Co-design, Collaboration and Communities: Context and environments that promote professional learning and changing practice

Abstract: Less examined in the CSCL literature are the collaborative and co-regulatory processes involved in work settings involving professionals learning together, e.g., *research-practice partnerships* (RPP; Penuel & Coburn, 2013) and communities of practice. In an effort to understand how collaborative learning applies to professional learning, we examine the process through the specific example of a RPP formed between educational researchers and higher education instructors co-constructing tools to support professional and systemic changes to instructional practice. Specifically, using a design-based research framework we provide an account of co-design involving researchers and instructors working jointly in a "tool creating" activity system within an authentic context of post-secondary STEM education. The early analyses identify the mediating role of the jointly constructed artifacts -- i.e., the workflows -- which are both the products and processes that allow for productive boundary crossings and collaborations between the participants.

Introduction

Sustainability and scalability of effective evidence-based educational interventions requires a new mindset that emphasizes collaboration and joint work between researchers and practitioners leading to mutual transformation (Fishman, Penuel, Allen, Cheng & Sabelli, 2013). Penuel and colleagues refer to such collaborations as *research-practice partnerships* (RPP; Penuel & Coburn, 2013). RPP privileges cultural exchanges and collaboration between the stakeholders, which involves "joint-work at boundaries" (Penuel, Allen, Coburn & Farrell, 2015). Typically, successful joint-work engages participants in a process of *co-design* (Penuel, Roschelle & Shechtman, 2007) and offers another perspective and setting from which to understand collaborative interaction. However, it is still rare to find examples in the literature of such new forms of mutualistic and mediated action. This study provides an account of co-design involving researchers and instructors working jointly in a "tool creating" activity system within an authentic context of post-secondary STEM education. Using a perspective borrowed from Cultural Historical Activity Theory (CHAT), we examine this process as well as the mediating tools – tools housed within an online platform consisting of an ecosystem of resources to promote the adoption of active learning. Specifically, we describe their development and begin to look at their prominence in the co-design process including the shaping of the participants' roles, within this RPP activity system; as well as the dialogical processes this places on the design of the tool itself. This study aims to explore how CSCL might learn from such work as well as how CHAT is an important framework that reveals aspects of the co-design process otherwise hidden.

Theoretical framework

Informed by socio-cultural theories of learning and instruction, which describe the socially based actions and the development of practice that, in turn, produces social outcomes (see Leont'ev, 1974, 1981, 1989; Nardi, 1996; Vygotsky, 1978), we consider co-design as situated, cyclical, and agentive tool-producing activity (see Voogt et al, 2015). From this socio-cultural activity research perspective, co-design is also seen as mediated action among subjects belonging to different (professional) cultural contexts (Engeström, 1999, 2001; Wertsch, 1997). Teacher practitioners and researchers engage in collaborative design of instructional materials by drawing on the cultural tools available in their respective sociocultural settings. From this perspective, analyzing co-design as mediated action involves focusing on artefacts used as tools, identifying them as parts of the whole "agent-acting-with-mediational-means" (Wetsch, 1997) and then recombining the various agent + tools situations (for instance the instructor, the researcher, the student). The notion of "object" in activity theory is helpful to support an expansive understanding of *enactment* and *embodiment* as engaging in activity systems where "motives and motivation are not sought primarily inside individual subjects – they are in the object to be transformed and expanded" (Engeström & Sannino, 2010). Much like Engeström's (2001) representation of third-generation activity theory, the joint work of co-design requires *boundary crossings* (Penuel et al., 2015). In this study we focused on the production of that

mediate the new practices. From this perspective, we frame the tool codesign process as an instrument-producing activity system that draws from the central activities of at least two different sociocultural traditions (teaching and research) and that is intended to lead to more advanced practices in both (Figure 1).
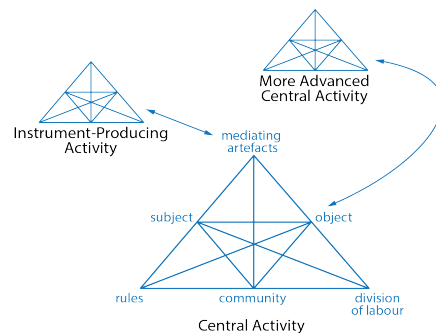
Figure 1. RPP codesign process as an instrument-producing activity in the CHAT framework. (adapted from Engeström [1987])

