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Abstract

This squib continues the ongoing conversation put forward by Wise and Schwarz around the direction and future of CSCL. We focus here on the question of whether or not CSCL should seek to make educational change. Here, we take the affirmative position by conceptualizing the network of design-centric research practice partnerships. We illustrate how this could work through an ongoing instantiation called Taking Citizen Science to School, a multi-year research center with joint funding from research and practice-based governmental institutions.

Keywords (separated by '-')	Citizen science - CSCL - Educational change - Research-practice partnership
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The opportunities of networks of research-practice partnerships and why CSCL should not give up on large-scale educational change

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Abstract
This squib continues the ongoing conversation put forward by Wise and Schwarz around the direction and future of CSCL. We focus here on the question of whether or not CSCL should seek to make educational change. Here, we take the affirmative position by conceptualizing the network of design-centric research practice partnerships. We illustrate how this could work through an ongoing instantiation called Taking Citizen Science to School, a multi-year research center with joint funding from research and practice-based governmental institutions.

Keywords Citizen science · CSCL · Educational change · Research-practice partnership

CSCL should not give up on educational change

Wise and Schwarz's (2017) Provocation 8 presents a debate in the CSCL community around the question of whether or not we should give up on the goal of promoting large-scale educational change (Fig. 1). While conceding that educational change projects that helped inspire CSCL—such as ENFI, CSILE, and 5thD—aimed for change, the provocateur/provocatrice argues that the field has since moved on from there (see P1 and 2 in Fig. 1). The main focus of CSCL, which has turned into understanding the complexities of collaboration with technology, has become a goal in itself, in many ways circumventing the need to work through the intricacies of normative educational contexts (P3). The provocateur/provocatrice continues with this line of argumentation that CSCL has not focused on trying to make wide-scale change, leaving the job for other

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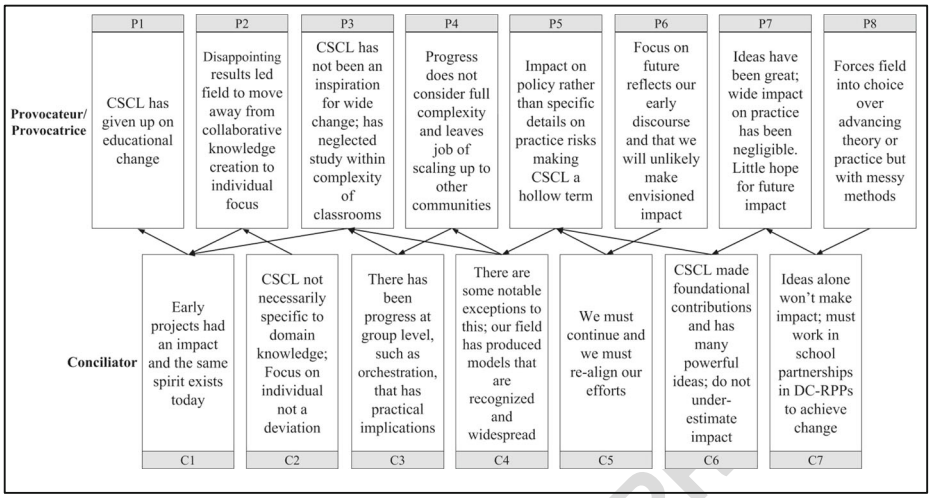

Fig. 1 Summary of Provocation 8

research communities (P4). Even if the field has contributed to policy generally (by demonstrating its importance), the lack of specific details on how it should be implemented given the real constraints of practice makes the goal of promoting large-scale change hollow (P5). The provocateur/provocatrice concludes with the sober point that the field has moved away and is unlikely to realize its envisioned impact (P6, 7), and instead should focus more on theoretical advancements than on implementation research (P8).

The conciliator of this debate concedes that CSCL has not made widespread educational change (C5). But, in the retort, argues that while the theory and methods to impact practice may need to be advanced, they are already an active part of the CSCL agenda (C1 through 4). These include a whole range of design-based research studies, even some at a large-scale (e.g., Chan 2011), which have led to implementation-based concepts like orchestration or macro-scripts. These also include some foundational ideas that have shaped the way people think about learning and education, even if the impact is often underestimated (C6). The conciliator concludes by pointing to the growing movement toward developing design–centric research–practice partnerships (DC-RPPs), which aim to develop scalable and sustainable approaches to CSCL and avoids the hubris of thinking the field can make change without engaging with teachers or school systems directly (C7).

