Two Viewpoints on the Challenges of ICT in Education: Knowledge-building Theory vs. a Pragmatist Conception of Learning in Social Action

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Introduction

The ubiquitous, rapidly developing information and communication technology (ICT) calls for changes in school education, educational policies, theories and research. Digital technology has already become a part of education in the form of laptops, tablets and smartphones used in both formal and informal learning; classrooms in well-resourced schools are now awash with digital equipment, which opens new kind of opportunities for schoolwork (Selwyn & Facer 2014, 482).

ICT development raises challenges for school education: as vast amounts of information are readily available in the Internet, the traditional view of school as a place where knowledge is poured into the heads of pupils has lost whatever sense it once had. According to policy-makers, school should prepare would-be citizens for the information society by teaching ICT-literacy, knowledge-assessment, and skills of digital communication and cooperation. Yet at the moment not all teachers have proficiency in ICT themselves, pupils' skills vary greatly,

and many of the established school practices may not be smoothly compatible with the new objectives of the professed information society.

In this article we consider two viable theoretical viewpoints on the educational challenges of and opportunities opening from digital learning environments. The first is the 'knowledge building' (or, 'knowledge creation') theory spearheaded by Carl Bereiter and Marlene Scardamalia (Bereiter 2002; Scardamalia & Bereiter 1999, 2006, 2010; Scardamalia 2004; Bereiter & Scardamalia 2014), recently developed into a 'trialogical' direction by Kai Hakkarainen, Sami Paavola and others (e.g., Hakkarainen 2003, 2009a, 2009b; Paavola & Hakkarainen 2005, 2014; Paavola, Lipponen & Hakkarainen 2004). Knowledge building is set out as a timely answer to the exigencies and challenges of the ICT-characterised 'Knowledge Age' or 'Knowledge Society' (Bereiter 2002; Scardamalia & Bereiter 2005). The other, probably less familiar approach in this context, is based on a pragmatist conception of (social) action, one of a Deweyan origins, dating back to the end of nineteenth century. Both approaches offer valuable contributions for understanding and improving the digital ICT-enhanced educational practices in the twenty-first century, but our own standpoint is a pragmatist one, stressing the Deweyan principles of learning by doing and cultivating children's natural curiosity and their own interests for educational purposes. We will argue that this pragmatist standpoint has certain benefits to offer for educational practices.

The article begins with an overview of knowledge-building theory in education, and discusses how advocates of this approach set it forth as the proper reaction to the digital era knowledge society. In the following section we detail a Deweyan, naturalist conception of action and knowing, and contrast it with the knowledge building approach. Finally, we outline some

ways in which our pragmatist approach could provide appropriate tools to seize new opportunities for education in the twenty-first century.

The Knowledge Society Metaphor and Knowledge-building Theories of Education

Internet-centred developments in ICT have made it evident that the container metaphor of the mind, with its implied view of education as filling pupils' heads with knowledge, is outdated (e.g., Bereiter 2002). Thus, as Paavola and Hakkarainen (2014, 67), among others, point out, a growing number of educational theorists today have become convinced of there being an urgent societal need for a new approach to learning that can pave the way for a twenty-first century reform of educational practices. According to Marlene Scardamalia and Carl Bereiter (2005), a whole 'new educational science' is needed that would, in particular, contribute to the rise of creativity to a level required in knowledge society. The idea is that the would-be citizens of knowledge society will have to be educated to be able to find whatever knowledge they need in our globally networked, ICT-abundant world, and to have a high level of digital literacy and good knowledge assessment skills. And to that end, educational experts have questioned the feasibility of Industrial Age educational methods such as lecturing in front of the class and rote learning. (See Tan & Tan 2014.)

The most popular conceptions of school learning and education have for some time come from the broad, and somewhat sectarian (see Phillips 1995), constructivist theory family. The flaws of extreme versions of constructivism have been exposed also on the pages of this journal; according to critics, many earlier versions of constructivism tried to gain plausibility by attacking 'straw man' versions of behaviourism, had little to add to common-sense

psychology, and led to misleading views of learning (Fox 2001; Kivinen & Ristelä 2003). However, recently there have been noteworthy advances in constructivism. Of particular interest in this regard is Scardamalia's and Bereiter's knowledge-building theory, which explicitly disassociates itself from the 'psychological' (overly individualistic) versions of constructivism and 'focuses on the advancement of community knowledge, with individual learning as a by-product' (Bereiter & Scardamalia 2014, 37; see Scardamalia & Bereiter 1999, 2006; also Hong & Scardamalia 2014). According to Scardamalia and Bereiter (2010), knowledge building offers the most apposite answer to the present century's 'need to work creatively with knowledge'.

