Special issue
Knowledge Building
as New Perspective
for Education

Edited by
Frank De Jong,
Stefano Cacciamani

Indice

Connecting between systems for classroom-based Knowledge Building sustainability and scalability

Thérèse Laferrière, Cesar A. A. Nunes**, Niall MacKinnon***,
Linda Massey****, Chew Lee Teo*****, Richard Reeve******,
Telma P. Vinha*******, Vincent Gagnon*********

Abstract

This paper addresses sustainability and scalability from the lenses of connections within and between Knowledge Building education sites. Firstly, Knowledge Building (KB) is positioned as a transformative emerging 'system within a system' and vignettes capture KB presence at different sites. Secondly, the methodology underlying the paper is presented. Thirdly, connections within and between activity systems, tensions that were overcome and next steps for KB sustainability and scalability are identified. Fourthly, the discussion is itself a KB process for cultural and organizational transformation of and within education systems, including public policy.

* Laval University, Quebec, Canada, ⓘ orcid 0000-0001-6560-3118.
** State University of Campinas, Brazil, ⓘ orcid 0000-0001-5792-507X.
*** Avernish Prospect, formerly of Plockton Primary School, Scotland, UK, ⓘ orcid 0000-0001-9797-6453.
**** Ontario Principals' Council, ⓘ orcid 0000-0002-0716-6703.
***** National Institute of Education, Singapore, ⓘ orcid 0000-0002-3526-3260.
****** Queen's University, Canada, ⓘ orcid 0000-0001-9915-922X.
******* State University of Campinas, Brazil, ⓘ orcid 0000-0002-0510-8390.
******** University of Quebec, Canada, ⓘ orcid 0000-0002-8356-1924.
Corresponding author: therese.laferriere@fse.ulaval.ca.

Introduction

The aim of this paper is to address sustainability and scalability pertaining to Knowledge Building (KB) in primary and secondary school systems. Sustainability refers to an innovation that persists over time and scalability to its spread within and beyond an educational system. We explore organizational and cultural transformations at local, regional, or national scales. What have been the connections and the tensions resolved for innovation to occur (Engeström, 2015), sustain and scale? What have been those unresolved, the connections discontinued, yet which were critically important for sustainability and scalability? What next steps are necessary?

KB is positioned as a transformative emerging 'system within a system'; the methodology underlying this paper features five case studies of KB evolution in five different countries. Results and vignettes of diverse KB systems and local, regional, national, and international KB connections are presented. Tensions that need to be overcome in and between systems are identified. Ways forward for such innovation, for its sustainability and scalability, are identified. The paper ends with next steps for cultural or organizational transformation of and within education systems.

Conceptual framework

In a variety of contexts, researchers, teachers, and administrators have set conditions for classroom-based KB. The more a classroom's activity embodies the KB principles (Scardamalia, 2002), the more it transforms itself into a fully-fledged Knowledge Building Community (KBC). These principles stress individual teachers' and students' agency as well as collective cognitive responsibility. At best, KB comes

to constitute the classroom curriculum as presentations at the annual Knowledge Building Institutes suggest.

There is linkage with cognate approaches such as Sahlberg's (2005) 'curriculum as a framework', moving away from his conceptualised 'curriculum as a product'. In Scotland an attempt to construct a different pedagogical approach across a system was termed 'Building the Curriculum' by the Scottish Government (2006-10) as a five-year five-stage programme of school collaboration, inquiry, and development. Interestingly this was met with the astute observation of Bloomer (2008) that "the dangerous word is curriculum". He noted that the national policy shift was altering the meaning of the term curriculum itself so that what was being 'built' was a transformational pedagogical approach. This created a deep tension, still being worked out.

Bereiter and Scardamalia have nurtured connections at all levels, local, provincial, national, and international. They undertook ground-breaking work with the Institute of Child Studies, now the Dr. Eric Jackman Institute of Child Studies (Toronto). They conducted the Computer Supported Intentional Learning Environment (CSILE) project with the participation of an Inuit nation and, at national level, headed two of the seven research strands of the Telelearning Network of Centres of Excellence (1995-2002, Canada). At the international level, they participated in the School for Thought project funded by the NSF in the USA. They created the Institute for Knowledge Innovation and Technology (IKIT) and the Knowledge Building Summer Institute (KBSI), within which international colleagues have been playing a key role. Knowledge Building International (KBI) is a more recent system whose membership includes KB graduates, teachers, researchers, administrators, and developers. KBSIs are now held under KBI, and a newsletter also connects KB members and their activities.