In our analysis of this debate, we believe that there are two main counter-arguments to the provocateur/provocatrice's position, strengthening the case that CSCL should promote educational change. The first counter-argument has to do with the provocateur/provocatrice's distinction made between advancing theory and practice at a small scale versus doing so at a large scale (P3, 8). *We believe there is a fertile, middle ground, between these two alternatives.* The provocateur/provocatrice argues that seeking scalable implementation would require different types of knowledge claims than those that are currently pursued. At its foundation, "CSCL is a field of study centrally concerned with meaning and the practices of meaning-making in the context of joint activity, and the ways in which these practices are mediated through designed artifacts" (Koschmann 2002, p. 20). Thus, the recognition of complexity and

factors that go beyond what researchers can control is already taken into consideration at both levels. Furthermore, knowledge advancement in CSCL (like any other field) depends on the distributed engagement of researchers in the community (Zhang et al. 2009). This fact is recognizable in the CSCL book series,[1] which covers topics across domains, technologies, contexts, and scales. While it may be challenging for individual researchers to be involved in both scales of study at the same time, as a field this is not the case. To the contrary, ideas developed on each of the different levels mutually enrich the other. For example, the idea of productive multivocality emerged when researchers from different analytic traditions came together to examine the same data (Suthers et al. 2013). Ideas from this research, such as the pivotal moments when participants match new meanings to others' interpretations, are clearly useful in implementations at the large-scale when there are varied stakeholders engaging around common goals.

The second counter-argument in response to the provocateur/provocatrice relates to P6 and 7. Their argument is that because there has not been widespread change (or at least a tangible impact) in practice despite CSCL's envisioned goals, there is little hope to realize this in the future. *We believe there are other conclusions to be reached.* Just because CSCL hasn't become pervasive across the formal educational landscape, it does not mean that the field has not made significant contributions to this effort (as the conciliator argues in C6). Moreover, it is possible that a tipping point is underway or about to commence (Collins and Halverson 2009), but given the scope of change required in the social, cultural, political, and economic institution of schooling, we are evaluating it from too close a resolution. Lastly, fostering change is a long-term effort. Even if we accept the provocateur/provocatrice's arguments that we have, to some extent, abandoned our focus on making educational change (P1) and group-centered knowledge-creation (P2), this does not mean that we have thrown out the baby with the bath water. It is essential that ideas in CSCL be tested in classrooms to assess their validity and educational applicability at scale; this type of rigorous research supports the field's effort to make large-scale change. Taking these points together suggests that we take a growth mindset (Dweck 2006). We should view the setbacks and challenges in our raison-d'être of making sustainable and scalable changes as opportunities to continue finding better ways to realize our vision.

To sum, if we accept the reasonable points that CSCL research (a) is diverse and can focus on many issues at various grain-sizes; (b) has made significant impacts but requires additional, wider-lens tools to make these impacts more visible; (c) requires a plethora of small-scale research to serve as a basis for large-scale implementation studies; and (d) must maintain a growth mindset regarding the long-term goal, then the conciliator's recognition of DC-RPPs as a next step in the evolution of the field is an appropriate one. To further advance this point, we draw out the model of DC-RPPs that the conciliator refers to, but also sharpen what we believe are its key features to effectuate sustainable and scalable change. We describe a current CSCL project in Israel to illustrate this model in the hopes that it can spur the re-alignment efforts that the conciliator described (C5). To sum, we believe CSCL research offers an exciting—if not inevitable—way forward to promote educational change and should not give up on it.

[1] www.springer.com/series/5814?detailsPage=titles

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Building networks of research-practice partnerships: A CSCL model for educational change

While a great deal of educational research can be characterized as having 'data extraction agreements' (Wagner 1997) where researchers study practitioners in the field, new lines of research have been developing approaches that challenge this type of hierarchical relationship (Kali et al. 2018b). In particular, *research-practice partnerships* (RPPs) seek mutually-beneficial collaborations in which people who come from different communities of practice—particularly researchers and practitioners—generate a common discourse around mutually-shared interests. For researchers, this is to investigate theoretical ideas that lead to some educational innovation; for practitioners, this is to support the learning of their students based on theoretically- and empirically-grounded pedagogies (Coburn and Penuel 2016).