Creativity has always been close to knowledge-building theorists' hearts; the very notion of 'knowledge building', introduced in educational theory about a quarter of a century ago (e.g., Scardamalia & Bereiter 1991), is akin to the idea of 'knowledge creation' in organisation theory (see Nonaka 1991; Nonaka & Takeuchi 1995). According to Bereiter and Scardamalia (2014, 35), knowledge is produced through 'purposeful acts of creation', those of building up new structures of ideas – designs, theories, or perhaps solutions to problems – out of other (simpler) ideas. And contrary to some other recent theorists like Paavola and Hakkarainen (2005), Bereiter and Scardamalia (2014, 38) take the term 'creation' quite literally, insisting that 'there is nothing metaphorical about it …., knowledge is either literally created or it is not'. Yet they also see noteworthy differences between the notions of building and creating knowledge; they favour the term knowledge building in educational settings, whereas knowledge creation might be more appropriate in the specific context of (work) organisations – not in schools, where education *per se* is the main issue. Knowledge building, in turn, 'has the whole world of human knowledge as its intellectual workspace' and therefore offers the

tools teachers need to promote their students' long-range interest in learning whatever might turn out to be useful to them later in life. (Bereiter & Scardamalia 2014, 36–39.)

A programmatic declaration of knowledge builders is that the educational system is 'ill-prepared for the Knowledge Age' (Bereiter 2002, 56), lacking a plan for how to 'educate a populace to be knowledge workers'. And this, they say, is mainly because people hold on to a wrong (folk) theory of the mind – the useless old container conception, which is utterly incompatible with decent knowledge-worker education (Bereiter 2002, ix–x, 4–10, 13 ff.). So knowledge builders demand discarding the container conception, or actually the whole common sense 'belief mode' of thinking that encourages conceiving of the teacher's role as that of assisting students in the acquisition of new sets of true and justified beliefs; according to Bereiter and Scardamalia (2014), the belief mode is to be replaced with 'design thinking', where the teachers' role is to assist students in (collaboratively) developing a mind-set of curiosity and questioning, one of striving for better explanations, ideas and understanding, by means of designing better theories and models (pp. 38–39). And this can only be achieved through the new educational science of knowledge building which, Scardamalia and Bereiter (2005, 21 ff.) claim, 'gets at the deep structure of socio-cognitive processes that create new knowledge'. This science alone can take school education to a level required by the Knowledge Age and help children onto a trajectory of creative achievement from a very early age, thus fostering the kind of collective creativity that knowledge society requires.

To that end, knowledge builders think that classrooms should become knowledge-building communities. Or, as Bereiter (2002) puts it, school should be turned into 'a miniature society' that fosters the creation of knowledge. That would be the proper way 'to do fuller justice to the role of knowledge in Knowledge Society' (and to thereby guarantee national prosperity).

(pp. 461–462.) As such a miniature society, school would rely heavily on pupils collaborating with each other. But also, according to the knowledge builders, we need a specific kind of (emergent) 'systems view' to properly understand these collaborations and other relevant cognitive processes whereby information is reorganised again and again until it emerges as, or self-organises into, true knowledge. (Scardamalia & Bereiter 2005.)

Knowledge builders have also developed some practical results: educational technology, software and digital environments for use in collaborative knowledge building (see Scardamalia & Bereiter 1991, 1999, 2006; Scardamalia 2004). According to Hakkarainen – a former student of Bereiter – Scardamalia and Bereiter have done ground-breaking theoretical and practical work and been well ahead of their time, especially in developing technology-mediated learning environments, most notably their 'Computer-Supported Intentional Learning Environments (CSILE)' and its later version, 'Knowledge Forum'.[1] These have made a considerable contribution to modern education – become a true 'icon of innovative education around the world'. (Hakkarainen 2009a, 213–218.)