Engeström (2015) suggests that the resolution of tensions in and between systems is innovation encapsulated. Such site-based tensions may emerge within or between the constituents of a single activity system or as an activity system interacts with other activity systems. Thus, classroom based KBCs are more likely to flourish if their initiators are

attentive to internal tensions that may appear within and between the constituents of their activity system as well as tensions that emerge as theirs interacts with other activity systems. These require strong conceptual and theoretical understanding together with local ownership of goals and processes even if within more overarching policy frameworks.

Coburn's (2003) definition of scalability includes: depth, sustainability, spread, and shift of ownership. *Depth* refers to the understanding of the essential characteristics of an innovation (e.g., KB principles) and its implementation given valued improvements over current practice. *Sustainability* is the extent to which innovations are maintained in ongoing use. *Spread* is the extent to which large numbers of people or organizations adopt an innovation. *Shift of ownership* involves users adapting an innovation to their own situations and advocating its usage to other, later potential adopters. Describing the River City curriculum, Clarke and Dede (2009) added "evolution" as a fifth component of scalability. *Evolution* concerns learning by the original creators of an innovation from its users.

Background

At the Knowledge Building Summer Institute 2022, KB activity at five education sites was presented with an emphasis on connections. Vignettes of these sites provide glimpses into the diversity of contexts and the nature of their KB activity:

Table 1. The activity systems at the education sites

Education sites	The activity system(s) at the sites	Description
Vignette Ontario, Canada LSA + KB Connects	*Linda Massey – Leading Student Achievement (LSA): Networks for Learning KB Connects in Ontario, Canada and Internationally*	The LSA project (2005-2019) developed infrastructures for collaboration on multiple levels for the benefit of student achievement. Partners of this large-scale effort to build capacity of school leaders for improving student learning were the Ontario Principals' Council, the Districts and their Schools, and the Government-Ministry of Education. "Selecting Knowledge Building as one of its central priorities accomplished several important objectives for LSA: it extended LSA's collaborative inquiry from staff to students, it addressed growing interest across the provincial school system in so-called 21st century skills, and it offered a vision of classrooms as learning/knowledge-creating organizations" (Leithwood, 2018, p. 110). "*Knowledge Building/Knowledge Forum Innovation Networks 2017-18*. The goal of the LSA KB Innovation Network Pilots was to provide educators with opportunities to refine their Knowledge Building (KB) practices using the support of the Knowledge Forum (KF) technology. Participants created learning communities that enabled both students and educators to work collaboratively in sharing, developing, and spreading their innovative practices and learnings. Dr. Marlene Scardamalia and Dr. Carl Bereiter supported the network by providing support, feedback, and next steps. Participants committed to using KB and KF in at least one curriculum area and shared outcomes and ideas on KF and during face-to-face meetings and virtual sessions." (Resendes, 2018) A *Knowledge Building Ontario Reconnect* team (formerly LSA KB leaders) met online in February 2022, and shared accounts of impressive research results and awards that resulted from earlier work. Since the Knowledge Building Research Institute had been established and was hosting a new global initiative *Advancing Knowledge for Public Good: Saving the Planet, Saving Lives,* we decided to establish an online "community of practice", *KB Connects*. This online community of practice provides an infrastructure and monthly opportunities for KB collaboration. KB research institute initiatives are highlighted, and collaboration is invited. Participants: • share work of what they are doing with KB in their classrooms, schools or educational organizations locally, regionally, and internationally • connect with each other to go deeper into KB work and foster collaboration, e.g., collaboratory, KB Forum, email • international practitioners of KB were invited to join KB Connects in April 2022 and a significant number of groups did so.

