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Participatory Design and the Learning Sciences

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Introduction

Learning scientists seek to study learning in context, often by immersing themselves in research within schools and classrooms, in collaboration with practitioners and other stakeholders. As they inquire into how learning happens, and how it can be improved, learning scientists frequently engage in the design and study of learning environments—an approach which affords opportunities for deep learning. Researcher–practitioner collaborations are essential vehicles to facilitate this process, as teachers and researchers each bring diverse perspectives to the joint effort. In this chapter, we use the terms "participatory", "collaboration" and "co-design" to refer to educational curricular, software, programmatic, or other design efforts involving researchers and practitioners (e.g., teachers, administrators) working together to address an identified problem of practice. These collaborations frequently involve designing an instructional tool that not only considers the needs of the students, but also addresses the needs of the teachers who are ultimately responsible for using these tools in the classroom (Edelson, Gordin, & Pea, 1999). Initially, the contributions of teachers and researchers to the design process may be distinct: researchers pay particular attention to theory-driven decisions, and teachers bring their pragmatic views on how learning is realized in practice. Over time, however, these roles may mesh and broaden, and all contributors develop deeper knowledge and expertise (Herrenkohl, Kawasaki, & Dewater, 2010).

The design and research stance involved in researcher–practitioner collaborations can be unfamiliar for both researchers and practitioners (Penuel, Coburn, & Gallagher, 2013). We begin by briefly discussing the foundations of current co-design approaches and guiding principles undergirding collaboration in the learning sciences literature, with a special focus on researcher–practitioner collaborative activities. We then highlight recurrent themes in the teacher–researcher collaboration literature, and describe the challenges and tensions that can emerge. We conclude the chapter with a discussion of the design principles that shape and guide these efforts, and offer insights into implications for practice and policy.

Foundations

Emergence of Participatory Design in Education

Research into participatory design originated in the work of Nygaard and Bergo, who created a handbook for the trade union movement based on their work with the Iron and Metal Workers' Union in Scandinavia (Nygaard & Bergo, 1973). Their effort described workers' disadvantage as

they struggled to participate in shaping production (Beck, 2001). To support effective negotiation with management (Nygaard & Bergo, 1973), participatory design efforts aimed to build trade unionists' deeper understanding of technical language and concepts about technology. As understandings about the importance of including end users earlier in the design process progressed, the notion of participation in design became more established in many applied fields, including architecture, civil planning, human-computer interaction, and the learning sciences.

In the early 1990s, researchers around the United States, in school-based efforts like Learning Through Collaborative Visualization (CoVis), the Center for Learning Technologies in Urban Schools (LeTUS), The Voyage of the Mimi, Schools for Thought, and the Supportive Scientific Visualization Environments for Education Project, were involved in participatory types of research, including software co-design, and professional development activities. For example, LeTUS (Marx et al., 2004), a collaborative project among Northwestern University and University of Michigan researchers and two large school systems (Chicago and Detroit), created contexts for curricular participatory design. These contexts, called work circles, represented an effort to democratize researcher–practitioner teams by explicitly recognizing, and drawing on, the distinct expertise and value of practitioners and researchers in joint curricular design efforts (Lewin, 1947). Undergirding these efforts was a commitment to creating curricular materials that were grounded in authentic contexts and pedagogy (Cognition & Technology Group, 1997) and in the interests of students and teachers (Rivet, Krajick, Marx, & Reiser, 2003). These early activities laid the groundwork for current co-design approaches, hereafter called participatory co-design (PCD), that focus on authentic problems of practice, and draw on the expertise of the group members (Kristiansen & Bloch-Poulsen, 2013).

Goals and Commitments of Co-Design

Typically, the object of activity in educational PCD is the development of an instructional tool or curriculum for specific contexts (e.g., D'Amico, 2010; Edelson et al., 1999; Kyza & Georgiou, 2014; Penuel & Yarnall, 2005). Researchers and teachers, as well as other key stakeholders (e.g., software designers, students, district administrators), collaborate to design or redesign an instructional innovation. As Recker (2013; Recker & Sumner, this volume) has noted, a central aim in involving teachers in design is to make instructional resources more useful and usable. Researcher–practitioner collaborations involve stakeholders as co-designers to address the needs of both students and teachers (Edelson et al., 1999; Penuel, Roschelle, & Shechtman, 2007), and to develop the practitioner capacity in, and ownership of, the instructional tools or curriculum (Kyza & Georgiou, 2014; Lui & Slotta, 2014).

