Chapter 15
Reflections and Commentary on Knowledge Creation in Practice

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Transforming Experience: It's Not Only About Problem Solving

KB is typically related to problem solving. This has to do with the focus on knowledge advancement and idea improvement, the yardstick usually being the extent to which these two help to overcome puzzles and problems, often set by teachers ("Why are plants green?") or problems grounded in the world of students. The proximity to problem-based learning is therefore not surprising (e.g., Yeo, Chap. 9). But knowledge can be more than a contribution to individual and collective problem-solving capacity.

Richard Prawat's writings (1991, 1993, 1999) have helped to identify the limitations of seeing knowledge and learning solely in the service of developing problem-solving competencies and of the corresponding pedagogical interpretation of constructivism as engaging students in solving practical problems. The tendency to equate the value of learning with its practical value, its relevance for individuals' everyday life, goes back to interpretations of Dewey's educational philosophy. However, as scholars of Dewey's work have been at pains to point out, he was profoundly ambivalent about the relevance issue. In contrast to much popular interpretation, Dewey can be read as seeing the relevance of education not so much—and certainly not only—tied to the improvement of practical knowledge and procedural skills, but to *the enrichment and expansion of everyday experience*. This is the interpretation that Pugh (2011) suggests based on Dewey's late work on aesthetic experience (Dewey 1934/1980), which has not been brought into contact much with his writings on education (Dewey 1938).

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The upshot is that we ought to consider not only the *impact of experience on learning* but also the *impact of learning on experience*. Dewey elaborates in his work on arts the notion of an experience as a special kind of experience, as explained by Jackson (1998):

> Our interactions with art objects epitomize what it means to undergo an experience, a term with a very special meaning for Dewey. The arts do more than provide us with fleeting moments of elation and delight. They expand our horizons. They contribute meaning and value to future experience. They modify our ways of perceiving the world, thus leaving us and the world itself irrevocably changed. (p. 33)

An experience is hence transformative—it expands both perception and value. Things more fully perceived can be subjected to more discerning value judgments, positive or negative. An experience is not just a passive phenomenon, something that happens to a person; instead, it equips the perceiver with certain anticipations and a sense of closure; it is ". . .so rounded out that its close is a consummation and a not a cessation" (Dewey 1934/1980, p. 35). This sense of anticipation is also characteristic for Dewey's notion of "an idea." Ideas are possibilities; each idea "is anticipatory of some possible future experience" (Dewey 1933, p. 117). Like an experience, an idea is transformative in that it guides attention, perception, and action.

Pugh (2011) suggests the notion of a "transformative experience," conceived as "a learning episode in which a student acts on the subject matter by using it in everyday experience to more fully perceive some aspect of the world and finds meaning in doing so" (p. 111). This definition includes the three elements found relevant by Dewey to characterize an experience: (a) expansion of perception, (b) experiential value, and (c) motivated use. Motivated use involves the trying out of ideas in everyday experiences. Experiential value refers to the valuing of content for the experience it provides. Specifically, it "involves attachment of additional meaning to those aspects of the world more fully perceived and to the concepts that brought about the expansion of perception" (Pugh 2011, p. 113). Thus, grounding knowledge building not only—and perhaps not even primarily—in problem solving but in an expansion of the capacity to perceive and experience would contribute to tempering a purely instrumentalist view of (school) learning and building links to the affective dimension of learning.

An orientation to students' experience—and experiencing—as part of what can be enriched by engaging in knowledge building focuses on the role of the individual learner. Since, as we have seen, ideas are in certain ways similar to experiences, and since ideas are the central object in knowledge-building theory and pedagogy, this orientation affords a closer look at the interplay of the individual and the social in knowledge building.

Ideas and Knowledge

Knowledge-building theory (KBT) does not make a systematic distinction between knowledge and ideas. Since idea improvement is perhaps the most important principle of knowledge-building pedagogy, and the central object in software supporting knowledge building, such as Knowledge Forum™ (Scardamalia and Bereiter 2006), it seems important to consider what the relation between ideas and knowledge might be. Reflecting on the nature of ideas will also help to be more precise about the interplay of the individual and the social.

As a tentative distinction, the notion of an idea seems closer to individual reasoning, and to psychological constructs, whereas knowledge by definition is a social construct. At least, *coming up with an idea* is something we would locate primarily in the individual. From another perspective, the notion of an idea is very close to Popper's World 3, because *sharing an idea* comes to us so easily; they are not as skin-bound as the carriers of individual knowledge (schemas, scripts, neurons) are said to be. It is probably fair to say that with the exception of Bereiter's early work on the learning paradox (Bereiter 1985), KBT glosses over the point of how ideas get generated and moves rather quickly to the question how they get shared and collectively improved. Besides being a gap in the theory, this also leads to pedagogical problems. Like Popper's falsifiability criterion for scientific theories (Popper 1962), improvability as a criterion for good ideas serves better as a constraint than a goal, as something to maximize: While it makes sense to advise students to create improvable ideas, it may occur to them that the worst ideas seem most improvable.

