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DEVELOPMENT ARTICLE

Reexamining technology's role in learner-centered professional development

Drew Polly · Michael J. Hannafin

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Abstract The American Psychological Association's *Learner-Centered Principles* provide empirically-based approaches to improving teaching and learning. However, in order to facilitate learner-centered, technology-rich instruction to K-12 students, teachers must be afforded opportunities to develop key understandings and skills, rarely evident in most professional development programs. In this paper, we synthesize empirically-based studies and recommendations for teacher learning and propose a learner-centered professional development (LCPD) framework to guide both professional development and empirical work on teacher learning. We describe LCPD components, discuss ways that technology can support LCPD, and highlight implications for research and practice.

Keywords Teacher professional development · Technology · Learner-centered instruction

Overview

Contemporary school reform movements emphasize situated, authentic, technology-rich learner-centered instruction that emphasizes complex problem solving and higher-order thinking skills (Bransford et al. 2000; McCombs et al. 2008; Wenglinsky 1999). Learner-centered teaching has potential to improve K-12 student learning in areas that have proven especially problematic (Cornelius-White 2007). Accordingly, significant shifts in curriculum standards have emerged across teaching domains. Current curriculum standards from national organizations now focus on providing relevant, meaningful tasks, developing higher-order thinking skills, and integrating technology as a tool to support learning. Learner-centered curriculum emphasizes conducting mathematical investigations (National

D. Polly (✉)
University of North Carolina at Charlotte, COED 370, 9201 University City Blvd, Charlotte, NC 28213, USA
e-mail: abpolly@uncc.edu

M. J. Hannafin
University of Georgia, Athens, GA, USA

Council of Teachers of Mathematics [NCTM] 2000), eliciting critical thinking in language arts (NCTE 1996), engaging in scientific inquiry (National Research Council 1996), conducting historical inquiries in social studies (National Council for the Social Studies 1994), and using technology to facilitate collaborative problem solving (International Society for Technology in Education 2007).

The shifts in curriculum standards have been made in response to a compelling and growing body of research. The American Psychological Association distilled *Learner-centered Principles* (APA Work Group 1997) from research on learning across K-12 students *and* adults (Alexander and Murphy 1998). The *Principles*, co-authored by researchers, educational psychologists and education scholars, synthesized empirical research on teaching and learning based in cognitive and constructivist theories of learning (Alexander and Murphy 1998). Several principles, for example, reflect compelling research evidence on the cognitive and metacognitive factors and emphasize providing challenging and relevant tasks for learners to construct their own understanding. Others were derived from research on intrinsic motivation, and reinforce the importance of embedding relevant tasks that build on learners' prior knowledge and personal interests, or synthesized social constructivist views of learning by aligning tasks with learners' intellectual, social and emotional needs. Still others were based on individual learner needs, such as research supporting learning via scaffolding and self-assessment.

While authors have suggested how to implement learner-centered instruction (Cornelius-White and Harbaugh 2009; Lloyd 2001; McCombs and Whisler 1997), classroom implementation of technology-enhanced, learner-centered instruction has proven problematic (Fishman et al. 2003; Heck et al. 2008). Teachers have tended to focus on surface-level rather than deep aspects of instruction, such as the use of hands-on activities or multi-step tasks (Fishman et al. 2003). Some teachers provided explicit problem solving procedures rather than facilitating student reasoning (Cognition and Technology Group at Vanderbilt [CTGV] 1997) but believed their directed activities were learner-centered (McCombs et al. 2008; Poly and Hannafin in press). While enacting technology-rich learner-centered tasks, at time teachers focused on teaching the technology per se, and inadvertently simplified otherwise complex learning tasks for their students (CTGV 1997; Polly and Ausband 2009).