Recently, members of the CSCL community have advocated the provocative notion that teaching can (and probably should) be viewed as a design science (Laurillard 2012). Design-centric research-practice partnerships (DC-RPPs) typically involve various types of practitioners who co-design learning environments in collaboration with educational researchers (Kali et al. 2018a, b; McKenney and Schunn 2018). The multiple expertise in such partnerships situate RPPs in especially productive positions to develop what Bereiter (2014) entitled 'principled practical knowledge'. Stated differently, the outcomes of DC-RPPs include design principles that enable people who wish to adopt (and potentially adapt) the model, to understand the rationale behind the design, and to learn from others' practical considerations of implementation (Kidron and Kali 2017).

While DC-RPPs underlie many CSCL efforts for implementing innovation in schools, several projects have risen-above this model to form *networks of DC-RPP*s that seek to foster large-scale educational change. For example, the Knowledge Building International Project (KBIP 2007–2014) focused on sustainable pedagogical-technological change by "building networks of stakeholders within the local communities and between the international communities[2]". KBIP involved the co-design of knowledge building communities from within and outside the classroom in partnerships between schools, universities, and government (Laferrière et al. 2015). Supporting Active Learning and Technological Innovation in Studies of Education (SALTISE) is another example of a community of researchers and practitioners who have created a network of local DC-RPPs. At the local level, researchers and practitioners engage in co-design methods to develop pedagogical innovations and the design of active learning classrooms. These local learning communities convene regularly to "expand their repertoire of best practices[3]" and tools that support practitioners' implementation of active learning instruction often including policy-makers to support their efforts (Charles et al. 2014). A third example is the community that has evolved since 1997 in relation to the Web-based Inquiry Science Environment (WISE) online platform for designing, developing, and implementing science inquiry activities (Slotta and Linn 2009).[4] WISE has served a growing community of more than 15,000 science teachers, researchers, and curriculum designers, as well as over 100,000 K-12 students around the world. Members of the community have developed multiple ways to learn from each other, synthesize, and share the design knowledge within the community. This includes workshops in which practitioners and researchers

[2] kbip.co/en/node/24
[3] www.saltise.ca/about/about-us/
[4] wise.berkeley.edu/

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collaborate to adapt and co-design modules (e.g., Matuk et al. 2015), an interactive database of design principles (Kali 2006), and co-authored publications that emphasize both research and practice (e.g., Linn and Hsi 2000), as well as policy (Kali et al. 2008).

The above examples represent CSCL-oriented endeavors not only due to the technology-enhanced collaborative learning they encourage among students, but also, due to the networked nature of the work among researchers, practitioners, policy-makers and others (Kali et al. 2018a). Although these examples may not call themselves *networks of DC-RPPs*, they are part of the way CSCL has re-aligned itself in recent years to make sustainable, large-scale change in educational practice. CSCL-oriented networks of DC-RPPs create a context for small-scale, local DC-RPPs to interact, collaborate and develop principled-practical knowledge at a broader level. Since policy-makers are in charge of high-level decisions that require consideration of multiple sets of local conditions, networks of DC-RPP provide them with both purpose and utility to join practitioners and researchers in an ongoing dialogue in the process of designing and implementing educational change (Fig. 2). This participatory role for policy-makers comes in addition to the traditional ways that researchers interact with policy-makers via proposals, funding, and reports (Penuel 2015).

Instantiating networks of DC-RPPs

Consistent with these developments within the CSCL research community, there are promising signals that practitioners and policy-makers are similarly attuned to these ventures. For example, in Israel, the Ministry of Education recently joined with the Israeli Science

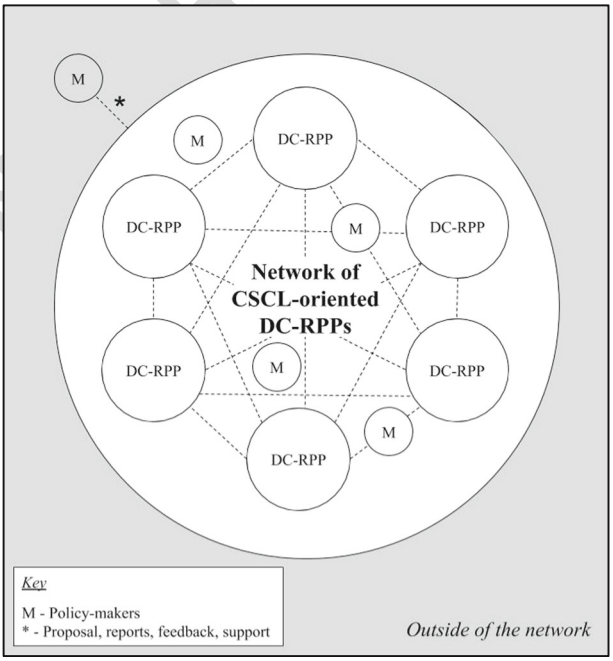

Fig. 2 CSCL re-alignment efforts to make sustainable, large-scale change through networks of CSCL-oriented design-centric research-practice partnerships that have ongoing dialogue with policy-makers