Vignette Quebec's RNS	*Vincent Gagnon – The Remote Networked School system: Its evolution through tensions, opportunities, and connections*	At the turn of the Century, Knowledge Building/Knowledge Forum (KB/KF) were considered the most promising avenue for enriching the educational environment of Québec's Francophone small rural schools. It was a matter of educational opportunity, a key principle of the provincial education system. KB/KF drove the installment of the Remote Networked School (RNS) initiative, and it remains today its most distinctive characteristic. The initial model has adapted to circumstances, and it keeps affording school teams an opportunity to reinvent their practices and broaden students' horizons.
Vignette-Scotland	*Niall Mackinnon – Scottish school system re-direction through pupil and student-centred collaboration towards building knowledge for life*	A 2004 national Scottish review reframed the purposes of school education as 'Four Capacities' of confidence, responsibility, contribution, with the fourth of learning as enabler. Thematic pedagogical approaches were taken forwards in 'Seven Principles of Curriculum Design' of 'challenges and enjoyment, breadth, progression, depth, personalisation and choice, coherence, relevance' to develop holistic 'experiences and outcomes'. The Scottish Government instituted annual five-stage 'Building the Curriculum' 2006-10 themed construction collaboratively with and by schools in conjunction with national agencies. These fitted alongside and within UK wide initiatives of Assessment for Learning prioritizing formative assessment, National Grid for Learning on pedagogic potentials of IT, Health Promoting Schools of wellbeing and Ecoschools relating to ecological principles. The integrated endeavour was cognate with KB particularly regarding institutional and professional 'building' of approaches explicitly termed. The annual Scottish Learning Festival showcases practice exemplification and innovation. Deep practice-theory issues remain little explored in policy discourses but articulate in research forums and also by practitioners (MacKinnon, 2009, 2011; 'Nigel' in Ball & Olmedo, 2013).

Vignette Singapore	*Chew Lee Teo* – Knowledge Building Community – researchers, teachers, and students	KB was introduced to selected K12 schools and to the teachers taking master's classes in the National Institute of Education early 2000. These teachers are encouraged to try out knowledge building in their own class as part of their course assignment or their thesis work. In 2010, KB pedagogy and technology was seeded in two schools by a group of specialists in the Education Technology Division (MOE) supported by a seed grant known as Propel-T (Propelling-Technologies in education) in Computer-supported-collaborative-learning (CSCL). Within the two schools, four teachers were connected via sharing and learning trips. The following year, each site decided to spread the practice to the whole Science department. Subsequently, KB was spread to two departments in each school – Science and Humanities in the Secondary school and Science and English in the Primary school. The number of teachers grew within these two sites. The KB teachers in these two sites also started sharing KB to their fellow teachers from other schools. This informal "community" initiated meeting during conferences, learning trips, and other meetups. In 2016, a formal Knowledge Building Community was organized and attended by 120 teachers (Teo et al., 2022a) after which a Knowledge Building Community-Network Learning was organized every three months, each hosted by a different school and revolved around different KB principles. In 2017, the Specialist who mooted the KBC moved from the Ministry to NIE. KBC in Singapore continues and different teachers were invited to collaborate in research projects. Various research projects revolved around Curriculum and Learning Analytics for KB; multimodal Learning Analytics for KB, and KB among preschool teachers were initiated. The community remained active and initiated smaller scale idea-café (20 mins short sharing) and KB Design Studios were set up to bring students together as KBC exploring real world problems on sustainability and developmental issues (Teo et al., 2022a). The community continues to meet online throughout the Pandemic lockdown. In 2022 we saw a branching out from the core community: three primary schools that are new to KB forms connected with an experienced KB school and started exploring KB across different schools.

Vignette Brazil	*Telma Vinha – Collective Knowledge Building in the Implementation of Public Policies for Living Together*	KF was used at the implementation level and KB processes in a small-scale program for moral development of students and improvement of school climate in the great region of Campinas, 2015-2017 (Vinha & Nunes, 2021). Communities for teachers, principals and implementers were created and fostered (Nunes et al., 2022). Two other large-scale programs based on improvement of professional practices of teachers and principals through collective knowledge advancement using KF served as experience and basis for the design of the present educational policy, a multilevel and large-scale program for developing capabilities for ethical and democratic living together involving students and adults inside schools, districts and the central level of the secretary. The insertion of knowledge building cycles while tackling problems that affect everyone inside schools allow for connecting publics (students, teachers, principal, families) and transforming organizational structures that contribute to the common good and human development. The program builds state capability by including an administrative top level enlightened component using a PDIA (problem-driven iterative adaptation) approach (Andrews et al., 2017) enriched by knowledge building processes that connects to the district and school level through multilevel communities of practice (Penuel & Gallagher, 2017). It is a program in which the more schools participate the better. Size is an advantage by design (Mulgan, 2017). Due to the pandemic the implementation of the program has been delayed and it is now in its initial phase. Developmental evaluation and DBIR (design-based implementation research) (Fishman et al., 2013) are being used.