Professional Learning

Setting up lofty goals of achieving sustainable change to practice as well as addressing the challenges faced by CSCL to make large scale educational change (Hod, Sagy & Kali, 2018), the cultural-historical reality that is the object of our study is the adoption of active learning approaches to teaching and the professional learning that accompanies it. Active learning (AL) is a student-centred instructional approach that engages students in doing and thinking about what they are doing (Bonwell & Eison, 1991; Chickering & Gamson, 1987). Compared to traditional teacher-centred instruction, AL is shown to increase learning and achievement, particularly in STEM (Freeman, Eddy, McDonough, Smith, Okoroafor, Jordt & Wenderoth, 2014; Prince, 2004). Due to the shift in instructors' and students' roles, and the increased need for pedagogically structured learning tasks, sustained adoption and implementation of this evidence-based pedagogy remains difficult (Henderson & Dancy, 2008; Henderson et al., 2011; Kirkland & Sutch, 2009). In part, this difficulty is due to traditional professional development model that fails to account for the transformation of teachers' pedagogical beliefs (Gibbs, 2013; Hammerness et al., 2005; Saroyan and Trigwell, 2015; Olsson & Roxå, 2012). Marking a key challenge, AL instruction compared to traditional methods requires considerable knowledge about the intersection of pedagogy, learning and content – i.e., pedagogical content knowledge (PCK; Koehler & Mishra, 2009; Shulman, 1986; Gess-Newsome & Lederman, 1999; Gess-Newsome, 1999). This study examines how an RPP approach, featuring co-design, can contribute to a changing activity system.

Research-Practice Partnerships

RPP is an effort to bridge the gap between knowledge generated by research and its adoption into practice and vice versa, i.e., knowledge generated by practice and used to examine and refine theory. RPP can positively re-position practitioners within the process of system reforms (district and institution) as well as local (professional development efforts). From this socio-cultural perspective, teachers no longer are considered the end-point for the uptake of research, rather, they are a source of insight into the solution and the foundation for "a theory of action" (Penuel & Coburn, 2015, p. 191). RPP work involves cycles of planning-doing-studying-acting. These iterative cycles involve developing indicators of success both in the development, design, testing and refining phases (Penuel, Allen, Coburn & Farrell, 2015). Adding to the challenge of coordinating across partners are the different time scales on which research and practice operate. Practice can move quickly because there is no call for testing, while research often moves slowly because of the rigour demanded. In focusing on "problems of practice," RPP interventions involve the use of co-design approaches to develop educational solutions and to anchor the collaboration in long-term mutualistic partnerships involving the joint work at multiple boundaries (Penuel, et al., 2015). Penuel and colleagues identify the socio-cultural processes considered *boundary crossing* and *boundary practices* as productive constructs and concepts for understanding the relationship between research and practice. A boundary crossing is an event, whereas, boundary practices are "new routines that bridge the practices of researchers and those of practitioners as they engage in joint work" (p. 190). To accomplish the hybrid work done as part of these new activity systems, tools are developed, which others have referred to as *boundary objects* (Star & Griesemer, 1989) facilitating researcher-practitioner transactions. Within the RPPs, these boundary objects (both material and procedural) have interpretive flexibility and provide organizational structure. Objects in our context should be considered *boundary tools* because they are intended to mediate the boundary crossings.

Relating CHAT to Research-Practitioner Partnerships

CHAT helps us understand the complexity of the learning affordances of RPPs whereby different stakeholders/actors/activity systems interact so as to introduce dialogical tensions within the joint activity system. These tensions serve to drive the shared sense making and mutually transform each cultural system in ways that cannot take place within a single stakeholder's (original) activity system. For example, the learning affordances of a practitioner-only system have a different set of tensions and contradictions driving them, and are missing the particular tensions that arise at the intersection of the researcher and practitioner systems.

Research focus

Our study, presented in the next sections, identify such cultural resources, artifacts that are developed and used in the expansive cycles of co-design. The collaborative nature of the work analyzed calls for a conceptual framework capable of accounting for the intersubjective, dialogic processes across interacting activity systems (Engeström, 1987, 2009; Wertsch, 1997). We begin to highlight the joint-work of co-design that generates new roles and new division of labour – i.e., "go-betweens" (Penuel, et al., 2013) – and we examine these new roles and forms of participation.