However, Hakkarainen also remarks that Scardamalia's and Bereiter's model does not work out in sufficient detail the role of social practices involved in the advancement of knowledge. By contrast, 'knowledge-building discourse focuses almost exclusively on ideas', Hakkarainen

[1] The basic idea of Knowledge Forum is to provide an electronic group workspace where to store and discuss ideas, explanations, texts, concept maps, and other materials for knowledge building processes. The pupils are expected to formulate a problem together (for example: 'How does the eye work?'), and to then start finding answers to this from the Internet, for instance. Knowledge Forum saves the pupils' progress (e.g., their theories, comments, concept maps), so that the knowledge-building process can later be examined from the outside and in its different stages. (Scardamalia 2004; see also Bereiter 2002; Scardamalia & Bereiter 2006.)

(2009a, 218) observes, referring to Scardamalia and Bereiter's (2006, 104) call for 'ideas interacting with ideas to generate new ideas'. This is related to Bereiter's and Scardamalia's view that objects of knowledge reside in 'World 3' of Karl Popper's (1979, 153 ff.) three Worlds model that separates (1) physical objects and events, (2) mental or psychological, subjective phenomena and (3) propositional culture, including ideas and other objective products of human minds. According to knowledge builders, World 3 is of utmost importance in education, because the successfulness of knowledge building is to be measured in the ideas and other conceptual artefacts built or created (e.g., Bereiter 2002, 306–308).

This sort of (over-)emphasising of ideas may, indeed, be a weakness of the knowledge-building model; as Hakkarainen (2009a, 218–219) points out, it hardly does justice to the material basis of epistemic and other social practices. It is doubtful whether good ideas, or even good ideas combined with supposedly 'self-organising', technology-enhanced learning environments, alone transform educational practice for the better. Technology depends on and coevolves with social practices and institutions. In this case these include the social practices of teachers and students, and the changing of such practices may take plenty of time and effort. (Hakkarainen 2009a, 214.)

As their own solution, Hakkarainen, Paavola and others have suggested a 'trialogical' (or, as it is sometimes called, 'object-centred') approach to replace both the old constructivist notion of individual learners' 'monological' acquisition of knowledge (conceived as forming the right kind of mental schemata) and the 'dialogical' notion of knowledge-acquisition through social participation or adaptation to community knowledge and cultural practices. The trialogical knowledge-creation approach is to go beyond these by bringing out the 'objective' aspects of learning instead of the merely 'subjective' monologue or 'intersubjective' dialogue by

emphasising 'interaction between individuals, communities, *and shared knowledge-laden artifacts being developed*.' (Hakkarainen 2009a, 215–216; see Paavola et al. 2011; Paavola & Hakkarainen 2014.)

In this connection, Hakkarainen (2009a, 215) also suggests that 'knowledge' should be understood in a broad sense, including not just scientific theories and texts and the related discourse but also experts' habits and their so-called 'procedural knowledge'. This is in concordance with our pragmatist theory of action, of which more shortly. Hakkarainen and Paavola (2014) connect these views to their 'inquiry-based' conception of learning, whose roots are partly in classical pragmatism. However, Hakkarainen and Paavola's inquiry-based, trialogical or object-centred approach differs in certain respects from the pragmatist approach defended herein. Following Dewey (MW 14, LW 12, LW 16), we do not subscribe Hakkarainen and Paavola's strong distinctions between 'objective', 'subjective' and 'intersubjective'. Instead, we encourage transcending the whole subject–object dualism and replacing 'interactionism' with a 'transactional' framing of activity.

In line with this transactional view, Dewey (LW 4, LW 12, LW 16) rejected the age-old 'Spectator Theory' of knowledge as a picture of independent reality, and encouraged, instead, understanding knowledge most crucially as a tool of action. The way how knowledge builders understand knowledge is crucially different from this pragmatist view. Perhaps their 'knowledge society' metaphor has led them to reify knowledge into a thing in its own right, to be aspired for its own sake. A pragmatist take on the knowledge society metaphor would be to say that all societies are knowledge societies in the sense that people have always had and made good use of knowledge in solving their daily action-related problems. Knowledge in an agrarian society, of course, is different from the knowledge needed in post-industrial societies,

but it would be futile to debate over the general superiority of one era's knowledge over that of another era; people just have different activities to perform and hence face different problems and need different kinds of knowledge to solve those problems in different periods and societies. It is certainly true that today there is more information 'lying around' than ever before and that much of it is accessible to vast numbers of people, but that does not mean that people today necessarily have better knowledge for their actions than people in the past had for theirs.