Foundation with a call for proposals around creating research centers seeking to implement and promote the understanding of meaningful learning.[5] We report here on our 5-year (2017–2022) nationally funded research center as an instantiation of our DC-RPP networks approach that is deeply rooted in CSCL and can help advance the field by providing a clear framework that builds on this idea. Specifically, our new center—*Taking Citizen Science to School*—promotes large-scale educational change by connecting scientists and citizen scientists to classrooms while including policy-makers as one of the voices around the table within the network of DC-RPPs.

Taking citizen science to school

Taking Citizen Science to School (TCSS) leverages exciting developments around the phenomena of citizen science to support meaningful learning. CSCL runs through multiple levels of this center, both by dealing with shared meaning making around online platforms as part of citizen science, and by bringing together different communities of practice into a joint network.

Generally defined as the direct participation of citizens in different stages of scientific research projects, citizen science has grown rapidly in recent years in many scientific fields including biology, physics, astronomy, ecology, geology and computer science (Silvertown 2009). For example, with the help of 100,000 citizen scientists, the Galaxy Zoo project[6] was able to classify over one million galaxies within nine months, a feat which would have been simply impossible to carry out by scientists and computation alone (Clery 2011). TCSS connects formal education with these citizen science endeavors primarily through the use of shared, online platforms so that participants can contribute to, analyze, and shape the growing knowledge base. Just as public participants benefit by acquiring new skills and knowledge and hands-on understandings of scientific processes (Brossard et al. 2005; Raddick et al. 2009), school students in TCSS are provided with opportunities to engage in the authentic advancement of scientific knowledge. However, these platforms are enhanced with co-designed learning environments that are suited for local needs, affordances and constraints.

TCSS brings together three pillars which, together, create a robust theoretical and practical foundation for meaningful STEM learning in the twenty-first century. The first pillar, *Vision II of scientific literacy*, articulates the goal of our initiative: To cultivate a scientifically knowledgeable citizenry to take part in democratic decision-making processes of social significance (Aikenhead 2005; Bybee and DeBoer 1994; Roberts and Bybee 2014). The second pillar, *Science and Data Literacies*, articulates the key competencies necessary for STEM learning (NGSS Lead States 2013; NRC 2012; Wild et al. 2018). Lastly, the *Connected Communities of Learners* pillar draws on state-of-the-art conceptions of learning that have practical implications on how to design and foster innovative learning environments in the networked society (Cole and Packer 2016; Sawyer 2014).

While evidence of the benefits of citizen science indicate its powerful potential for learning, vital developments are needed that tie theoretical groundings of STEM learning with citizen science in schools as well as ways to foster their successful implementation at scale (Mota et al. 2017; Vitone et al. 2016). Stated differently, comprehensive approaches that integrate cutting-edge theory and lessons learned from best practices are needed to connect formal education and citizen science. We have therefore created a network of DC-RPPs—called the TCSS

[5] www.isf.org.il
[6] www.galaxyzoo.org

network—as a CSCL framework that seeks to (a) advance theory, (b) foster large-scale educational change, and (c) guide long-term policy (Fig. 3).

The TCSS network

TCSS seeks to build the capacity of existing local school ecologies to engender sustainable change and innovation at scale. Doing this involves identifying and realizing a shared vision between researchers, practitioners, experts, and policy-makers who co-create knowledge, which is at the heart of the *research-practice partnerships* (Coburn and Penuel 2016) and *teachers as designers* movements (Kali et al. 2015; Goodyear 2015) and which underlies the notion of network of DC-RPPs.

The foundation of the TCSS network is a progressively growing number of DC-RPPs. The core effort is to bring together multiple stakeholders by hosting network-wide events that support the developing DC-partnerships. To advance the ideas that emerge, we have designed a revised Design Principles Database (DPD: Kali 2006). The DPD is a socio-epistemic-technological infrastructure that allows all the stakeholders to publish, connect, discuss, review, and advance their ideas. The purpose is to capture the lessons learned regarding the various implementations, addressing issues related to the combinations of locality (teacher, school, district), support (pedagogical, technological, organizational), phase (modeling, coaching, fading), and policy (Shamir-Inbal et al. 2009). The principles provide a common language for sharing, as well as continued collaboration on context-specific ideas among the TCSS network, beyond the 5-year scope of TCSS as well as with wider domestic and international audiences.