Methods

Research Design

This research is an ethnographic case study using a Design Based Research (DBR; Anderson & Shattuck, 2012) approach. DBR is a methodology that uses mixed methods and iterative cycles of implementation and testing to help design tools or conceptual models that improve understand of the context and/or the intervention, in the process, adapting these to the support better learning and instruction. DBR findings, in addition to possibly informing theory, are directly applicable to the local environment and help to plan the general principles for creating subsequent educational interventions. Our analyses of the data is in the early stages and include a mix of qualitative approaches, here we present a narrative analysis from the perspective of the RPP team.

Participants and Context

The RPP is made up of approximately 18 participants, six educational researchers, five graduate students (all but one being from STEM disciplines) and six practitioners (instructors from STEM and non-STEM, instructional designers, and IT developers), from five post-secondary institutions situated in a northeastern city in Canada. The joint-work is accomplished primarily face-to-face but involves the direct use of the "Resources" section of the online platform, with particular emphasis on the representational form used to describe the documented AL instructional scripts - i.e., the workflows . Shaping this content, the Resources section is structured into a taxonomy consisting of three types: *approaches* grounded in instructional models (social-constructivist philosophy), *strategies* for promoting engagement (cognitive and social-cognitive mechanisms), and *activities* produced by practitioners (content-specific instructional scripts and materials to carry them out). The focus of the co-design process and DBR is the development of tools to document and share the activities. These tools allow for the joint-work of the practitioner and researcher team.
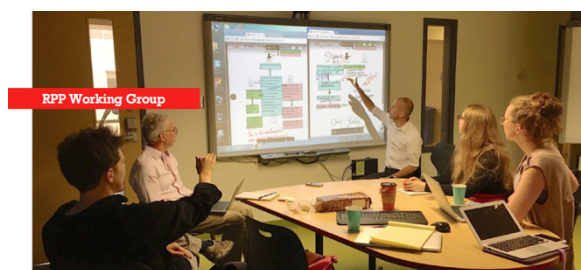
Figure 2. RPP team working on understanding the use of the workflow artifact leading to co-design.

Data Sources

The data in this study include both the historical records of meetings, audio/video recordings, field notes from documentation interviews and artifacts, including protocols, produced as part of the RPP team's development and joint work. Importantly, they include 72 activities collected from a purposeful sampling of practitioners, early adopters (or power users) who have designed and implemented active learning instruction in their own classrooms, in a

sustained manner over several years.. The workflows, boundary tool, described below, are generated from these documented activities and are both the object of the joint work as well as its outcome - i.e., both product and process.

Development of the Project

To date, the DBR project has gone through three phases. Phase 1, started in 2015, involved a RPP team made up of six individuals (two researchers, one research assistant (STEM discipline expert) and five practitioners, early adopters of active learning instruction), who together developed procedures and protocols for the collection and documentation of activities. Initial documentation involved activities used by these same practitioners, members of the RPP team. In an effort to describe the activities, the joint-work generated the first iteration of the workflows (Figure 3), this artifact allowed for the identification of tasks and the scripts that are inherent in AL activities. Phase 2 expanded the RPP team to include four more researchers, five research assistants (all graduate students, four with STEM expertise; original research assistant was replace) and gathering more activities from over 30 practitioners (not part of the RPP team). This phase allowed for further co-design and refinement of the workflows – i.e., depiction of relationships between the tasks involved in the activity and the instructional strategy (see Figure 4). Additionally, this phase saw a further development, a greater level of transformation of the research assistants into "go betweens." The next iteration, phase 3, is currently in progress and involves another level of collaborative work, the validation of the activities and the deployment of the boundary tools by the larger community, its other practitioner stakeholders. It will be is examining the role of these go-betweens and how their interactions with contributing practitioners leads to other forms of co-design including new mediating artifacts - templates of workflows that assist with the make sense of the workflow tools (see Figure 5). This phase is not fully described in the current paper.
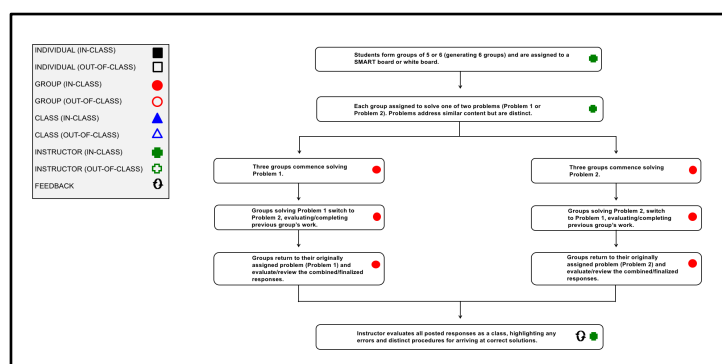