A Pragmatist Theory of Transactional Action

The objectification of knowledge readily leads to over-intellectualising learning and school education because, insofar as knowledge is separated from action as reified sets of propositions about how the world lies, it becomes something that may be learned through purely intellectual, contemplative efforts (Dewey MW 9, MW 12). That was one of the main points of criticism directed against Bereiter and Scardamalia's and a few other constructivists' approaches already fifteen years ago in Osmo Kivinen and Pekka Ristelä's (2003) article 'From Constructivism to a Pragmatist Conception of Learning', published in this journal. Kivinen and Ristelä observed that unlike pragmatists, many constructivists tended to over-intellectualise and psychologise cognition and learning, thereby even mystifying them.

As said, recent years have witnessed noteworthy improvements in the constructivist theory family. For one thing, many constructivists have grown more appreciative of the importance of learning communities, thereby stepping back from purely individualistic tenets. Moreover, at times at least, Bereiter and Scardamalia have even seemed to appreciate the Deweyan

critique of intellectualism, for instance when Bereiter stated that knowledgeable understanding is quite like 'a feeling of confidence…. that we know how to proceed' (Bereiter 2002, 113).[2] However, elsewhere in the same book Bereiter (e.g., pp. 301–302) is keen to distance himself from Deweyan pragmatism, and we are afraid that, despite recent improvements, certain traces of over-intellectualisation still plague Bereiter and Scardamalia's knowledge-building theory, already because of its dualism between knowledge (as the grasping of ideas) and physical activity. We agree with Dewey that knowledge is always action-related and can only be gained in action.

The knowledge builders' focus on Popper's World 3 may have contributed positively to the shift of emphasis away from the supposed mental space (construed schemas) inside individual learners' heads. However, from a pragmatist standpoint the Popperian view fosters unnecessary philosophical dichotomies, stressing as it does the irreducible distinctness of each of the three 'Worlds'.[3] We think that such a stratified many-worlds model with its deep distinctions between the physical, natural, mental, social or cultural aspects of organism–environment transactions introduce counterproductive complications (see Kivinen & Ristelä 2003, 369–370; Kivinen & Piiroinen 2004; Piiroinen 2014; also Dewey MW 12, MW 14, LW 1, LW 16).

Following Dewey (LW 4, LW 12), all knowledge-that, including scientific theories, or indeed all conceptual artefacts, are tools of action. Here is a crucial difference to Bereiter, who insists

[2] However, Bereiter does not refer to Dewey in this connection, but only to Popper, the renowned rationalist.

[3] In fact, the Popperian World 3 of culture is so detached from the physical World 1 that it only interacts with it via the special mediator of the mental World 2 (Popper 1979, 154–155). Physical activity is thereby relegated to a lowly position, separated from the objective knowledge items to be learned and the mental processes whereby students are to learn them.

that 'conceptual artifacts are not just tools'; this is because conceptual artefacts can be true or false and logically implicate one another; they function more like recipes or building materials than tools. (Bereiter 2002, 476.) Yet a Deweyan pragmatist still asks: why is it that scientific theories (or recipes and building materials) cannot be conceived of as tools? Theories like any other pieces of knowledge can only be grasped and evaluated in action, in light of the consequences – how well they work in helping people get what they want. Thus conceived, knowledge or inquiry do not imply different worlds, levels of reality, or that age-old theory–practice dualism which has hampered so many fields of life, including science and education (see Dewey MW 9, MW 12, LW 4; Kivinen & Ristelä 2003; Kivinen & Piiroinen 2004, 2006). That dualism goes along with the mind–body dualism, which, to put it bluntly, should be dropped already because mind or reasoning do not work free of habits (Dewey MW 14: 25). Knowledge or even perception cannot emerge *ex nihilo*, but depend on habits, on what one can do and is in fact doing. 'The scientific man and the philosopher like the carpenter, the physician and politician know with their habits not with their "consciousness"' (Dewey MW 14: 128).