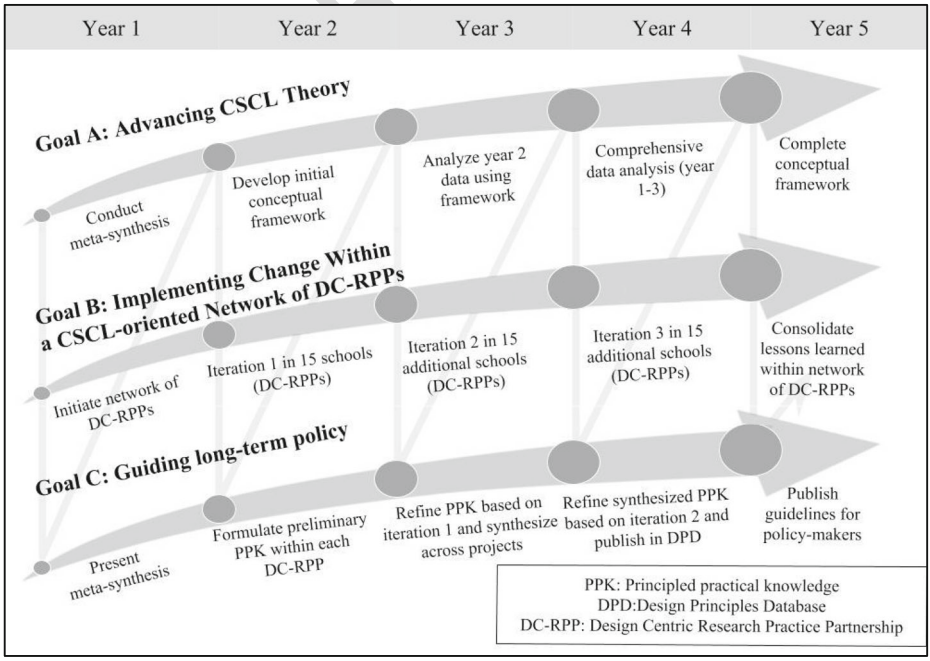

Fig. 3 Taking citizen science to school major milestones and relations between theoretical, implementation, and policy goals

In summary, the network of DC-RPPs is a CSCL instantiation that aims to foster sustainable change at-scale. To do this, various mechanisms give the relevant stakeholders a legitimate voice throughout the process. Network-wide events give all the stakeholders an opportunity to share their unique perspectives, listen and learn from one another, consider and reconsider the mission and vision, and advance the collective knowledge. The negotiated principled practical knowledge from the ongoing activities that come together during these network meetings and conferences become artifacts for later use and advancement through the revised DPD.

Discussion and conclusion

The provocateur/provocatrice received the last word in Provocation 8! In this squib, we have tried to support the conciliator's position that CSCL has and should continue to focus on making educational change at scale by providing new counter-arguments and supporting them with relevant explanations and examples. It is not our intention to introduce a definitive model nor to argue that all CSCL should be focused at this level of research. Rather, our intention in this squib is to show that the field has not abandoned its original mission, if only requires the constant re-aligning necessary with any large endeavor. Therefore, by participating in this debate we have leveraged the opportunity not only to strengthen an argument, but also to highlight a path forward for the field. We have argued that for CSCL to make educational change at scale, the principled practical knowledge that needs to be created and advanced should be at the nexus of practitioners, researchers, and policy-makers. Networks of DC-RPPs are conceptualized along these lines, helping us to operationalize these ideas in practice. The TCSS center illustrates one possible model for doing this, built-on years of CSCL innovations and organized by CSCL researchers.

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Q3. The citation “Kali, Eylon, McKenney & Kidron, 2018” has been changed to “Kali et al., 2018b” to match the author name/date in the reference list. Please check if the change is fine in this occurrence and modify the subsequent occurrences, if necessary.
Q4. The citation “Kali et al., 2018” has been changed to “Kali et al., 2018a, b” to match the author name/date in the reference list. Please check if the change is fine in this occurrence and modify the subsequent occurrences, if necessary.
Q5. The citation “Kali, Baram-Tsabari & Schejter, 2018” has been changed to “Kali et al., 2018a” to match the author name/date in the reference list. Please check if the change is fine in this occurrence and modify the subsequent occurrences, if necessary.
Q6. Please check captured doi for this reference if correct.