al., 2008). While the review noted that few studies move beyond teachers' self-reports of positive impact, analysis of the 11 studies found cumulative evidence of impact. The review concluded that participating in learning communities affects teaching practice, as teachers become more student-centered, and improves student achievement over time. A recent meta-analysis of PLCs' impact based on five studies (three of them included in the analysis by Vescio et al., 2008) reported a small but statistically significant effect of PLCs on student achievement (Lomos, Hofman, & Bosker, 2011).[2] Thus, although most studies supporting PLCs are case studies, the evidence seems to support a connection between teachers' efforts to improve instructional practice through peer study and changes in classroom practice and student achievement.

What factors facilitate or challenge the work of professional learning communities?

Factors such as school size and history, location in a rural or isolated area, and school culture and norms have been found to affect the success of PLCs (Stoll & Louis, 2007). External influences, including community support, policy decisions, and learning infrastructure (such as access to university faculty and programs), are cited as additional factors. Three external factors appear to be especially important to the success of PLCs (see bottom of table in box 1 in main report): supportive school leadership, structural and logistical support to PLCs, and the fit between PLCs and school culture and norms.

Researchers have consistently found supportive school leadership to be important to the success of PLCs, but they disagree on what "supportive" means (DuFour, 2007; Hargreaves & Fink, 2006; Hord, 1997; King, 2011; Richmond & Manokore, 2011; Thompson, Gregg, & Niska, 2004; Wood, 2007). For some, it means a top-down leadership structure that requires active involvement and facilitation of PLCs by school principals (for example, DuFour, 2007; Graham, 2007; Hord, 1997; King, 2011). Others emphasize the importance of distributed leadership to the success and sustainability of PLCs, with teachers assuming leadership responsibilities for PLC-related tasks and thus supporting a sense of community and mutual accountability (for example, Hargreaves & Fink, 2006; Stoll & Louis, 2007; Thompson et al., 2004; Wood, 2007). One study suggests that the key issue is leadership style rather than the leaders' identity and status, with a professional leadership style winning out over a bureaucratic style in cultivating a culture of collaboration that leads to improved student achievement (Talbert, 2010). According to that study, a "professional strategy" uses decisionmaking structures, professional expertise and knowledge resources, and leader modeling and feedback to bring about change, while a "bureaucratic strategy" uses traditional management tools of directives and rules, prescribed routines, and sanctions as ways to promote compliance and change.

Another factor frequently mentioned as crucial to the success of PLCs is the scope and quality of technical and logistical support available to teachers (Chappuis et al., 2009; DuFour et al., 2005; Hord, 1997; Lieberman & Mace, 2009; McLaughlin & Talbert, 2001; Richmond & Manokore, 2011). Schools need to set aside time for PLCs to meet and interact regularly and to provide a meeting space that is conducive to meaningful interaction. Beyond that, access to integrated learning resources, dedicated staff expertise (such as coaches, lead teachers, and researchers at institutions of higher education), robust student

achievement data, and extended time for teacher collaboration appear to help PLCs achieve their goals.

A third factor frequently mentioned in the literature is school culture (Chappuis et al., 2009; Hord, 1997; McLaughlin & Talbert, 2001; Richmond & Manokore, 2011; Stoll & Louis, 2007; Wood, 2007). Many teacher groups formed through mandates simply comply with the letter of the law rather than assess student performance and collaborate to improve teaching and learning—thus failing to improve student achievement (Talbert, 2010). School norms that place greater value on personal accountability than on collaboration are often blamed for teachers' resistance to collaboration. By contrast, school norms that encourage innovation and collaboration provide a nurturing environment that promotes positive impact and sustainability. The school culture, it seems safe to assume, is to some extent a function of leadership and leadership style, as discussed above.

Appendix B. Methodology and outcomes of the literature search

This appendix describes the methodology and outcomes of the literature search for traditional professional learning communities (PLCs) and online and hybrid PLCs. It also explains how the analysis was conducted.

Literature search for traditional professional learning communities

While the project's goal was to review and synthesize knowledge about online and hybrid PLCs, the literature on traditional PLCs was reviewed to suggest relevant dimensions and criteria for evaluating online PLCs and to organize the review (see appendix A). No effort was made to conduct an exhaustive review of the literature on traditional PLCs, which would duplicate past efforts.

Search strategy. Accordingly, the search strategy was to find reviews of the literature on traditional PLCs that have appeared in peer-reviewed journals, prioritizing the most recent reviews and the most highly or frequently cited. Reviews of literature conducted by university faculty or commissioned by government offices were also considered if the review was evidence-based. Databases including Academic Search Premier, PsycINFO, and ERIC were searched for relevant work using a basic query ("professional learning communities" OR "communities of practice" AND education AND review). To target the search more finely, it was limited to work published during 2000–12 and to abstracts rather than the entire text. This search yielded 351 citations.