To learn more about the process of idea generation, and to clarify the ambiguities regarding the individual and social aspects of idea generation, one can again refer to Dewey and, to his contemporary, Charles Sanders Peirce. Both Dewey and Peirce did us the favor of providing a rather elaborate answer to the question where (new) ideas come from; they both suggest a process called *abduction*. Abduction is complex but has the benefit of shedding light on the learning paradox (the question how something new can be learned at all), helping us understand the relation between the individual and social in idea production and providing insights into the role of language and extralinguistic processes. I build on the analysis of Dewey's and Peirce's work on abduction in Prawat (1999) to provide at least a cursory description of the process of abduction here.

Ideas can be generated in three ways: by deduction (from what is already known), by induction (generalizing from instances), and by abduction. Only via abduction can we create really new ideas; deduction reveals only what is already known, albeit indirectly; induction as such does not produce new descriptors and concepts. Abduction, on the other hand, consists of devising a new theory to explain facts. In the formal sense, abduction is straightforward: "The surprising fact, C, is observed; but if A were true, C would be a matter for course; hence, there is reason to suspect A is true" (Peirce 1931–1958, p. 117). But to come to A, the explanation for C, or the mechanism that brings about C, usually requires intensive and creative

thinking. This is because one cannot suggest just any cause or reason, but needs to come up with explanations that are acceptable within a discourse community (such as mathematicians, scientists, historians), hence are related to existing bodies of knowledge and world views.

Abduction is often a metaphoric process; deep insights are gained by reasoning analogously from what is known in one area to another area that is in need for explanation. Metaphorical reasoning—for instance, seeing an atom as a miniature planet system or a plant as a miniature food factory—can provide deep insights for students and has provided deep insights for scientists (Miller 1996). The metaphorical core of abduction can be elaborated with Peirce's theory of signs. As a communicative act, abduction involves a sign (e.g., the food factory), an interpretant (the set of experiences one anticipates having in relation to an object), and the object and event one wishes to understand (Prawat 1999, p. 62). The sign relation can be of three kinds or stages: iconic, indexical, and symbolic. In its iconic function, the image of the food factory is all that is needed to invoke certain experiences. If the food factory is used in the indexical relation to a plant, it focuses attention on the structural relation between two entities or processes. At this stage, one would think about similarities and differences between a plant and a food factory. In its symbolic function, the relation to other more general and abstract concepts is expressed. The metaphoric process involves a blending of all three sign functions, reaching from the prelinguistic to the symbolic.

The role of society and of specific discourse communities in abduction is complex. Not only does society provide the resources for the symbolic stage in form of language and concepts, but it also provides resources for the iconic stage, as the example of the food factory makes clear. However, both Peirce and Dewey insist that abduction has also a strong individual aspect in that the value of the metaphor must be evaluated and appreciated *by the individual*; without the personal experience that a metaphor plays out well, that an idea provides productive "epistemic access" (McEwan and Bull 1991), the idea will not be further pursued by the individual. For an idea to be of social value, it needs to be not only improvable but go beyond what is known so far or open up a new perspective for seeing something that has been explained before. In academic contexts, good ideas are good explanations; they make the natural and social world more understandable. Particularly good ideas "unify" ideas that have been suggested for explaining different phenomena.

It is probably fair to say that the aspects of idea creation that are closer to the individual-psychological side have not received much attention in the writings of Bereiter and Scardamalia. From the pedagogical point of view, this has had the disadvantage that methods and techniques for idea generation have not been systematic part of the knowledge-building classroom. However, the recent surge in interest in developing creativity and innovation capacity in students begins to remedy this point. There is really no strong reason why idea generation should be treated as a black box and why creative thinking should not be taught and practiced, in particular in the knowledge-building classroom. The scientific and not so

scientific literature on creativity is enormous, making it sometimes hard for teachers to identify good sources, such as Johnson (2010).

The role of the social in knowledge construction has found considerable more attention, in the form of research on knowledge practices, to which I turn next.