PCD projects have historically been researcher-initiated. In this sense, the problem to be addressed may be identified at the launch of the co-design process (Penuel et al., 2007). Early conversations involve participants in defining the problem in greater detail, discussing pedagogical beliefs, and determining co-design goals (Cober, Tan, Slotta, So, & Könings, 2015). In co-design activities, researchers typically seek to co-create, or redesign, a locally useful instructional tool or curriculum. In each effort, it is important to consider whether all key stakeholders are involved in the process (Penuel et al., 2013).

Researcher–practitioner collaborations serve multiple goals. For example, pragmatically, teams need to attend to co-design tasks like the development of educational artifacts and tools. Research suggests that teachers indicate that this is of high priority to them (Gomez, Gomez, Cooper, Lozano, & Mancevice, 2016). At the same time, in co-design, researchers also aim to develop and validate theories. The collaborations pose opportunities and challenges, and require multiple levels of negotiation. The kinds of questions that can be explored are also highly dependent on the context of collaboration.

PCD educational artifacts are typically locally useful tools (Penuel & Yarnall, 2005). In many PCD contexts, researchers explicitly take a "distributed expertise" stance (e.g., Kyza & Nicolaidou, 2016), recognizing participants' expertise at different points of the design process (e.g., Lau & Stille, 2014). Researchers typically seek to maintain the team's focus on project goals (Penuel et al., 2007) as they

structure, facilitate, and document the design process (Kyza & Georgiou, 2014; Kyza & Nicolaidou, 2016; Penuel et al., 2007). Practitioners' roles and responsibilities often relate to pedagogical and curriculum decisions and planning, as well as implementing and reflecting on designs (Cober et al., 2015). However, we acknowledge the uniqueness of design, as roles evolve to fit design stages and needs (e.g., Herrenkohl et al., 2010; Penuel et al., 2007).

To be successful in researcher–practitioner co-design efforts, all participants need to feel that their contributions are valued (Cober et al., 2015; Herrenkohl et al., 2010). Achieving this requires mutual trust, scaffolding of participation, and situated reflection. The co-design process involves an ongoing negotiation of participants' expectations and goals, design goals, and constraints of the local context (Edelson, 2002; Johnson, Severance, Penuel, & Leary, 2016). However, the authority role attributed to researchers, due to funding and research priorities, cannot be ignored (Gomez, Shrader, Williams, Finn, & Whitcomb, 1999; Penuel et al., 2007). Recognition of issues of ownership, control, and power are important for team dynamics; however, in cases where this authority was set aside in favor of parity, researchers observed a negative impact on co-design processes (Lau & Stille, 2014).

Theoretical commitments. Generally agreed upon theoretical commitments to PCD efforts in the learning sciences include a commitment to the value of all co-design participants' expertise and contributions, and a sociocultural theoretical commitment to learning from, and designing for, local contexts. Co-design has evolved, over the past two decades, with respect to membership, frequency and length of meetings, designed tools, targeted audience, aims for transformation and local reform with attention to classrooms (Gomez et al., 1999), schools (Coburn & Stein, 2010), and district practices (Penuel, Fishman, Cheng, & Sabelli, 2011). Current efforts retain an emphasis on democratic participation and broader participation among relevant stakeholders, attending directly to practice in authentic contexts, and have a focus on the learners who will experience the designed artifacts. Closely connected to the co-design commitment is an aim towards researcher and practitioner capacity building, particularly understanding which designs are most effective, when, how, and for whom. Together, through co-design, researchers and practitioners contribute to and/or refine theory and knowledge about practice (Gomez et al., 1999).

Methodological commitments. Methodologically, co-design efforts are documented through, and refined within, a design-based approach. Co-design typically involves several sequential but often overlapping phases of design, documentation, and iterative refinement. Inquiry into, and documentation of, this process is often described as design-based research (Barab & Squire, 2004). Within these phases, participants collectively engage in problem identification, and identify the tool(s) and/or processes that will be designed/redesigned. Often one or more of the co-design participants iteratively "try out" processes, tools, curricula, etc. in local rather than laboratory settings, to ensure that the designed artifact meets local needs (Gomez et al., 1999). The design rationale serves as a North Star, as the team juxtaposes the design and implementation with project aims, checking to ensure that the initial stimulus problem is being addressed. As teachers "try it out," efforts are reported to the group, analyzed, critiqued, and often iteratively refined until the group converges on mutually satisfactory results. Local setting testing, and iterative refinement, help to ensure that the tool meets the needs of everyday users—teachers, students, and/or administrators. Throughout the co-design effort, collective reflection, multi-voiced discussion and decision-making, and public critique are emphasized.