The point is that knowledge can only be gained in action. It is inherently related to practices, to specific tasks, problems and results of action (see Dewey MW 9, MW 12, LW 4, LW 12). Knowledge is tied to habits of action, which arise and are shaped in action – when a living body adapts to the pressures of its environment and learns from the consequences of its actions (Dewey MW 14). An important evolutionary function of habits is the economising of energy, enabling the organism to perform its daily activities more effortlessly (James, [1890] 1950: 104 ff.). Habits cannot but be formed and changed in action, by actually doing things. Even scientific minds are dependent on their environments, most crucially on communities of people – scientific communities. Just as a sailor is intellectually at home on the sea and a

painter in his studio, scientists are intellectually at home in their laboratories, scholars amongst their books, in the academic world, because that is where their professional habits of thought work best. (Dewey MW 14: 49–50, 123.)

The relevance of these ideas to the subject matter of ICT is obvious: today's environment for most people in the developed countries includes ICT, and people, therefore, need habits that are useful in high-tech, information-processing environments. Insofar as educational systems should help people form and develop such habits, this ought to be taken into consideration in the design of school education.

Due to advanced ICT there are now loads of information available to people. In order to access that information and to turn it into knowledge, people need suitable habits. The flipside is that no idle piece of information by itself constitutes knowledge; it needs to be incorporated into habits to count as knowledge. As Dewey (MW 9: 354) stressed, information is knowledge only when it has been appropriately organized into one's dispositions and enable one to better adapt the environment to one's needs or one's aims to the situation. An educational implication is that schooling should not be detached from practical connections and potential uses, from the transactions people are having with their environment. Learning is all about developing apt habits that work in our environment, and education should promote the learning of habits as versatile as needed to solve or avoid a wide variety of potential problems that people may encounter in their social action, in various environments, be they natural or digital.

Hakkarainen and Paavola's trialogical knowledge-creation framework comes close to our position in that they also have reservations over Bereiter and Scardamalia's intellectualism,

and emphasise not just the conceptual but also the material aspects of knowledge and education (Paavola & Hakkarainen 2014, 68). But we doubt that the trialogical approach takes this point quite far enough to thoroughly overcome the knowledge builders' obstinate dualism between knowledge and practical activity – or that between subject and object, for that matter. Paavola and Hakkarainen (2014, 67) do claim that their approach transcends the traditional harmful dichotomies involved in cognition and learning, as it emphasises the role of 'mediating elements' between the Cartesian subject(ive) and object(ive). However, a Deweyan pragmatist cannot but ask: what 'mediating elements' do you need if you are not committed to any Cartesian dualisms at all?

Nevertheless, it is likely that Hakkarainen and Paavola would agree with us that learning is first and foremost an active process, a matter of doing things – not passive, 'theoretical bystanding' or mere cognitive activity, 'application of intellect unconnected with physical action'. For us pragmatists, an inquiry that leads to learning is initiated by a 'doubtful situation', a problem faced in action; it starts when the smooth flow of habitual actions is blocked. Learning, therefore, is not knowledge building inside one's head, but all about developing apt habits of organism–environment transactions, solving problems and promoting actions toward current ends-in-view. The adoption of even the most theoretical and conceptual habits of thinking comes down to forming embodied knowing-how and appropriate (tool-using) habits, achieved only by doing things and learning from the consequences of actions. (See Kivinen & Ristelä 2003, 365–366, 372–373.)

This is antithetical to Scardamalia and Bereiter's constructivist notion that learning calls for specific intentionality and cognitive expertise on the learner's part, that pupils must target

learning itself as an explicit goal;[4] Dewey argued for the very opposite view (see Chee 2014). According to Dewey, the most useful and versatile habits are developed and improved as by-products of actions, as it were – not by forcing it upon pupils to intentionally 'study' a topic, making them think of that as 'having to learn something'.[5] We should avoid making learning 'a direct and conscious end in itself' and should instead just engage pupils in actions, participating in activities in which they will learn, having been introduced to the subject 'for real reasons and ends, and not just as something to be learned' (Dewey MW 9: 176).

Bereiter (2002), in turn, rejects the Deweyan notion that the remoteness and unfamiliarity of the facts taught constitutes a problem in education. In fact, he believes that Dewey committed two serious fallacies: first, 'the "hands-on" fallacy' of approaching education through what is concrete and familiar to the student – beginning with the home and the things the child herself uses frequently; and, second, the 'learning-by-doing fallacy' of putting too much weight on the problem-centred approach where 'practical tasks and problems lead naturally to inquiry'. Bereiter thinks that that is just 'wishful thinking' (yet he nonetheless admits that insofar as 'working with ideas is also [a form of] learning by doing', then obviously '[w]e do learn by doing'). (pp. 301–302.) More fundamentally, he sees no need for students to even look for any practical connections between the facts to be learnt and the things with which they are already familiar or in which they have an interest (pp. 299 ff.). Instead, he suggests that we just trust

[4] Intentionality appears even in Scardamalia's and Bereiter's Knowledge Forum's earlier name (CSILE – Computer Supported Intentional Learning Environments) (e.g., Scardamalia 2004, 183).