Calls for reform have significant implications for both students and teachers. Learner-centered Professional Development (LCPD) has been advocated to support teacher knowledge and skill construction by providing learning experiences as students, and in turn implementing learner-centered instruction (e.g., Putnam and Borko 2000). In this paper, we identify the components, foundations, and assumptions of learner-centered professional development (LCDP), compare and contrast LCPD to traditional approaches to teacher learning, discuss technology's role in supporting LCPD, and identify implications for future research.

The case for learner-centered teacher professional development

Synthesis of literature

Our analysis focused on: (1) large-scale synthesis studies across multiple projects in order to identify characteristics of effective professional development programs; and (2) projects designed to support learner-centered instruction. Research from the Eisenhower Professional Development Institutes (Desimone et al. 2002; Garet et al. 2001), the Local

Systemic Change initiative (Heck et al. 2008), and the New Opportunities Funding Initiative (Davis et al. 2008) each used common instruments across multiple projects within a larger initiative. Each also emphasized teachers' use of either learner-centered instructional practices and/or learner-centered curricula. Others (Kennedy 1998; Yoon et al. 2007) analyzed the impact of the professional development projects on student learning outcomes.

Analyses of professional development activities, the research methods employed, and the findings were conducted. We placed special attention on professional development factors that were empirically associated with increases in teachers' uses of learner-centered instructional practices and gains in student learning outcomes. Studies that embodied learner-centered principles and supported learner-centered instruction were identified. Studies cited in Kennedy's (1998) and Yoon et al.'s (2007) syntheses were also examined, since these projects examined the influence of professional development on student learning outcomes.

Components of LCPD

The National Partnership for Excellence and Accountability in Teaching (NPEAT 2000) recommended strategies to implement learner-centered professional development. While some NPEAT components overlap APA's *Principles* and descriptions of effective professional development (Lawless and Pellegrino 2007; Penuel et al. 2007), Guskey (2003) noted "the research evidence regarding most of the identified characteristics is inconsistent and sometimes contradictory (p. 751)." It is critical to define elements of LCDP and to ground them in related research and theory. To this end, we synthesized findings from research underlying APA's *Principles* with professional development research studies.

Identifying LCPD principles

As summarized in Table 1, six principles were refined by synthesizing available research and theory and following consultations with authorities in technology-enhanced learning, learner-centered instruction, and learner-centered approaches to professional development. Each theme was identified in multiple empirically-based papers (e.g., Desimone et al. 2002; Garet et al. 2001; Penuel et al. 2007; Yoon et al. 2007) as essential components of learner-centered professional development. The authorities provided feedback on refining the theme and how each contributed to the overall goal of LCPD.

Focus on student learning

The primary goal of professional development is to improve student learning (Yoon et al. 2007). Learner-centered instruction has proven potential to bridge well-documented achievement gaps (Cornelius-White 2007). Learners benefit from actively constructing meaning from experiences related to their prior knowledge (APA 1997; Lawless and Pellegrino 2007). In LCPD, teachers participate as learners in model lessons, and learn to facilitate student learning by experiencing specific pedagogies, such as modeling and questioning (Penuel et al. 2007).

Professional learning communities and computer-based assessments enable teachers to use student work samples and assessment data as to identify gaps in student learning, select learner-centered tasks that will address the gaps, and make instructional decisions based on

Table 1 Characteristics of learner-centered professional development, supporting research, and implications for LCDP