Research Themes

To date, with few exceptions, most educational PCD efforts have originated in Europe and North America. Research typically centers on teachers and teacher learning, rather than on researchers or other participants, and predominantly describes K-12 classroom efforts, designing within the STEM and language arts (e.g., literacy) domains. Among others, research has examined the design and use of new software tools, online virtual lab activities, project-based classroom learning, and assessments.

Studies have been primarily qualitative in nature, employing ethnographic and case study approaches, as researchers seek to understand how to facilitate the co-design process while investigating its tensions, challenges, opportunities, and outcomes. Several principal research themes and findings are evident:

- Forms of teacher participation and the conditions which might have supported their involvement (Cober et al., 2015);
- Teachers' perceptions about co-design and ownership (Cviko, McKenney, & Voogt, 2015; Gomez et al., 2015; Kyza & Georgiou, 2014);
- Student learning as the outcome of teachers' collaboration in co-design (Cviko, McKenney, & Voogt, 2014; Gomez et al., 2016; Kyza & Nicolaidou, 2016; Shanahan et al., 2016);
- Tensions, strengths, and challenges of teacher–researcher co-design sessions (Hundal, Levin, & Keselman, 2014);
- Impact of co-design on teachers' professional development (Johnson et al., 2016; Jung & Brady, 2016; Kyza & Nicolaidou, 2016);
- Power structures, equity, and parity in participatory research (Lau & Stille, 2014; Samuelson Wardrip, Gomez, & Gomez, 2015; Vines, Clarke, Wright, McCarthy, & Olivier, 2013).

Opportunities for Future Exploration

Although there is a growing literature on educational co-design research, further research on co-design processes, challenges, and benefits seems warranted. While PCD teams, which are often interdisciplinary in nature, frequently require boundary-crossing negotiations to co-exist and thrive, we know very little about *how* participants, and other stakeholders, negotiate, cross, and experience these boundary crossings. Recent studies (Bronkhorst, Meijer, Koster, Akkerman, & Vermunt, 2013; Jung & Brady, 2016; Lau & Stille, 2014; Penuel et al., 2007) suggest that inquiry into boundary crossings is an important area to investigate.

PCD work is resource-intensive, may span months, and even years, and often yields large datasets, raising issues of what should be investigated, and how. Researchers increasingly examine the development, efficacy, and impact of designed products, and also the *role* of design as professional development for practitioners (Gomez et al., 2015; Greenleaf, Brown, Goldman, & Ko, 2013; Kyza & Nicolaidou, 2016). Although some research suggests that teachers who participate in PCD report increased ownership and agency (Bronkhorst et al., 2013; Kyza & Georgiou, 2014), it is not clear that the PCD is an effective approach for all teachers. Teachers' perceptions of pedagogy seem to influence co-design commitment (Cviko et al., 2015). Other such variables should be investigated in future research.

Few studies consider PCD quality and failures, as well as successes (Kwon, Wardrip, & Gomez, 2014); we need to understand more about what works in PCD, and under what conditions. For example, we need to know more about the impact of co-design versus other transformational practice approaches on teacher perceptions of their PCD roles, and contributions. To date, PCD quality refers to the relationship between the PCD process, the product (e.g., tools or curriculum), and alignment with the group's initial goals (e.g., student outcomes). Future research should aim to fine-tune hypotheses regarding PCD's impact on participants, and on targeted reform initiatives.

Theory building about PCD should increasingly explore its sustainability and the likelihood of scaling up beyond initially targeted impact. Most co-design teams are small, with only a handful of researchers and teachers involved. We need to know more about the different support needs of classrooms, schools and districts that seek to engage in productive co-design activities (Fogleman, Fishman, & Krajcik, 2006; Kwon et al., 2014; Kyza & Georgiou, 2014). Recently, studies employing design-based implementation research explore these concerns (see Fishman & Penuel, this volume). However, more empirical evidence, using varied methods, is needed in order to build learning sciences theory on scale and sustainability in co-design.

Challenges and Tensions in Collaborations

PCD participants work towards creating a new, shared activity system (Greeno & Engeström, 2014) in which expertise is distributed and supports mutual learning. Several considerations are essential to supporting the new system.