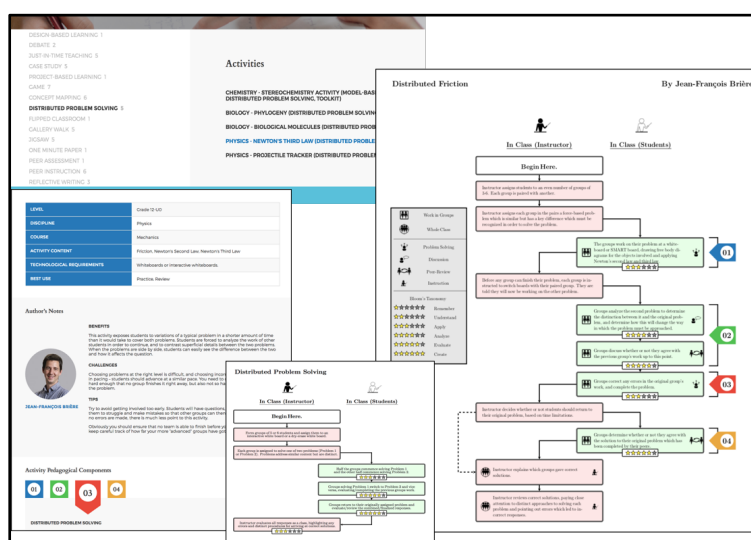Figure 3. Original workflow for Distributed Friction activity.

Figure 4. The framework describing the instructional activity including the workflow and the activity's components.
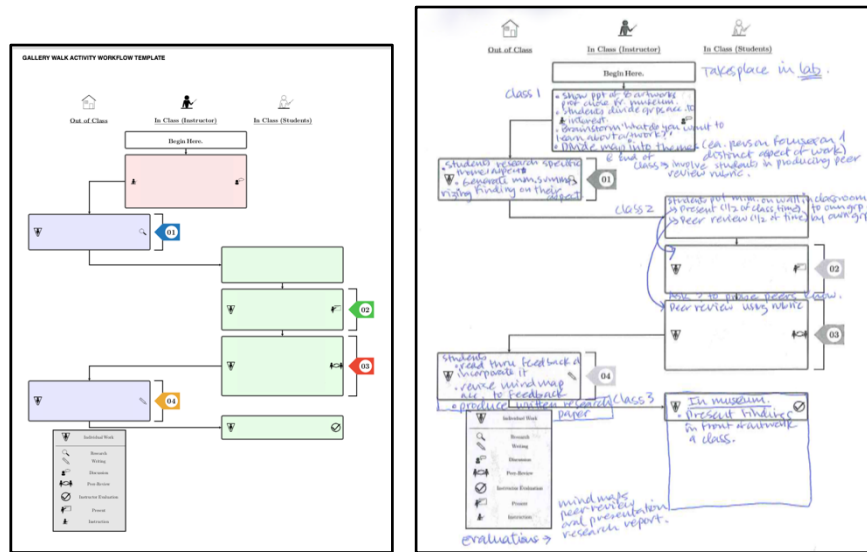
Figure 5. Workflow template and new practitioner attempt to develop new activity.