[5] Although Bereiter and Scardamalia, too, acknowledge that one part of learning is only a by-product of activities, and even make the Deweyan point (although without mentioning Dewey in this connection) that education should help students adopt a useful mind-set, 'way of thinking that becomes habitual' (Bereiter & Scardamalia 2014, 37–39), it seems that, for them, school learning is mainly a by-product of intentional, knowledge-building activities.

that children will naturally become excited about learning about the world, that they will start theorising and debating and building knowledge about it to 'take advantage of what … adults have discovered' (pp. 334–335). This method, Bereiter insists, does not start with the things children are already familiar with: 'The progression is not from the home out into a wider and wider world. It starts with the whole world and the progression is toward deeper levels of understanding'. (p. 334.)

Bereiter's views here rely on a 'depth' metaphor (of deeper and deeper levels) of knowledge and reality. Knowledge-building communities are expected to drill deeper into the structures of the world, to collaborate so as to produce deeper and deeper knowledge about how it all really is, theorising about it and then rejoicing when someone disproves those theories because each such falsification improves the community's knowledge (see Bereiter & Scardamalia 2014, 39–40). Knowledge builders are after educative progress 'toward deeper levels of understanding' (Bereiter 2002, 334). We, in contrast, leaning on pragmatist methodological relationalism (see Kivinen & Piiroinen 2006, 316), would recommend replacing this idea of inquiry as striving to reveal deepening layers of the world with a notion of inquiry as investigation that organises data into coherent webs of useful descriptions – which, like the whole linguistic symbol system, are inherently relational already because any concept and hence any piece of knowledge cannot but be thoroughly relational: anything 'nonrelational' would be simply impossible to comprehend. That is why knowledge cannot develop by vertical deepening but by horizontal widening. (Rorty 1999, 82–83; see also Dewey LW 4, LW 12.)

Knowledge acquisition involves weaving wider and more coherent webs of information that we can use in our practices. The pupils in Dewey's Laboratory School, therefore, at one time

learned a great deal by interacting with nature and artefacts that were significant parts of their living environment. Today's children's environment includes many elements that were not a part of the late-nineteenth and early-twentieth century environments, such as ICT and the Internet. These should be utilised in schools today just as much as, say, agricultural and early industrial or commercial tools were used in the Laboratory School a hundred years ago. Furthermore, intriguingly, digital tools can offer some novel educational opportunities, like virtual action-environments.

Pragmatism, ICT, and Twenty-first Century Education

Knowledge builders like Bereiter (2002) intellectualise education to the point where they reject the Deweyan notion that education should start with the already familiar and interesting – with the children's own 'world of the home and the playground', so to speak. The reasoning for this is that, '*their* world does not include the Norman Conquest and the Periodic Table of Elements', for instance, and Bereiter finds it 'not an inviting set of choices' that we should either not teach these things to children at all, or find ways to make them care about them, or perhaps 'design games and other engaging activities that will in effect trick them into processing information about things that policymakers have decided must be in the curriculum'. (p. 334.)

Our pragmatist approach, by contrast, encourages using any workable tools, including games where possible. Dewey would have appreciated that games and play are natural parts of children's action environment. Today, digital games in particular are a big part of children's

world, and a Deweyan educator will not hesitate to make use of the educational possibilities of these technologies as well.

Of course, ICT by itself does not promote education. The usefulness of any tool depends on how it is used, and the development of technology is embedded in social practices. Making the best use of ICT in education requires changes in the education-related social practices where these technologies are embedded. (Hakkarainen 2009a; see also Livingstone 2012.) As Hakkarainen remarks, knowledge builders like Bereiter and Scardamalia have plenty of work to do in this respect: 'in order to make a stronger impact on educational transformation, the knowledge-building approach should be developed in a direction that better takes social practices into consideration' (Hakkarainen 2009a, 214). Indeed, the usefulness of Scardamalia and Bereiter's digital knowledge-building forums has remained all too dependent on individual teachers' and students' ability to create the necessary new practices for themselves, i.e. a classroom culture of enthusiastic knowledge-building, where these tools can be useful; which has meant that successful knowledge-building cultures have remained '*radically local* … not easily transferred even next door' (Hakkarainen 2009a, 221–222).