Time, Scheduling, and Pacing

Designing curricula and instructional materials is often an intensive and lengthy time commitment. School leaders must provide space and time for PCD within teachers' in-school schedule (Stieff & Ryan, 2016) and out-of-school constraints (e.g., Kyza & Georgiou, 2014). Researchers must negotiate funder-created project timelines. In PCD, group goals for teacher enactment and collaborative refinement of curricular and instructional materials compete within these constraints, and may lead to teachers implementing materials or assessments that are still in the early stages of development (Ko et al., 2016). Related to this issue of pacing, indicators of co-design impact may be still emerging (Penuel et al., 2007).

Shared Language and Understanding Goals

As in most other group contexts, each PCD participant will have his or her own interpretation, and way of describing, the group's goals and expectations. The language, that researchers and teachers use to discuss design problems and their solutions, relate to their understanding of the goal and outcomes. Even among teachers at one school, there are often different communities of practice according to discipline and grade (Samuelson Wardrip et al., 2015). Ko et al. (2016) provide illustrative examples of how teams in the READI project grappled with different understandings of how to support students to make claims within a discipline.

To ensure that all participants can fully participate in design, researchers need to be aware of how issues of power (Kristiansen & Bloch-Poulsen, 2013) and equity may affect the co-design process (e.g., Penuel et al., 2007; Stieff & Ryan, 2016). For example, a participant may hesitate to disagree or share an experience with someone who is an authority figure in their school or district (Stieff & Ryan, 2016). Relatedly, teachers may defer to researchers as the experts on a particular topic (Penuel et al., 2007). Researchers have tried to foster equitable co-design processes by highlighting practitioner expertise in the co-design process (Gomez et al., 1999) by making transparent how practitioner recommendations were important to the co-design progress, and were incorporated in newly designed materials (Stieff & Ryan, 2016), and with respect to the co-design effort itself, by emphasizing the frequent absence of predetermined design paths and content (Penuel et al., 2007).

Implications for Practice and Policy

In this chapter, we have discussed co-design as a vehicle for sharing and building expertise, the development of usable, pragmatic designs that meet the needs of the target audience, and as a capacity-building professional development tool. The research we described focused on researcher–practitioner co-design partnerships. While the learning sciences, as a discipline, remains in the early stages of theory building about co-design, research on this important and exciting approach to researcher–practitioner collaborations has begun to yield useful design principles that speak to structuring co-design efforts and attend to social and organizational considerations. These principles reflect the challenges, tensions, and opportunities that can inform both policymakers and practitioners about important analytic and design considerations in future co-design efforts.

The design principles for effective collaborations that we present in this section reflect accumulated understandings extracted from the co-design studies reviewed in this chapter. These principles are associated with more effective co-design processes and researcher–practitioner relationships. We

also offer insights regarding how these principles inform policy considerations on co-design and collaboration.

The Co-Design Process

- Co-design teams should establish and sustain honest relationships, trust, and mutual respect for the diversity of expertise contributed by each participant (Herrenkohl et al., 2010).
- Co-design teams should serve as contexts of situated learning, most often resembling learning communities and communities of practice (Fogleman et al., 2006).
- Co-design teams should focus on changing practice, and on student thinking, which are foci that help the different stakeholders unite on a shared vision for the co-design (Herrenkohl et al., 2010).
- Co-design team members, including researchers, must be explicit about what they hope to accomplish in the collaboration (Gomez et al., 2016).
- Co-design teams should establish mutually agreed-upon criteria for "what counts" as success (Blomberg & Henderson, 1990). These criteria are often context-based and can also reflect participants' positionality. A relevant concern is whether success criteria are iterative or summative in nature, or both.
- Co-design participation should be coupled with enactment to facilitate reflection about the co-design product and instructional practice, and to promote the enacting teachers' in-situ professional development (Kyza & Nicolaidou, 2016).
- Researchers should scaffold the co-design process (Cober et al., 2015); this scaffolding should include social and emotional support (Herrenkohl et al., 2010).