The precision of the results (the ability of the search strategy to retrieve the most relevant work from the database) was assessed by randomly sampling approximately one-fifth of all items (n = 70) and scanning them for relevance. Less than 7 percent of the sample was judged relevant. To improve precision, the search was limited to articles or reports with the keywords appearing in the title. This yielded a more refined sample of 135 citations, which were scanned for relevance. This subsample was far more precise (precision = .19), but the search still picked up many book reviews as opposed to literature reviews. The search query was modified to replace "review" with "review of the literature" OR "systematic review." The new subsample (n = 16) yielded 11 potentially relevant items (precision = .68), all of them flagged as relevant in the previous step (signaling high recall, or ability to represent the universe of relevant work on the topic).

Synthesis of sources along five critical dimensions of professional development. The final selection of six items (box B1) favored prominence (impact on the field as measured by number of references to the work) and substantive contribution to the body of knowledge (based on grounding in empirical evidence or organization around critical questions, such as why and how PLCs are expected to influence outcomes) over lists of recommended practices. Based on this guiding principle, one item was included for its seminal contribution to the literature even though it predated the selected time framework (Hord, 1997). The next step was to synthesize these six sources along five critical dimensions of professional development to benchmark the work on online models of PLCs:

- Degree of personal motivation to participate.
- Quality of individual engagement and learning.
- Quality of group interaction and group dynamics.
- Potential for translating learning into actual practice.
- Potential for changing organizational culture.

Box B1. Selected literature reviews of traditional professional learning communities

Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). Professional learning in the learning profession: A status report on teacher professional development in the United States and abroad. Stanford, CA: Stanford University, National Staff Development Council.

Feger, S., & Arruda, E. (2008). Professional learning communities: Key themes from the literature. Providence, RI: The Education Alliance at Brown University.

Hord, S. M. (1997). Professional learning communities: Communities of continuous inquiry and improvement. Austin, TX: Southwest Educational Development Laboratory.

Lomos, C., Hofman, R. H., & Bosker, R. J. (2011). Professional communities and student achievement: A meta-analysis. *School Effectiveness and School Improvement: An International Journal of Research, Policy and Practice, 22*(2), 121–148.

Stoll, L., Bolam, R., McMahon, A., Wallace, M., & Thomas, S. (2006). Professional learning communities: A review of the literature. *Journal of Educational Change, 7*, 221–258.

Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education, 24*(1), 80–91.

Literature search for online professional learning communities

A review of the literature on online and hybrid PLCs is the unique contribution of this report. The review is intended to summarize and synthesize evidence on educators' experience and professional development outcomes in online and hybrid PLCs and is organized around the same five crucial dimensions of professional development used to synthesize the literature on traditional PLCs (see previous section). The review also summarizes evidence on ways (resources, arrangements, processes, and tools) to increase the productivity and sustainability of professional development for educators.

A two-tier search strategy. A two-tier literature search strategy was used. Tier 1 included searching, retrieving, and using relevant peer-reviewed journal articles on online and hybrid PLCs published during 2000–12. Tier 2 supplemented this effort with targeted searches for relevant published books and edited volumes, research, policy and government reports, and conference proceedings. In both tiers the focus was on reports on online and hybrid PLCs in a professional development context rather than in a context of learning more generally (for example, online courses offered to college students).

To identify peer-reviewed journal articles, some basic keyword queries were used to search ERIC and Academic Search Premier, two comprehensive databases that archive much of the peer-reviewed scientific work on online and hybrid PLCs. The initial inquiry revealed only a slight overlap between the two databases, so both were used in iterative searches to maximize the search strategy's ability to represent the universe of relevant work. The same search query and limiters were used for both databases. And the query was narrowed gradually to increase precision (table B1).

Because of the large number of potentially relevant journal articles retrieved, two independent coders rated a sample of 100 items for relevance after each search. Degree of

Table B1. Results of the iterative search for relevant peer-reviewed articles

Query	Limiters	Items retrieved	Precision
("professional learning communities") OR ("communities of practice")	Scholarly (Peer Reviewed) Journals; Published Date from: 20000101–20121231; Document Type: Article; Language: English	2,452	.018
("professional learning communities" OR "communities of practice") AND (education)	Scholarly (Peer Reviewed) Journals; Published Date from: 20000101–20121231; Document Type: Article; Language: English	1,974	.024
("professional learning communities" OR "communities of practice") AND (online OR technology)	Scholarly (Peer Reviewed) Journals; Published Date from: 20000101–20121231; Document Type: Article; Language: English	802	.076
("professional learning communities" OR "communities of practice") AND (education) AND (online OR technology)	Scholarly (Peer Reviewed) Journals; Published Date from: 20000101–20121231; Document Type: Article; Language: English	657	.092
("professional learning communities" OR "communities of practice") AND (education) AND "professional development" AND (online OR technology)	Scholarly (Peer Reviewed) Journals; Published Date from: 20000101–20121231; Document Type: Article; Language: English	184	.350

Source: Authors' literature review, as described in this appendix.

agreement between the coders was assessed using Krippendorff's alpha coefficient, a rigorous (and thus conservative) measure of agreement across multiple coding decisions (Krippendorff, 2004). The intercoder reliability was good (Krippendorff's alpha = .91), and any remaining disagreements were resolved ad hoc. At each step relevant articles were scanned for additional keywords that might increase precision. Precision improved with each step. Because the number of articles retrieved from the two databases with the last search query was manageable (n = 184), no more keywords were added to the search query to further reduce the number of eligible articles.