Characteristic	Correspondence with APA principles	Supporting research on learning, learner-centered instruction, and professional development	LCPD implications
Focus on student learning	Learners construct meaning by actively combining knowledge with experience, receiving adequate support over time, connecting new knowledge with prior knowledge. Learning is enhanced with effective tools, such as technologies, and well-designed learning environments (Principles 1, 2, 3, and 6)	Focus on what students are to learn and ensure all students learn (National Partnership for Excellence and Accountability in Teaching (NPEAT) 2000a) Technology-based assessments can facilitate the collection and analysis of student learning data (Hord 2004)	Technology should support teacher's work bridging the gap between (a) goals and standards for student learning and actual student performance and (b) preparing teachers to bridge that gap (Hord 2004)
Teacher-owned	Motivation influences the extent to which learning occurs. Motivation can be increased by learner's personal interests, beliefs, goals and the relevance of the learning activities. Learners have diverse backgrounds, learning preferences and instructional needs that should be considered (Principles 7, 8, 9, 10, 12, 13)	Support creation of artifacts of knowledge, such as lesson plans, instructional units, assessments (Fennema et al. 1996) Build on teachers' classroom activities (van Es and Sherin 2008) Follow-up workshops with classroom-based experiences (Yoon et al. 2007) Reconcile differences between teachers' beliefs and expected teacher behaviors (Fennema et al. 1996) Build upon intrinsic interests, such as improving student learning, addressing instructional problems, increasing teachers' knowledge of pedagogies and content (Davis et al. 2008; van Es and Sherin (2008) Teachers plan and implement based on their individual professional development priorities (National Partnership for Excellence and Accountability in Teaching (NPEAT) 2000) Employ research-based practices related to teacher learning (Garet et al. 2001; Yoon et al. 2007)	Involve teachers in selecting the content of professional development programs and, if possible, give teachers choices about learning activities (Davis et al. 2008). Professional development should address teachers' beliefs about learner-centered instruction (Glazer et al. 2009) Promote teachers' interests through the use of internet-based learning opportunities (Russell et al. 2009; So et al. 2009)

Table 1 continued

Characteristic	Correspondence with APA principles	Supporting research on learning, learner-centered instruction, and professional development	LCPD implications
Develop knowledge of content and pedagogies	Learners actively construct knowledge by combining prior knowledge with new experiences, and through support over time. Learners should be empowered with thinking strategies and critical thinking skills (Principles 1, 2, 4, and 9)	Provide active learning experiences (Garet et al. 2001; Penuel et al. 2007) Combine active experiences with information about specific content and pedagogies (Garet et al. 2001; Desimone et al. 2002)	Address teacher's pedagogical content knowledge (Schulman 1987), technological pedagogical content knowledge (Mishra and Koehler 2006), and content-specific knowledge for teaching (Hill et al. 2005)
Collaborative	Learning is a social process that can be mediated through technology and other resources. Through collaboration, learners contribute and draw from the common understanding established by themselves and their colleagues (Principles 6, 10 and 11)	Develop a community of teacher learning and collaboration (Glazer et al. 2009; Hord 2004; Penuel et al. 2007) A focus on problem solving among teams and/or whole faculty (National Partnership for Excellence and Accountability in Teaching (NPEAT) 2000) The internet can support collaboration among teachers (Ravitz and Hoadley 2005)	Support teaching by providing collaborative learning opportunities (Hord 2004) and developing the problem solving skills needed to teach effectively (van Es and Sherin 2008) Technology can support LCPD (Taylor 2008)
Ongoing	Learning must be facilitated by a more knowledgeable other over time with adequate opportunities for learners to apply their knowledge and skills (Principles 2 and 9)	Provide ongoing v. isolated professional development (Banilower et al. 2006; Heck et al. 2008) Continuous and ongoing professional development needed to provide feedback and support reflection to deepen knowledge and skills (National Partnership for Excellence and Accountability in Teaching (NPEAT) 2000) Provide appropriate support related to enactment of classroom practices (Davis et al. 2008; Fishman et al. 2003) Provide follow-up to workshops with classroom-based experiences and technology-rich collaborations (Yoon et al. 2007) Include in-class support to support classroom practices (Fishman et al. 2003) Use technology to facilitate the sharing of ideas and resources (Ravitz and Hoadley 2005; Taylor 2008)	Connect professional development efforts to a comprehensive change process focused on improving student learning (Heck et al. 2008). Technology can be used to support follow-up