Knowledge Practices and Artifacts: It's Not Only About World 3

As Lee (Chap. 10) and Hakkarainen (2009) note, while knowledge-building pedagogy is in practice massively concerned with (mostly classroom) practices, as a theory introduced and elaborated by Bereiter and Scardamalia, it lacks nevertheless an explicit account of the socio-material aspects of knowledge practices. Practices of two kinds are under-theorized. Firstly, classroom practices: The effects of software tools such as CSILE and later Knowledge Forum have rarely been analyzed in terms of how they change classroom practices other than those directly related to using the software. For instance, in most studies, the Knowledge Forum log files get analyzed, and/or students' communication around knowledge objects represented in the software, but not the classroom organization and practice more generally. But, as Hakkarainen argues, a comprehensive analysis of the knowledge practices, including those outside of the software itself, may be necessary to explain the causes for successful and unsuccessful take up of knowledge-building pedagogy.

Secondly, knowledge practices outside of the classroom, those that take place in authentic settings such as a research lab, a design meeting, or a quality control circle, have been rarely made the subject of knowledge-building pedagogy. Instead, knowledge-building implementations yielded their own practices: those that are characteristic for the school classroom, usually in science education. Activity theory (Engeström 1999) is used in many KB studies—including a number of studies reported in this book—as the conceptual backdrop and methodological framework, in particular for describing tensions between KB pedagogy and the existing dominant classroom practices and culture. However, it is less used to understand knowledge practices outside of the classroom for the purpose of making those practices more accessible in the classroom. Exceptions exist, for instance, in Hakkarainen's and colleagues' work, which is characterized as breaking boundaries between knowledge communities. More generally, mobile learning has the potential to expand learning beyond the classroom walls (see also So and Tan, Chap. 8) but so far has had more focus on "outdoors learning" rather than on making contact with knowledge practices.

A better understanding of knowledge practices is necessary for theoretical as well as pedagogical purposes. For the purpose of theory development, an understanding of the socio-material practices around knowledge objects contributes to demystifying the process of idea and knowledge creation. As the entanglement of

cognitive work with physical, symbolic, and social resources becomes ever better documented and understood—in general (e.g., Clark 2011) and for specific areas such as scientific research (e.g., Latour and Woolgar 1986)—it becomes clear that a theory of creativity and idea generation will need to be grounded not only in psychology but also in sociology, organization science, and semiotics. Any specific study will need to capture knowledge practices in a comprehensive sense.

From a pedagogical perspective, describing and theorizing practice contributes to more authentic learning and to a broader approach to advance practices. Importantly, knowledge often takes the form of practices, in addition to tools and artifacts; they are hence worth knowing and learning about (and practicing). Related to the pedagogical purpose, a better understanding of technology—mediation in knowledge practices will also contribute to developing technology for supporting knowledge building as part of formal education.

The extension of knowledge-building theory by sociocultural and socio-material aspects has been well advanced, in particular in form of trialogic learning theory (Hakkarainen 2009; Paavola and Hakkarainen 2005; Ritella and Hakkarainen 2012). Yet, I would argue that even this line of research has not fully succeeded in reducing the gap between knowledge practices in schools and in professional contexts. We need more pedagogically inspired research on authentic knowledge practices, i.e., research that aims at documenting knowledge practices in real work contexts and aims for making these practices accessible in the classroom. While there needs to be space for knowledge practices that are specific to the world of schools, there also needs to be room to learn about knowledge practices originating outside of schools. Crucially, the latter comprise *specific* conceptual and physical tools, specific to professional communities of practice, for instance, the tools and representations used by engineers, health professionals, fashion designers, and urban planners. Providing students during their school years with a sense of the richness of representations, tools and practices will go a long way to prepare them for participating actively in the knowledge society. Knowledge-building tools specifically developed for schools, such as Knowledge Forum, are essential for learning about the generic ways of working with ideas, but they are not sufficient to learn about the many specific ways in which knowledge gets reified, shared, and advanced.

Teachers as Knowledge Builders

Compared to many other professional disciplines, such as health services or engineering, education lacks a widely shared culture of continuous quality improvement by small changes or what Kenney (2008) calls a "science of improvement." In K–12 education, the predominant innovation model is one of large-scale quasi-experimental field trials (at least, this is the purported "gold standard," National Research Council 2002). However, this method is chronically slow and faces many challenges on the way to affecting actual educational practices. Also, it suffers from the

"one model fits all" constraint. Alternative innovation methods that can be deployed in a more agile manner, and with more concern for local contexts, are slowly making their way into policy-relevant areas, for instance, design research (Plomp 2009) and design-based research (Barab 2006).