The problem space that was delineated for KBSI2022 prioritized connections and tensions arising as interactions occur in and between activity systems. Ahead of each, synthesizing sessions framed three symposium meetings. These allowed for reflection of content and clarification, or revision, of the inter-site comparative process. A parallel symposium, entitled KB Infrastructure sought understanding of KB evolution in complex systems. Following KBSI2022, 'build on' continued through individual and collective analysis using the advancement of practical knowledge within systems using the 12 KB principles as reference.

Methodology

Building on the papers presented as well as on the written and verbal contributions made during KBSI2022, the co-authors of this paper

prepared tables regarding connections that propelled KB in and between activity systems, tensions that were resolved and ones remaining unresolved, and next steps that could be taken at local, national, and international levels.

Connections within and between activity theory (AT) constituents (agent, object, mediating signs/tools/instruments, community, roles and policies/rules) were analyzed according to their similarities and differences. Tensions in and between systems were identified by co-authors most familiar with one of the five sites whereas common tensions lived across sites were identified through consensus.

Engestrom's AT framework stresses that tensions may be manifestations of more endemic contradictions, ones that resist innovation or impair its sustainability and scalability. That is why Engeström and other Cultural-Historical Activity Theory (CHAT) researchers are now adopting a unit of analysis inclusive of the activity systems that interact with one another. Figure 1 exemplifies tensions that reveal contradictions of different levels (Engeström, 2015): level 1 tensions may exist within a single node (level 1) (e.g., a teacher, a school), between nodes (level 2), between the object/motive of the dominant form of the activity of a system (e.g., direct instruction) and the object/motive of a culturally more advanced form of activity (e.g., knowledge building) (level 3), and between the activity of an emerging system (e.g., KB curriculum) and the activity of the system in place (level 4).

Figure 1. The unit of analysis
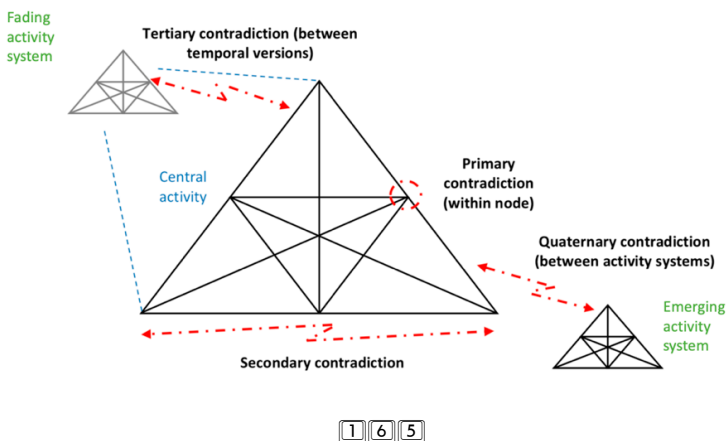
We adopted this unit of analysis for each site (see Tables 1, 2, 3 contents in <u>Annex</u>). Co-authors have all been engaged in participant observation and collaborative discourse at their local site. These activities provided them with inside knowledge that informed the description of the sites' evolution. Moreover, to increase data saturation, we included three additional sites (<u>Annex</u>, Table 4).

Results

The Tables of the <u>Annex</u> show a broad diversity of activity by the agents aiming at offering school students an enriched educational experience through KB across the sites. Site agents bear similarities: lead researcher, be s/he a knowledgeable, committed, reliable and KBI-connected individual, talented schoolteachers, proactive graduate students, and classroom students. Knowledge Forum (KF) is the dominant platform in use for connecting thoughts and ideas.