Table 1 continued

Characteristic	Correspondence with APA principles	Supporting research on learning, learner-centered instruction, and professional development	LCPD implications
Reflective	Assessment of progress is part of the learning process. Learners develop critical thinking skills to self-assess and reflect on their learning (Principles 1, 4, 5, and 14)	Develop higher-order thinking skills and metacognitive strategies (Penuel et al. 2007) Use technology to collect artifacts of classroom instruction and student learning data (So et al. 2009) Utilize multiple indicators of student learning and development (National Partnership for Excellence and Accountability in Teaching (NPEAT) 2000) Support creativity through the design of instructional material and assessments (Davis et al. 2008) Ensure that teacher self-assessment of artifacts (e.g., videos of lessons, student work samples, etc.) (National Partnership for Excellence and Accountability in Teaching (NPEAT) 2000)	Allow and support teachers to reflect on evidence of their teaching: (a) student work samples and (b) artifacts from their own teaching (van Es and Sherin 2008)

evidence of student learning (Dufour and Eaker 1998). These digital assessment systems provide detailed diagnostic data on students' strengths and weaknesses and prescribe interventions to support student learning (Hord 2004). In LCPD programs, teachers analyze data, examine and discuss student work, identify students' misconceptions, and devise plans to close the gaps in student performance (Hord 2004).

Teacher-owned

Teachers are most likely to adopt professional development pedagogies when they perceive ownership by selecting content and activities (Davis et al. 2008). During LCPD, teachers become increasingly motivated when tasks build on prior knowledge, align to their personal interests and beliefs, and encourage ownership of their learning (APA 1997; Garet et al. 2001). This approach helps teachers to embrace key conceptual differences related to epistemological assumptions and pedagogies underlying learner-centered instruction (Penuel et al. 2007).

Online professional development programs have been found to promote teacher ownership of their learning, as participants choose the focus of their learning, and complete tasks at times that are chosen by them (Dede 2006). In one case, teachers reported adopting professional development pedagogies after collaboratively critiquing video episodes of their and other teachers' classroom practice (So et al. 2009). Teachers also adopted these pedagogies in their classroom after completing the modules and subsequently implemented related pedagogies in their classroom when they felt comfortable (Russell et al. 2009).

Develop knowledge of content and pedagogies

Research suggests that both teachers' content knowledge *and* pedagogy are significantly correlated with student learning (Hill et al. 2005). Pedagogical content knowledge (Schulman 1987), technological pedagogical content knowledge (Mishra and Koehler 2006), and content-specific knowledge for teaching (Hill et al. 2005) all emphasize the need to simultaneously develop teachers' knowledge of content and content-specific pedagogies. Meta-analyses of large-scale professional development projects indicated that adoption of target practices increased when teachers' actively learned specific content and related pedagogies (Desimone et al. 2002; Garet et al. 2001; United States Department of Education 1998). Teachers are most likely to adopt technology-rich, learner-centered tasks when they experience model lessons as learners (Polly and Ausband 2009), engage in discussions about the concepts embedded in the lesson (van Es and Sherin 2008), and explicitly connect content with pedagogies (Heck et al. 2008).

In prior studies, technology has supported teacher learning; teachers completed technology-rich tasks, which they implemented in middle school science classrooms (Penuel et al. 2007). Other studies have utilized the use of video cases to provide models of effective pedagogies (van Es and Sherin 2008). Technology connects professional development activities to classroom practice, which is essential to impact teachers' instruction (Fishman et al. 2003).

Collaborative

Collaborative school-based professional learning communities have been associated with both adoption of new instructional practices (Marzano 2003) and modest gains in student

learning outcomes (Vescio et al. 2006). Successful collaborations have been noted between teacher-leaders and their colleagues (Glazer et al. 2009), district leaders and classroom teachers (Strahan 2003), and university faculty and classroom teachers (Snow-Gerono 2005; Polly and Hannafin in press).