In the absence of useful innovation and quality enhancement methods that work at scale, quality improvement and innovation in K–12 and higher education often take the form of "tinkering" with local solutions. Tinkering in itself is not the problem; the problem is that the tinkering remains a local or a private practice, with lessons learned not disseminated to other practitioners, and with no systematic means to engage with others in *collective* tinkering. The Internet and related communication technologies have, in principle, made it easier to collaborate in innovation and to share solutions and experience worldwide, with the click of a mouse button. However, it turns out that this kind of infrastructure is necessary, *but not sufficient*, for ongoing innovation and quality improvement to occur.

I agree with Morris and Hiebert's (2011) suggestion that a major reason for the lack of continuous improvement and innovation in education is the absence of public, changeable knowledge products and shared practices around such products. In K–12 education, the only globally used knowledge product is the *lesson plan*, and even that is scarce/missing in higher education. Educational knowledge products are important for guiding practice and for providing a repository for the continuously accumulating knowledge about practice. In their absence, practice becomes highly fragmented, and knowledge does not accumulate. Building on research on innovation practices in a number of disciplines, in particular in health services, Morris and Hiebert (2011) identify three features that enable the development and refinement of jointly constructed knowledge products:

1. *Shared problems across the system*: For instance, in health it is not only the frontline practitioners but also researchers and everybody else involved in the chain from basic research to application, who agrees on the shared goal of fighting diseases.
2. *Small tests of small changes*: In addition to large-scale field trials and evaluation studies, many practitioners engage in experimenting with small changes, in gathering data just sufficient to document the outcome of these small changes, and in sharing these data so that they add to the larger picture. Knowledge is thus created through the accumulation of small trials and through the replication of small trials in diverse settings.
3. *Multiple sources of innovation*: For instance, *every* employee in a hospital agrees that his or her primary task is to help patients regain their health; it is not only the doctors' task. The hospital provides the means for all its employees to improve processes.

In K–12 education, *lesson study* (originating in Japanese schools) is the best example of approaches that embody the second and third of these innovation features. In higher education, educational design patterns offer an example of innovation aligned with the second feature (Goodyear and Retalis 2010; Laurillard and Ljubojevic 2011). Given the rather thin knowledge and innovation practices in

the teaching profession, creating opportunities for systematic knowledge building during their pre- and in-service education, as demonstrated in Chaps. 11 and 14, is an excellent approach. Over time, this could lead to a richer set of representations, tools, and practices for creating and improving pedagogical knowledge.

The Chapters

A number of chapters in this section address the topic of knowledge building and teachers' professional development. Teo (Chap. 12) and Law (Chap. 13) follow teachers who practice KB over some time, tracking and documenting changes to teachers' beliefs and the enactment of KB practices in their classes. While their focus is mainly on descriptive accounts of teachers' knowledge and how it changes over time, Hong (Chap. 11) and Lee and Tan (Chap. 14) describe intervention studies with teachers. In Hong's study, preservice math teachers use the Knowledge Forum software to experience what knowledge building means from the student perspective and to develop and reflect ideas on math education. I consider this as important enrichment of teaching students' representational and social practices, one worth following through beyond the preservice stage: How can such richer knowledge practices be implemented for in-service teachers? What are the actual pedagogical innovations that result from such knowledge practices? Lee and Tan's intervention uses an older but tremendously important knowledge technology: the book. Using activity theory, they document and analyze the knowledge practices emerging when groups of teachers read and discuss books of relevance to their work. Yew-Jin Lee describes in Chap. 10 among other case studies one where *annotated lesson plans* play the role of shareable knowledge objects, building on the work of Morris and Hiebert as described above. This chapter makes an impressive case for the socio-material extension of knowledge-building theory, expanding on what I have described above in terms of Hakkarainen's work.

The insights on teachers' knowledge, learning, and practices around knowledge-building pedagogy communicated through these five chapters are profound. This line of research is tremendously important for developing knowledge-building pedagogy further and for scaling it up to more schools and systems. As is the case with all reforms in schools, without an understanding of teachers' beliefs and concerns and without the development of their capacities and practices, the reforms are doomed. Importantly, knowledge building *by teachers* holds the potential of a second level innovation: Not only are specific pedagogical practices innovated, the *manner innovations are brought about* in schools can be innovated.

The two remaining chapters, Chap. 8 by So and Tan and Chap. 9 by Yeo, have their focus on students' knowledge building. So and Tan's study is a nice example for the potential of mobile technology to lead to "pervasive" knowledge building, thereby addressing what I identified above as an area of concern and in need for further research: bringing authentic knowledge practices into the classroom or the students into sites where they can experience authentic knowledge building. As

mentioned before, I think that future research should use mobile technologies not only for exploring knowledge artifacts outside of the classroom, such as in the outdoors, but also for documenting, if not participating in, respective knowledge practices. To use a metaphor, we might be thinking of involving students in doing ethnographic work on knowledge practices outside of the school.