Workflow as Boundary Tool

We identify the activities workflow as our boundary tool because it allowed the team to cut across the instructional landscape that includes both pedagogy and content demands - i.e., boundary crossings between the native activity system of the respective stakeholders. The workflows transform the instructional activities into a symbolic language, understandable by researchers and practitioners alike but for different purposes. Based on the data, recordings of meetings, these artifacts provided researchers and practitioner a way to focus on the same element of the script to discuss their perspectives and opening up new conversations. Originally, in phase 1, the data show that these artifacts allowed the researcher to closely examine the instructional scripts of practitioners and identify where they may be intuitively implementing theory-based strategies and/or mechanisms. Some of these may or may not have potential to promote learning – e.g., the pre-class activity that includes written explanations eliciting the benefit of self-explanation (Chi et al, date) vs. reading assignment with no scaffolding of the learning. Meanwhile, originally, the practitioners appeared to view the workflows along the dimension of activity feasibility. Over time, in phase 2, the artifact has taken on new meaning to both stakeholders. The conversations between the researcher and practitioner have shifted to the icons and abstraction of the scripts, which allowed stakeholders to open up a new conversation and further co-design refinements to the tool - i.e., the icons (see legend on Figure 4). Additionally, this refinement provided opportunity for new boundary practice of sense-making around the workflow - i.e., reading the workflows like a symbolic script. On the side of researchers, they have begun conversations with practitioners that investigate the activities scripts for how well they move the content and objectives of the instructors – what might be considered orchestration (Dillenbourg, date). This effort at sense-making saw practitioners recognizing that their activity consists of components whose mechanisms originate in strategies. For example, in reviewing an activity, a group of practitioners recognized a series of tasks within the activity under study also described tasks that were part of a Peer Instruction strategy (see the component arrows in Figure 4). While such joint-work was more one that developed among practitioners, facilitated by research assistants, this new boundary practice of looking for strategies components has begun to develop between activity systems of the practitioners and research assistants. This co-design is resulting in the research assistants becoming the "in-betweens" adopting language that reflects both their discipline knowledge and their growing pedagogical knowledge.

A Model of Co-Design – the relationship between RPP and the boundary tools

As we examine the value of the workflow framework we observe that, like a Rosetta Stone, it appears to allow for boundary crossings. Consistent with our theoretical framework and DBR approach, we are beginning to analyze how the boundary tool helps to mediate our understanding of the co-design process and add to the understanding of collaborative processes. Thereby, we are developing a model that shows how we are moving toward a representation of the evolving activity systems that consist of the "go-betweens" (Figure 6). This new figure is helping us examine

how, like the third generation activity system shown earlier (Figure 1) how an artefact is continually refined, transformed and adapted to capture the knowledge co-production and exchange processes. In the case of our intervention, the workflows a boundary tool that allows researchers and practitioners to engage in the boundary practices that includes the cycle of developing and designing new instructional practices based on both the literature (research) and implemented activities (practice).
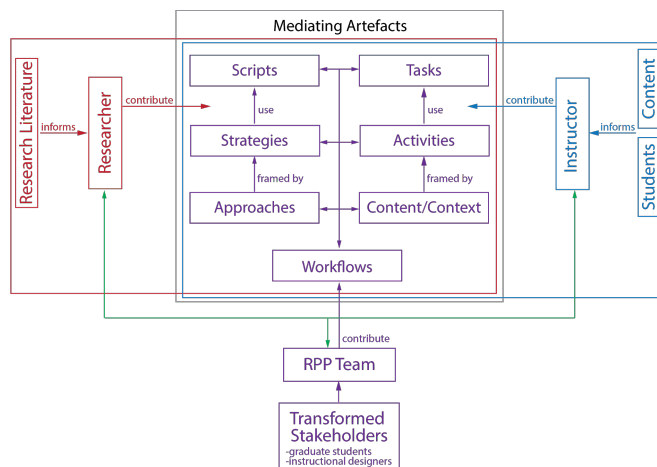
Figure 6. Iteration 2 of the instructional design boundary practices, joint work of practitioner and researcher within a common tool.

Significance of the Study

CHAT is a third-generation, social constructivist paradigm that, like the 4E (embodied, enactive, extended and embedded) paradigm, allows us to coherently study complex systems at play in the RPP professional learning processes, including personal, social, (multi-) cultural and technological interdependencies. It is helpful to support an expansive understanding of *enactment* and *embodiment* as engaging in activity systems.