Internet-based communities of practice have proven effective in fostering teacher collaboration (So et al. 2009; Taylor 2008). These approaches include video analysis (So et al. 2009), discussions about classroom experiences (RMC Research Collaborative 2005), and resource sharing (Ravitz and Hoadley 2005). Studies indicate that the success of these efforts requires that teachers take the initiative to facilitate and sustain activities (Schlager et al. in press).

Ongoing

Research indicates that while only minimal impact on teachers' instructional practices and student learning is evident after year one, significant impact was evident during subsequent years (Fennema et al. 1996; Fishman et al. 2003). Teachers often require sustained, extended time to incubate ideas, internalize beliefs, and refine the associated practices (Orrill 2001). To the extent that substantial differences exist between current and desired practices, substantial ongoing support may be required (Heck et al. 2008) A meta-analysis of a large-scale initiative indicated that 30 h of sustained professional development were needed to realize a durable shift in teachers' learner-centered practices and 60 h for a significant impact student learning (Banilower et al. 2006).

To support implementation upon return to the classroom, Internet-based systems have provided teachers feedback on instruction, facilitated sharing of resources, and enabled support among teaching communities (Ravitz and Hoadley 2005; Schlager et al. in press; So et al. 2009). These web-based supports allow teachers to have just-in-time access to resources and more opportunities to communicate with others about issues related to their teaching (Shlager et al. in press).

Reflective

Researchers report benefits from efforts that focus on daily praxis (Garet et al. 2001), are situated in teachers' work (So et al. 2009), and allow teachers to examine specific instances of their own teaching (Recesso et al. 2009; van Es and Sherin 2008). Paradoxically, typical professional development efforts are disconnected from rather than integral to classroom activity (Yoon et al. 2007).

Both APA's *Principles* and metacognition researchers (Flavell 1976) suggest that learners benefit by reflecting on self-assessments of a variety of higher-order and critical thinking strategies. Technologies have enabled teachers to reflect on and revisit classroom-based evidence to examine potential changes (Land and Zembal-Saul 2003; So et al. 2009), affording opportunities to critically their own (or others') classroom teaching practice. Archival documentation may include student work samples, audio recordings, and video-recordings of lessons which can be used to scaffold teacher and professional developer reflection (So et al. 2009). By examining artifacts of their own practice, teachers' became increasingly cognizant of problems associated with both classroom instruction and students' learning (van Es and Sherin 2008), as well as their efforts to modify their classroom pedagogies (Shepherd & Hannafin in press).

Considerable research and theory have been published regarding learner-centered instruction, but relatively little has research has documented the impact of learner-centered

professional development on either teachers' practice or student learning. Although LCPD holds promise to improve both learner-centered instruction and student learning, the methods used to advance learner-centered professional development require further examination.

Implications and future research

Examining student learning outcomes

Surprisingly few researchers have examined LCDP's impact on student learning outcomes. The LeTUS project (Fishman et al. 2003; Penuel et al. 2007), and Kennedy (1998) and Yoon et al. (2007) examined student learning outcomes that were aligned with both the professional development and the tasks teachers were expected to implement. Teachers attempted to integrate technology-rich science activities and associated pedagogies, but a lack of knowledge of content (Fishman et al. 2003) and pedagogy (Polly and Hannafin in press) impeded their efforts when students struggled during lessons. In some projects, significant increases in teachers' practices or student learning did not occur until at least year two of projects (ongoing), when professional developers modified activities to better meet teachers' perceived needs (teacher-owned) (Fishman et al. 2003; Penuel et al. 2007).

Concerns associated with professional development research and student learning have been well-documented. Learner-centered tasks should be performance-based and enable teachers to gather student learning data (Hord 2004), but often they are not. Although advocates suggest that authentic assessments should be embedded within the tasks students complete during instruction, Yoon et al. (2007) noted substantial misalignment with the content and pedagogies emphasized during professional development and classroom implementations. In order to bridge teacher enactment of LCPD practices with student learning, assessments need to align each (cf Borko 2004).