Connections

There are similarities and differences regarding agents' connections within and between sites:

- Connections (<u>Annex</u>, Table 1) that are most frequent are those between school-based teacher(s) classrooms, and a university-based research team. The Quebec and the Singapore sites share these types of connections and the Ontario, Brazilian and Albany sites too.
- Brazil, Ontario (LSA), Quebec (RNS) and Singapore sites have experienced strong connections with government agencies as well as the Catalonia and Italy sites (<u>Annex</u>, Table 4). Curriculum – KB alignments have been or are currently manifested.
- The Brazil site's connection materialized in the form of a professional development (PD) program, a Principled Practical KBC (Bereiter, 2014).
- The Scotland site presents well-informed and committed schoolteachers working with national and external partners aiming at

transforming the national curriculum in ways as to foster students' agency, one of the 12 KB principles.
- Galvanized by Bereiter and Scardamalia's leadership and other colleagues, site agents have engaged in international connections during summer institutes, online events, and onsite visits.

Tensions

Tensions (<u>Annex</u>, Table 2) identified at each site are reflective of their KB activity. Sites must face internal tensions for KB to gain strength and relevance as emerging education systems. As it became a sustainable and scalable innovation, each site's dominant system has itself replaced a pre-existing system. Tension analysis point to the following ones:

Tension between breadth and depth. Quebec and Singapore sites stand out in this respect: the latter has succeeded in resolving tensions and preserving the integrity of KB innovation whereas in the former KB activity, while remaining the attractive and most exciting innovative activity within which students engage, moved to the fringes. The main research effort terminated after 15 years, and the new coordination team resolved in that manner the growing tension with the funding government agency then pursuing different motives regarding digital education and PD. In Clarke and Dede's terms, it has traded depth for breadth as a shift of ownership occurred.

Tension between leaders over digital platforms (tools). The Quebec site lived through tensions regarding platforms which is not the case in Singapore with its peaceful co-existence of digital tools. Of all sites, including the additional sites, the RNS seems to be the one that has encountered most tensions regarding which collaborative technologies to offer teachers and students. One of the two major tensions at the Brazil site is a lack of sovereignty at the state or school level to offer infrastructure for KB communities as a dispositive for self-organization. In Clarke and Dede's terms, evolution is at issue.

Tension between innovators' competitive/cooperative roles. The Quebec site developed connections with innovation-driven non-governmental organization (NGO), partly because of their fascination with the KB approach, but results are both-sided: on the one hand, it has intensified its activity and strengthened its visibility but, on the other hand, it has diluted the KB vision. Quebec´s experience is being taken as a lesson for the Brazil site in the development of relations to NGOs at its initial stage so far. None of that has been happening in Singapore: scaling is progressive and there is no current sign that a NGO wants to "harness" the energy of the KB teachers and classrooms to insert its own innovation within these innovative classrooms. Contrasting also with the Quebec case is the Ontario site as the LSA's leadership was that of an internal NGO, composed of principals' associations. Besides the RNS, there were variable connections with NGOs, some highly beneficial of KB but some conflicting with system imperatives themselves changing rapidly. A KB deterrent may arise when initiative funding is withdrawn as for Ontario. In Clarke and Dede's terms, shift of ownership is at issue.

Tension over data privacy (rules). A major tension at the Brazil site is a recent rule on data privacy that enforces restrictions on collaboration among communities. In Quebec, a dedicated local KB server was the platform of choice until other collaborative platforms disseminated (e.g., Google suite, MicroSoft Teams). In Clarke and Dede's terms, sustainability is at issue.

Tension between national and KB curricula. The Scotland site encountered tension with national bodies as the promising 2004-10 curriculum was overridden and repurposed. Leaders at this KB site are doing all in their power to reignite the "flame". In Quebec, some loud journalists and scholars opposed constructivism, and promoted direct instruction. The Italy site, which was attracted by the KB effort in Francophone Quebec, is rising. Will that bring curricular tensions, as occurring in Ontario that had a strong and large KB initiative going on before a conservative government was elected with shifting priorities? The opposite may be in sight in Brazil now that a new govern-

ment may reinstall priorities that have allowed this KB site to develop through a strong and scalable-by-design professional development program. In Clarke and Dede's terms, spread is at issue.

Across sites, tensions have arisen through the internationalising of comparative performance data. KB as an initiative and method cuts across this, not in opposition, but pushing the boundaries of school students' experience and thereby their development.

Next steps

To seize new research opportunities, including funding, primarily for sustaining KB sites, stands out as a next step (Annex, Table3).