With this paradigm, we've described a highly collaborative, tool-producing activity. The *boundary* nature of these tools allows them to mean different things to the various stakeholders in the activity, while still holding together the work and effectively mediating collaborative interactions over cooperative. To instructors they are tools for lesson planning; to researchers the tools are both deductive representations of the research-principles in action as well as objects of study to induce effective learning principles; to instructional designers they are transferable tools for promoting faculty professional learning through the adoption of active learning practices. Producing the tools allows each stakeholder to represent their own needs and expertise in the tool and to benefit from the representations of the other stakeholders' professional needs, expertise, ways of thinking, etc. The learning processes that take place within the RPP are thus highly interdependent on each stakeholder's contributions to the boundary objects and thus to the co-design process. They act as mediating tools that, in effect, bridge the divide between research and practice. The professional learning is also mutually expansive and transforming to all stakeholders. Despite the varied reasons for engaging in the RPP, the instrument-producing activity is intended to lead to improved practices, or more advanced central activities for each of the stakeholders (see Figure 1). For instructors, this entails the sustained adoption of effective active learning practices through understanding the structured, principle-based thinking of researchers. For the researcher, this entails the integration of practical expertise and contextual concerns in their own thinking, research programs and methodologies. For ID, this might entail a greater ability to use these sociocultural activity systems, themselves as tools to facilitate these types of expansive professional learning experiences with faculty. Each stakeholder emerges with a new, more evolved paradigm for their classical work. The CHAT model suggests the concomitant [could we say 'isomorphic'?] changes to occur in these change processes. For example, changes in RPP participants are expected in terms of identity (any refs for identity changes in teachers through prof dev?). Changes in the division of labour, such as how instructors work with others in the design and implementation of their teaching practices, how researchers work with practitioners to... And changes in the communities involved in and supporting those improved practices.

References

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research?. *Educational researcher*, *41*(1), 16-25.

Bonwell, C. C., & Eison, J. A. (1991). *Active Learning: Creating Excitement in the Classroom. 1991 ASHE-ERIC Higher Education Reports*. Washington, DC: ERIC Clearinghouse on Higher Education.

Çakır, M. P., Zemel, A., & Stahl, G. (2009). The joint organization of interaction within a multimodal CSCL medium. *International Journal of Computer-Supported Collaborative Learning*, *4*(2), 115-149.

Chickering, A. W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE bulletin*, *3*, 7.

Dobozy, E. (2012). Failed innovation implementation in teacher education: A case analysis. *Problems of Education in the 21st Century*, 40, 35-44.

Dougherty, D. (2016). Organizing Practices in Services: Capturing practice-based knowledge for innovation. *Strategic Organization, 2*(1), 35-64.

Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research.* Helsinki, Finland: Orienta-Konsultit.

Engeström, Y. (2009). The future of activity theory: A rough draft. *Learning and expanding with activity theory*, 303-328.

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1), 133-156.

Engeström, Y. (1999). Activity theory and individual and social transformation. *Perspectives on activity theory*, *19*(38).

Engeström, Y., & Sannino, A. (2010). Studies of expansive learning: Foundations, findings and future challenges. *Educational Research Review*, 5(1), 1-24. doi:10.1016/j.edurev.2009.12.002

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410-8415.

Fishman, B. J., Penuel, W. R., Allen, A. R., Cheng, B. H.,& Sabelli, N. O. R. A. (2013). Design-based implementation research: An emerging model for transforming the relationship of research and practice. *National society for the study of education*, *112*(2), 136-156.

Gess-Newsome, J., & Lederman, N. G. (Eds.). (1999). *Examining pedagogical content knowledge.* Boston, MA: Kluwer.

Gess-Newsome, J. (1999). Secondary teachers' knowledge and beliefs about subject matter and their impact on instruction. In J. Gess-Newsome & L. M. Lederman (Eds.), *Pedagogical content knowledge and science education* (pp. 51–94). Boston, MA: Kluwer.

Gibbs, G. (2013). Reflections on the changing nature of educational development. *International Journal for Academic Development*, *18*(1), 4-14.

Hammerness, K., Darling-Hammond, L., Bransford, J., Berliner, D., Cochran-Smith, M., McDonald, M., & Zeichner, K. (2005). How teachers learn and develop. In L. Darling-Hammond (Ed.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 358-389). San Francisco, CA: John Wiley & Sons.

Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of Research in Science Teaching, 48*(8), 952-984.

Henderson, C., & Dancy, M. H. (2008). Physics faculty and educational researchers: Divergent expectations as barriers to the diffusion of innovations. *American Journal of Physics*, *76*(1), 79-91.