Four selection criteria. Four criteria were used to select the final pool of relevant peer-reviewed journal articles:

- Was an empirical study (quantitative and qualitative), review article, or theoretical or discussion piece.
- Published or accepted for publication in peer-reviewed journals (including refereed conference proceedings).
- Published during 2000–12.
- Addressed one or more of the following aspects of online or hybrid PLCs in education settings, including K–12 education and higher education:
  - Characteristics of online and hybrid PLCs (structure, roles, core activities).
  - Scope and nature of school- and district-level support to online and hybrid PLCs.
  - Experience of teachers and school administrators with online and hybrid PLCs.
  - Challenges in forming and maintaining online and hybrid PLCs.
  - Online and mobile technologies used in support of online and hybrid PLCs.
  - Evidence on the effectiveness of online and hybrid PLCs in professional development outcomes for teachers (motivation, engagement, learning, teamwork,

and translation of knowledge into practice), organizational culture and learning, and student outcomes.

Of the 184 articles considered, only 66 met one or more of the selection criteria. Eight additional articles were identified through a supplementary Google Scholar search. In all, 74 peer-reviewed journal articles were used. (These articles are marked with an asterisk in the reference list.) Of these 74 articles 39 were empirical studies of aspects of online PLCs, 29 offered conceptual or theoretical discussions of online PLCs, and 6 were review pieces. A large portion of the theoretical literature was concerned with one of the following: prescriptions for designing professional development, insights into adequate use of technology to support professional development, benchmarks for assessing the effectiveness of professional development (participation level, participant satisfaction, subject knowledge, pedagogical knowledge, critical reflection orientation, skills, and efficacy), and desirable characteristics of online collaboration. Much of the empirical work (28 of 39 articles) consisted of case studies applying a qualitative methodology (such as participant interviews or focus groups, content analysis of threads posted on discussion boards, and summaries of participants' qualitative evaluations of their PLC experience).

In addition, 14 quantitative studies in the pool used teacher surveys or quantitative analysis of online interactions among PLC participants. Two of them used an experimental design to compare teachers' experiences in online PLCs with varied components (such as face-to-face and online, completely online, and hybrid).

PDF files of all articles were archived on a project website, and the research team received training in coding and analysis.

Coding and analysis

Each item selected for the review was coded for the following characteristics:

- *Relevance.* The project-specific research questions and subquestions addressed.
- *Type of study.* Conceptual, empirical, or review piece.
- *Methodology.* Quantitative (experimental, observational, content analysis), qualitative (ethnography, interview, focus group), mixed, or literature review and synthesis.
- *Setting.* Within or between units (schools, districts), within or across content areas (math, sciences, language arts, others), and K–12 or higher education.
- *Primary population.* Teachers, trainees, school and district administrators, college professors, or other.
- *Collaboration module.* Online or hybrid (online and face-to-face).
- *Inclusion or exclusion of outcomes measures.* Direct (for example, classroom practices) or indirect (for example, students' learning outcomes).
- *Online tools used.* Email, discussion boards, knowledge-sharing platform (such as Jing), chat (instant messaging), video conferencing, blogs and wikis, social media, virtual reality (such as Second Life), games and simulations, representational tools (concept maps, diagrams, visualization tools), intelligent system (such as simulated agents, Intelligent Tutoring Systems), and other tools.
- *Size and composition of group.* Number of participating members and the distribution of roles within the group.
- *Length of collaboration.* Duration (in months) and frequency of interactions.

This enabled the study to portray the current landscape of online and hybrid PLCs based on what is reported in the literature, as well as to note any potential biases and gaps.

Once classified, items were grouped by online model (online or hybrid). Items in each group were coded separately for the five critical dimensions of professional development (see above). For example, the coders recorded any evidence that pertained to teachers' motivation to actively participate in and contribute to the group, as well as accounts of how teachers responded to the online or hybrid PLC. Once the coding was complete, the results were synthesized in three steps. First, for studies with quantitative analyses, distributions on key variables (such as teachers' level of satisfaction with the online PLC) were compared to identify generalizable patterns across populations and settings. Second, narrative syntheses were prepared for studies with qualitative analyses that involved noting any similarities across studies (for example, a common challenge teachers face in the online environment). Third, a meta-synthesis of the research brought together the results of quantitative and qualitative syntheses, to identify where there was consensus on research findings.

Notes

1. Many of the studies reporting on more than 20 participants involved large regional or national professional development efforts where size was a function of teachers available to participate rather than a substantive consideration.
2. $d = 0.25$, $p < .05$.

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