At each site, next steps include where and how could connections be established or reinforced. Moreover, a tension resolved may resurface as new agents come in or operate under new circumstances and will need to be addressed. Ways in which a tension was dealt with at one site may inspire a next step at another site e.g., accentuation of student agency into Singapore's national curriculum; Scotland's launching of a National Discussion; KB Connects seeing its international meetings as research opportunities.

Steps toward scalability may move a site in one direction or another. For instance, at the Quebec site once KB activity convinced decision makers to add more agents, tools, and schools/districts, this next step toward scalability diluted student KB experience in all but a few classrooms. This has not happened in the Singapore site where progress is incremental (Teo et al., 2022a). The Brazil site aims at introducing tensions in increasing levels of complexity and favor conditions for assimilation and accommodation by entangling collective and organizational, local and regional levels (Wilson et al., 2013) in such a way that the scale leads to sustainability, in a slow search for viable KB progress.

That KB agents and policy makers behave as knowledge builders rather than conventional curriculum developers is a next step all sites would like to see happening. What local students accomplish as knowledge builders, and collating these, could help move systems in this direction.

Discussion

A broad diversity of connections is required for KB to deepen at the sites, sustain and scale and take root elsewhere. Overcoming tensions that arise may occur through double stimulation (Sannino, 2015), which means that more reachable goals are set to avoid stagnation (e.g., to condense KB principles for collaborative inquiry; to explicate student agency with the KB principles). Using a range of collaborative platforms for KB (e.g., scaffolds, principles) could be a next step.

As an activity system, KB is distinctively enabled on KF. Local agents will seek research funds, emancipative forms of professional development along with local and international connections strong enough to face and move beyond inevitable scale related tensions. By stressing educators' interaction in and between activity systems, we extend Bielaczyc's (2013) social infrastructure fourth dimension (interaction with the outside world) for creating learning environments with technology. Infrastructuring (Chen, 2022; Kashi et al., 2023) as a concept to improve the uptake and sustainability of educational technology projects is a promising framework that seeks to settle out issues that are derived when we focus on the "things" that are part of our interventions. The relational affordances of infrastructuring yield a means of dealing with the issues often encountered when KB communities grow and develop beyond their initial researcher supported instantiations.

Conclusion

This paper documents how KB agents framed connections, tensions and next steps occurring at KB sites. They took an active role in constructing and literally 'building' their approaches, working within and between systems and nudging those systems to work more sympathetically and coherently. Thereby they could focus more effectively on the generation of agency and on to Knowledge Building at the level of overarching policy and procedure formulation. KB as evidenced-based sense making can be considered as a pedagogy, but it is

also a means of systemic integration which needs to work at the level of infrastructure and policy development.

The above results may inspire principle-based practices, especially KB practices, elsewhere. Anchoring educational innovation in the KB principles means giving enhanced agency to educators and school communities themselves. Sites show efforts to link KB to school procedure, policy, practice and theory in adaptive and mutually beneficial forms within and across systems. This is in meeting the needs and enabling the potentials which emerge in school communities, and which go on to serve and create the societies of which they are a part. Education is formative to society and not just a preparation.

These point to the need for grounding of policy, procedural and practice developments within education going far beyond learning or development. This is the essence of Knowledge Building. The way forward involves persistence in creating cross-national effective conditions for KB at and as the national system level and across systems internationally.

References

Andrews, M., Pritchett, L., & Woolcock, M. (2017). *Building State Capability: Evidence, Analysis, Action*. Oxford University Press. https://bit.ly/3UvYkhj

Ball., S., & Olmedo, A. (2013). Care of the self, resistance and subjectivity under neoliberal governmentalities. *Critical Studies in Education*, *54*(1), 85-96. https://doi.org/10.1080/17508487.2013.740678

Bereiter, C. (2014). Principled practical knowledge: Not a bridge but a ladder. *Journal of the Learning Sciences*, *23*(1), 4-17. https://doi.org/10.1080/10508406.2013.812533

Bielaczyc, K. (2013). Informing design research: Learning from teachers' designs of social infrastructure. *Journal of the Learning Sciences*, *22*(2), 258-311. https://doi.org/10.1080/10508406.2012.691925

Bloomer, K. (2008, February 15). The dangerous word is curriculum. *Times Educational Supplement for Scotland*. https://www.tes.com/magazine/archive/dangerous-word-curriculum