Hod, Y., Sagy, O., Kali, Y. & Taking Citizen Science to School. (2018). The opportunities of networks of research-practice partnerships and why CSCL should not give up on large-scale educational change. *International Journal of Computer Supported Collaborative Learning.* DOI 10.1007/s11412-018-9287-9

Kirkland, K., & Sutch, D. (2009). Overcoming the barriers to educational innovation: A literature review. National Foundation Education Research. Retrieved from https://www.nfer.ac.uk/publications/FUTL61/FUTL61.pdf

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)?. *Contemporary issues in technology and teacher education*, *9*(1), 60-70.

Koschmann, T. (2002, January). Dewey's contribution to the foundations of CSCL research. In *Proceedings of the Conference on Computer Support for Collaborative Learning: Foundations for a CSCL Community* (pp. 17-22). International Society of the Learning Sciences.

Leont'ev, A. N. (1974). The problem of activity in psychology. *Soviet psychology*, *13*(2), 4-33.

Leont'ev, A. N. (1981). *Problems of the development of the mind*. Moscow: Progress.

Leont'ev, A. N. (1989). The problem of activity in the history of Soviet psychology. *Soviet psychology*, *27*(1), 22-39.Lipponen, L., Hakkarainen, K., & Paavola, S. (2004). Practices and orientations of CSCL. In *What we know about CSCL* (pp. 31-50). Springer, Dordrecht.

Lipponen, L., Hakkarainen, K., & Paavola, S. (2004). Practices and orientations of CSCL. In *What we know about CSCL* (pp. 31-50). Dordrecht: Springer.

Nardi, B. A. (Ed.). (1996). *Context and consciousness: Activity theory and human-computer interaction*. Cambridge: MIT Press.

Olsson, T., & Roxå, T. (2012). A model promoting conceptual change in higher education – an integrated approach. In N. Brown, S. M. Jones, & A. Adam. (Eds.), *Research and Development in Higher Education: Connections in Higher Education*, 35 (pp 213 – 223). Hobart, Australia, 2 – 5 July.

Penuel, W. R. (2014). Emerging Forms of Formative Intervention Research in Education. *Mind, Culture, and Activity*, 21(2), 97-117. doi:10.1080/10749039.2014.884137

Penuel, W. R., Allen, A. R., Coburn, C. E., & Farrell, C. (2015). Conceptualizing research–practice partnerships as joint work at boundaries. *Journal of Education for Students Placed at Risk*, *20*(1-2), 182-197.

Penuel, W. R., Coburn, C. E., & Gallagher, D. J. (2013). Negotiating problems of practice in research–practice design partnerships. *National Society for the Study of Education Yearbook*, *112*(2), 237-255.

Penuel, W. R., Fishman, B. J., Haugan Cheng, B., & Sabelli, N. (2011). Organizing Research and Development at the Intersection of Learning, Implementation, and Design. *Educational Researcher*, 40(7), 331-337. doi:10.3102/0013189x11421826

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*(01), 51-74.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, *93*(3), 223-231.

Sannino, A., Daniels, H., & Gutierrez, K. D. (Eds.). (2009). *Learning and expanding with activity theory*. New York: Cambridge University Press.

Saroyan, A., & Trigwell, K. (2015). Higher education teachers' professional learning: Process and outcome. *Studies in Educational Evaluation*, *46*, 92-101.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14. Stahl, G. (2002, January). Contributions to a theoretical framework for CSCL. In *Proceedings of the Conference on Computer Support for Collaborative Learning: Foundations for a CSCL Community* (pp. 62-71). International Society of the Learning Sciences.

Timmis, S. (2014). The dialectical potential of Cultural Historical Activity Theory for researching sustainable CSCL practices. *International Journal of Computer-Supported Collaborative Learning*, *9*(1), 7-32.

Van Aalst, J., & Hill, C. M. (2006). Activity theory as a framework for analysing knowledge building. *Learning Environments Research*, *9*(1), 23-44.

Voogt, J., Laferrière, T., Breuleux, A., Itow, R. C., Hickey, D. T., & McKenney, S. (2015). Collaborative design as a form of professional development. *Instructional science*, *43*(2), 259-282.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wertsch, J. V. (1997). Mind as Action. Oxford: Oxford University Press.