Yeo's work (Chap. 9) on combining elements of problem-based learning with knowledge building touches on the theme I labeled "transforming experience." While Yeo employs knowledge-building pedagogy to counteract students' tendency to overly focus on solving a problem instead of learning from the problem solution process, my point was that we need to be broader also regarding what the goal of learning (from problem solving, from knowledge building) ought to be: to expand students' capacity for experiencing and for valuing culturally provided means to do so, not only for problem solving. A focus on experience and value is not an alternative to the focus on increasing individual and collective capacity for problem solving, but the two can go hand in hand; likely, they need to go hand in hand for students to become lifelong knowledge builders and idea advancers.

References

Barab, S. A. (2006). Design-based research. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 153–169). New York: Cambridge University Press.

Bereiter, C. (1985). Toward a solution to the learning paradox. *Review of Educational Research, 55*, 201–226.

Clark, A. (2011). *Supersizing the mind. Embodiment, action, and cognitive extension*. Oxford: Oxford University Press.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. Boston: D.C. Heath and Co.

Dewey, J. (1980). *Art as an experience*. New York: Perigee. (Original work published 1934)

Dewey, J. (1938). *Experience and education*. New York: Macmillan.

Engeström, Y. (1999). Activity theory and individual and social transformation. In Y. Engestroem, R. Miettinen, & R.-L. Punanmäki (Eds.), *Perspectives on activity theory* (pp. 19–38). Cambridge: Cambridge University Press.

Goodyear, P., & Retalis, S. (Eds.). (2010). *Technology-enhanced learning: Design patterns and pattern languages*. Rotterdam: Sense Publishers.

Hakkarainen, K. (2009). A knowledge-practice perspective on technology-mediated learning. *International Journal of Computer-Supported Collaborative Learning, 4*, 213–231.

Jackson, P. W. (1998). *John Dewey and the lessons of art*. New Haven: Yale University Press.

Johnson, S. (2010). *Where good ideas come from. The seven patterns of innovation*. London: Penguin.

Kenney, C. (2008). *The best practice: How the new quality movement is transforming medicine*. New York: Public Affairs.

Latour, B., & Woolgar, S. (1986). *Laboratory life: The construction of scientific facts* (2nd ed.). Princeton: Princeton University Press.

Laurillard, D., & Ljubojevic, D. (2011). Evaluating learning designs through the formal representation of pedagogical patterns. In J. Kohls (Ed.), *Investigations of e-learning patterns: Context factors, problems and solutions* (pp. 86–105). Hershey, PA: IGI Global.

McEwan, H., & Bull, B. (1991). The pedagogic nature of subject matter knowledge. *American Educational Research Journal, 28*, 316–344.

Miller, A. I. (1996). *Insights of genius. Imagery and creativity in science and art*. Cambridge: MIT Press.

Morris, A. K., & Hiebert, J. (2011). Creating shared instructional products: An alternative approach to improving teaching. *Educational Researcher, 40*(1), 5–14.

National Research Council. (2002). *Scientific research in education*. Washington, DC: National Academy Press.

Paavola, S., & Hakkarainen, K. (2005). The knowledge creation metaphor—An emergent epistemological approach to learning. *Science & Education, 14*, 535–557.

Peirce, C. S. (1931–1958). *Collected papers of Charles Sanders Peirce, vols. 1–8, edited by C. Harthshorne and P. Weiss*. Cambridge: Harvard University Press.

Plomp, T. (2009). Educational design research: An introduction. In T. Plomp & N. Nieveen (Eds.), *An introduction to educational design research* (pp. 9–35). Enschede, the Netherlands: SLO—Netherlands Institute for Curriculum Development.

Popper, K. (1962). *The logic of scientific discovery*. London: Hutchinson & Co.

Prawat, R. S. (1991). The value of ideas: The immersion approach to the development of thinking. *Educational Researcher, 20*(2), 3–10.

Prawat, R. S. (1993). The value of ideas: Problems versus possibilities in learning. *Educational Researcher, 22*(6), 5–16.

Prawat, R. S. (1999). Dewey, Peirce, and the learning paradox. *American Educational Research Journal, 36*(1), 47–76.

Pugh, K. J. (2011). Transformative experience: An integrative construct in the spirit of Deweyan pragmatism. *Educational Psychologist, 46*, 107–121.

Ritella, G., & Hakkarainen, K. (2012). Instrumental genesis in technology-mediated learning: From double stimulation to expansive knowledge practices. *International Journal of Computer-Supported Collaborative Learning, 7*, 239–258.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 97–115). New York: Cambridge University Press.