Chen, B. (2022). *Toward a framework of infrastructuring for sustainable educational innovations* [Paper presentation]. October 2022 AECT Inter-

national Convention, Las Vegas, Nevada; United States. https://osf.io/preprints/socarxiv/svf4r/

Clarke, J., & Dede, C. (2009). Design for scalability: A case study of the River City curriculum. *Journal of Science Education and Technology*, *18*(4), 353-365. https://doi.org/10.1007/s10956-009-9156-4

Coburn, C. E. (2003). Rethinking scale: Moving beyond numbers to deep and lasting change. *Educational Researcher*, *32*(6), 3-12. https://doi.org/10.3102/0013189X032006003

Engeström, Y. (2015). *Learning by Expanding: An Activity-Theoretical Approach to Developmental Research* (2nd ed.). Cambridge University Press.

Fishman, B. J., Penuel, W. R., Allen, A., Cheng, B. H., & Sabelli, N. (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. https://doi.org/10.1177/016146811311501415

Kashi, S., Hod, Y., Lee, A., Yuan, G., Cohen, E., Bielaczyc, K., Chen, B., & Zhang, J. (2023). Infrastructuring for Knowledge Building: Advancing a framework for sustained innovation. *Qwerty. Open and Interdisciplinary Journal of Technology, Culture and Education*, *18*(1), 139-156.

Leithwood, K. (2018). *Leadership Development on a Large Scale: Lessons for Long-Term Success*. Corwin.

MacKinnon, N. (2009, November 27). Two cultures of a child-centred approach. *Times Educational Supplement for Scotland*. https://www.tes.com/news/two-cultures-child-centred-approach

MacKinnon, N. (2011). The urgent need for new approaches in school evaluation to enable Scotland's Curriculum for Excellence. *Educational Assessment, Evaluation and Accountability*, *23*(1), 89-106. https://doi.org/10.1007/s11092-011-9116-4

Mulgan, G. (2017). *Big Mind: How Collective Intelligence Can Change Our World*. Princeton University Press.

Nunes, C. A. A., Vinha, T. P., & Campos, S. B. (2022). Responsive processes in the design, implementation and evaluation of programs for improving the quality of coexistence in schools. *Revista online de Politica e Gestao Educacional*, *26*(3), 1-13. https://doi.org/10.22633/rpge.v26iesp.3.16960

Penuel, W. R., & Gallagher, D. J. (2017). *Creating Research-Practice Partnerships in Education*. Harvard Education Press. https://doi.org/10.31244/dds.2021.01.05

Resendes, M. (2018). *Knowledge Building/Knowledge Forum Project Summary Report 2017-2018*. Ontario Principals' Council.

Sahlberg, P. (2005, June 8-10). *Curriculum change as learning – In search of better implementation* [Paper presentation]. International Conference on Curriculum Reform and Implementation in the 21st Century: Policies, Perspectives and Implementation, Istanbul, Turkey.

Sahlberg, P. (2011). *Finnish Lessons – What Can the World Learn from Educational Change in Finland?* Teachers' College Press.

Sannino, A. (2015). The principle of double stimulation: A path to volitional action. *Learning, Culture and Social Interaction*, *6*, 1-15. https://doi.org/10.1016/j.lcsi.2015.01.001

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.), *Liberal Education in a Knowledge Society* (pp. 67-98). Open Court.

Scottish Government. (2006-10). *Building the Curriculum 1, 2, 3, 4, 5*. Education Scotland. http://bit.ly/3zNjpMy

Teo, C. L., Lee, A. V. Y., Ong, A., & Yuan, G. (2022a). A three-year design-based study: Cultivating students' collaboration using principle-based approach in student Knowledge Building Design Studio. AERA.

Vinha, T. P., & Nunes, C. A. A. (2021). Professional development and transformation program for ethical and democratic coexistence in Brazilian schools. In M. A. Ramos, L. B. Ramos, & E. L. Noriega (Eds.), *Redes de Cultura Escolar en pro de la Educación para la Paz – Experiencias, análisis y propuestas de intervención* (pp. 162-171). Fundación Vivir en Armonía.

Wilson, D. S., Ostrom, E., & Cox, M. E. (2013). Generalizing the core design principles for the efficacy of groups [Supplement]. *Journal of Economics Behavior & Organization*, *90*, S21-S32.

Acknowledgements