Technology has potential to significantly support the alignment between teacher practices and assessments of student learning outcomes. Many curricula and student assessment systems provide K-12 teachers with digitally-based assessments that can be customized to match the concepts that teachers focus on in their classroom. Following LCPD, professional developers and teachers can collaboratively determine the concepts that will be emphasized, and assessments can be designed accordingly. However, professional developers and teachers sometimes do not reach consensus on the primary concepts.

Examining teachers' instructional practices

In order to link LCDP efforts with student performance, we need to document the extent to which those methods advanced during professional development are actually enacted (Borko 2004). In both the CGI and LeTUS projects, initial implementation fidelity was inconsistent, but was subsequently aligned with the professional development focus in order to assess the relationship between classroom teacher practice and student learning (Fennema et al. 1996; Fishman et al. 2003). Recent advances in video capture and analysis technologies enable the unobtrusive capture and mark-up of standards-based pedagogies, which support researchers' efforts to associate the presence and quality of specific teaching practices with specific student learning outcomes (Polly and Hannafin in press; Recesso et al. 2009; Rich and Hannafin 2008a, 2009; van Es and Sherin 2008).

Research on adoption of instructional practices indicates that teacher beliefs (e.g., Ertmer 2005; Song et al. 2007), scaffolding provided (Glazer et al. 2009), and in-classroom support during implementation (Davis et al. 2008; Yoon et al. 2007) all influence success. By promoting ownership, teachers became more likely to enact professional development pedagogies in their classrooms (Garet et al. 2001). In the CGI project (Fennema et al. 1996), some teachers incorporated learner-centered practices once their beliefs changed; for others, beliefs changed following implementation of learner-centered practices. LeTUS teachers enacted technology-enhanced lessons with improved fidelity after participating in a series of workshops focusing on integrating technologies and pedagogies within, rather than detached from, the curriculum (Fishman et al. 2003). In the Video Clubs Project (van Es and Sherin 2008), teachers' practices became increasingly learner-centered after they analyzed videos and student work samples from their own classroom, given appropriate experiences, support and time. Based on observations and surveys, teachers in England who participated in technology integration professional development involving teacher selection of their activities were more likely to enact the workshop pedagogies upon return to their classrooms (Davis et al. 2008).

Reconciling differences between beliefs and practice

Teacher beliefs and practices are often misaligned; in many instances, teachers are unaware of these discrepancies. Studies undertaken in the California mathematics reform initiative in the 1980s, for example, documented misalignment between teachers' perspectives about their teaching and the perspective of observers of their teaching (Peterson 1990; Wilson 1990). Teachers believed they implemented the reform-based pedagogies correctly, but the researchers' reported observing primarily didactic teaching methods (Poly and Hannafin in press). Thus, research documenting mismatches between teachers' beliefs and practices suggest no or few changes in teaching practices despite professional development emphasizing reform-based pedagogies. These discrepancies can, however, be overcome. According to van Es and Sherin (2008), the beliefs and methods of teachers who collaboratively critiqued videos of their teaching with peers gradually became more closely aligned with both the underlying beliefs and target practices advanced through professional development.

Several researchers have applied technology-enhanced methods to help teachers more closely identify discrepancies between beliefs and practices. Stecher et al. (2003) used classroom vignettes to assess how teachers believe a concept should be taught (e.g., teacher-directed without resources, teacher-directed with resources, student discovery with guidance). Data from classroom vignettes was then matched with observations in order to examine intersections between teachers' beliefs and their observed instructional practices. Bryan and Recesso (2006) and van Es and Sherin (2008) successfully used video capture and analysis to contrast actual evidence of classroom teaching with teacher's espoused practices. Similar findings involving multiple sources of data, including video evidence of classroom teaching enactments with active student engagement and e-portfolios (Shepherd and Hannafin in press; So et al. 2009) and standards-based teaching practices (Rich and Hannafin 2008a) have been reported. Future studies should examine this interaction through the collection of multiple data sources that gather data about teachers' instruction as well as their beliefs about their classroom teaching as well as student learning.