Organizational Considerations

- Systemic constraints, such as the co-design effort's fit with school priorities, should be taken into account; otherwise, teacher commitment to the team may diminish (Hundal et al., 2014; Jung & Brady, 2016; Penuel et al., 2007).
- Schools hosting co-design teams should allocate sufficient time for co-design work, the value of which is innovations that can be meaningfully used in teachers' classrooms. Traditionally, schools operate within a 6.5 - to 7-hour day structure. When teachers, or teachers and researchers seek to collaborate, they depend on planning time during the school day, allocated professional development day(s), or after-school time. District and school-level administrators should prioritize planning and scheduling to support co-design.
- Co-design team members should be aware that the co-design process is an iterative, collaborative, and practice-oriented endeavor, which requires substantial time and effort to be achieved, often occurring over several months or longer (Penuel et al., 2007).
- Co-design teams require sufficient resources. More than 20 years ago, Darling-Hammond and McLaughlin (1995) called for a redistribution of resources to "provide time for collegial work and professional learning" (p. 4). Too few state and local district policymakers prioritize the allocation of resources to support collaborative design at the local school level. State policymakers and university administrators share in this responsibility.
- Co-design efforts need dissemination mechanisms to share what has been learned, so that it can be of use to future researcher–practitioner collaborations. How co-design unfolds, and the benefits and challenges of these efforts, remains opaque to many educational researchers, school leaders, and practitioners. Dissemination that goes beyond conference presentations and publications is needed. Policymakers at the local district, and state levels, can signal the import of dissemination as a public good through linking expectations for sharing findings and, ideally, offering examples of white paper guidelines.

Conclusions

Learning scientists seek to understand learning in context, to build knowledge about learning, and to support learning. A particular approach to addressing issues of learning, in context, is the participatory co-design activity. In this brief chapter, our aim has been to characterize the foundations, theoretical commitments, and lessons learned from co-design research.

Researchers and practitioners bring diverse perspectives to collaborations as they analyze problems of practice, and co-design materials, tools, and processes to address complex local classroom teaching and learning concerns. By contrast to traditional approaches of non-context informed curricular design, in PCD the end-users are both the local context designers (practitioners) and those towards whom the design is directed (students). To arrive at a working design requires a great amount of investment of time and effort. While there is, yet, much to be learned about the long-term impact of co-design participation on practitioner professional learning, and its impact on the practice it seeks to transform (Cviko et al., 2015; Kyza & Nicolaidou, 2016), research suggests that the investment may be well worth the effort (Gomez et al., 2016; Kyza & Georgiou, 2014).

Further Readings

Cviko, A., McKenney, S., & Voogt, J. (2015). Teachers as co-designers of technology-rich learning activities for early literacy. *Technology, Pedagogy and Education, 24*(4), 443–459.

Cviko, McKenney, and Voogt conducted a case study to explore teachers' co-design experiences and students' learning outcomes. The authors conclude that the teachers' pedagogical approaches affected their co-design involvement and that co-designed activities had positive effects on student learning.

D'Amico, L. (2010). The Center for Learning Technologies in Urban Schools: Evolving relationships in design-based research. In C. E. Coburn & M. K. Stein (Eds.), *Research and practice in education: Building alliances, bridging the divide* (pp. 37–53). Lanham, MD: Rowman & Littlefield.

D'Amico presents a study of the Center for Learning Technologies in Urban Schools (LeTUS) project. The author highlights how the differing district contexts in Chicago and Detroit, and researchers' prior experiences with the districts, related to the co-design work in the two cities.

Herrenkohl, L. R., Kawasaki, K., & Dewater, L. S. (2010). Inside and outside: Teacher–researcher collaboration. *New Educator, 6*(1), 74–92.

Herrenkohl, Kawasaki, and Dewater present three moments from a teacher–researcher effort to characterize the nature of their collaboration. The authors suggest these efforts shifted teachers' and researchers' identities, and argue that teacher-researcher collaboration supports teacher and researcher professional learning.

Penuel, W. R., Roschelle, J., & Shechtman, N. (2007). Designing formative assessment software with teachers: An analysis of the co-design process. *Research and Practice in Technology Enhanced Learning, 2*(1), 51–74.

Penuel, Roschelle, and Shechtman provide a definition of educational co-design research, and describe characteristics of a co-design process.

Shanahan, C., Bolz, M. J., Cribb, G., Goldman, S. R., Heppeler, J., & Manderino, M., (2016). Deepening what it means to read (and write) like a historian: Progressions of instruction across a school year in an eleventh grade U.S. history class. *History Teacher, 49*(2), 241–270.

Shanahan and colleagues describe efforts to design history instruction that incorporated disciplinary reading and writing practices as part of Project READI. The authors provide an overview of learning goals that the history design team developed, and present an example of how one teacher on the design team integrated the learning goals in her regular history units.

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