Scaffolding in-class implementation

Consistent with Vygotsky's (1978) Zone of Proximal Development, teacher learning opportunities are most effective when a more knowledgeable individual provides support (Glazer et al. 2009). To optimize LCPD, implementation may require support during workshops as well as ongoing support for implementation in the classroom. Numerous studies indicate that collaboration (e.g., co-planning and co-teaching) with a more knowledgeable peers or experts can support teachers' early attempts to implement technology-rich, learner-centered tasks (Davis et al. 2008; Lawless and Pellegrino 2007; Polly and Hannafin in press). For example, inservice teachers became increasingly proficient in developing and integrating computer-aided lessons when paired as collaborative apprentices with peer mentor teams (Glazer et al. 2009). Professional learning communities provide opportunities for teachers to co-plan and collaboratively examine student work (Hord 2004). In technology-based projects (So et al. 2009; van Es and Sherin 2008) teachers collaboratively examined videos of their teaching, and enacted emphasized pedagogies in future lessons. Research is needed, however, to examine how to guide novice teachers' implementation of learner-centered pedagogies. Further studies are also needed to examine how out-of-classroom experiences influence both teachers' in-class instruction as well as their students' learning.

To date, technology-enhanced LCPD implementations have required extensive in-classroom support, which while effective may ultimately prove impractical. Research is needed to examine the feasibility and scalability of, as well as alternatives for providing classroom-based scaffolding for significant numbers of teachers. Telementoring, provided via Internet-based technologies, has enabled teachers to access resources and support from experts around the world (Schlager et al. in press). Self-paced professional development programs also show promise in supporting teachers' understanding and improving self-assessments (Russell et al. 2009).

Documenting the impact of LCDP

Researchers have developed various scales and rubrics to identify and categorize teachers' instructional practices (e.g., Schifter and Fosnot 1993; Schneider et al. 2005), enabling the coding and analysis of classroom observation data, align specific components of teaching with LCPD, and assess the extent to which practices have been enacted. In addition, recent technology developments have made possible the use of video to capture, code, and analyze teaching practices (Rich and Hannafin 2008b). Research is needed to further codify and apply the attributes of LCPD using available analytical tools. These methods have the potential to increase our confidence in individual assumptions about classroom implementation of professional development practices. However, researchers (e.g., Borko 2004; Desimone et al. 2002) have advocated the need for multi-site studies to examine the impact of professional development on LCDP practices using common instruments or frameworks of analysis.

Concluding comments

While learner-centered instruction has demonstrated potential to improve student learning and higher-order thinking, teachers often struggle to enact these pedagogies (CTGV 1997; Lawless and Pellegrino 2007). LCPD represents a synthesis of empirically-based

recommendations, contemporary theories of learning, and studies on teacher learning. However, linkages between professional development, teacher learning, classroom implementation, and student learning need to be strengthened. Guskey (2000) proposes professional development research to collect multiple sources of data involving participants' perceptions and reactions, knowledge and skills, enactment, and student learning outcomes related to the professional development. Future research is needed to examine how LCPD programs impact teacher knowledge, enactment of learner-centered pedagogies, student learning outcomes, and attitudes; more importantly, research is needed to verify which LCPD components improve both teachers' practices and student learning outcomes.

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Drew Polly is an Assistant Professor in the Department of Reading and Elementary Education at the University of North Carolina at Charlotte. His research agenda focuses on designing and examining the influence of learner-centered professional development on teachers' instructional practices in the areas of elementary mathematics and technology integration.

Michael J. Hannafin is Professor in the Department of Educational Psychology and Instructional Technology at the University of Georgia, where he directs the Learning and Performance Support Laboratory. His research is at the intersection of psychology, technology and education, where he develops and validates frameworks for technology-enhanced, student-centered teaching and learning.