Conditions in schools are not always perfect for teachers to teach and pupils to learn. For one thing, there are often dozens of pupils in a single teacher's group. Nonetheless, improving and making more appropriate use of digital learning environments could offer some solutions to these problems – for example, by promoting appropriate kinds of educational differentiation and thereby personalisation of learning. Digital technology seems apt in providing tools for the teacher to monitor and evaluate the progress of individual pupils, both in real time and retrospectively, and tools for individualised tutoring as well. For instance, Internet-connected digital learning environments provide opportunities for sharing some of the teacher's

workload by allowing programmes, experts and designers to do much of the planning and assessment of how a particular student, considering his individual pitch, interests and character, might best be encouraged and challenged with just the right kind of problematic situations (neither too difficult and therefore depressing nor too easy and uninspiring). Conceivably, this means that the teacher will have more time for personal interactions with each pupil, as technology takes some of the load off her shoulders. (Kivinen & Kaarakainen 2014.)

In the best Deweyan spirit, school education that uses ICT and any other equipment available should be tied to the pupils' own current interests so as to make learning as engaging as possible and not a matter of practice-detached, conscious contemplations. In this respect, Yam San Chee (2015) has argued, there is an urgent need for an attitude change: to stop thinking of digital equipment mainly as 'tools to teach' (like chalk and blackboard, school books and slide projectors) by means of which we can teach some specific knowledge contents to the pupils; instead, we should start thinking of them as 'tools to learn' that are naturally interesting and engaging for the students and thus offer them opportunities to learn by doing. A parallel juxtaposition can be made between learning (how) to swim by going in the water and trying to do it in practice, as opposed to a teacher lecturing pupils about swimming. (See Chee 2015; cf. Egenfeldt-Nielsen 2007; Livingstone 2012, 16 ff.).

This is not to say that the teacher could be eliminated from school education. As another educational theorist inspired by Dewey's work, Gert Biesta (2014) says, too much of education has been misguided by the constructivists' individualistic ideal of 'learnification', glorifying the individual learner's mental processes in a way that would effectively spell 'the end of teaching' – and the end of true education as well (pp. 44–46, 62–66). Human beings are

thoroughly social, so education, too, is largely communication and participation in cooperative undertakings, where the teacher has a key role as the more experienced participant who guides the process to make sure that everybody participates and the educational goal of shared understanding is achieved. This shared understanding, Biesta stresses, is an outcome of communication and cooperation in action (and not a precondition of such action) – as Dewey already also knew. (Biesta 2014, esp., 6, 26–35.)

Undoubtedly, technology could also be better utilised in educational practices, and the Deweyan way to do this, as Chee (2015) notes, is to embrace the child's own interests and familiarities – Bereiter's objections notwithstanding – and to use them as the starting-point for education, making learning a natural part of the child's organism–environment transactions. Digital learning environments should be designed to take full advantage of how real life topics, issues and potential problems relate to the actual concerns and interests of given students, be they fairy tales, football, role-playing games, movies, cartoons or science fiction fantasies.

Recent digital technologies certainly open up novel possibilities in this regard: learning environments can now range from the bottom of the sea to a top-level political meeting over nuclear weapons, from city tours in medieval London to the plains of planet Mars; consequently, activities, problems and challenges may vary from those of a CEO of a multinational company to those of an ancient Roman legionary or a chemist manufacturing highly dangerous chemical compounds. None of these need to be presented as 'something to be learned' – they can be made familiar through thoughtfully designed digital environments. Countless activities and problem situations can be engaged with, accessed or simulated, by

means of digital technologies, thereby allowing the pupils to learn safely and affordably, removed from the consequences of costly and potentially dangerous situations.

Pupils can be confronted with any number of digitally accessed or created learning situations, related to issues that interest them, thereby setting up exciting novel problem-fields that may also combine various school subjects in an interdisciplinary spirit. For example, in principle there is no limit to what a young football enthusiast, say a fan of FC Barcelona, might learn from a digital game-like tour revolving around FC Barcelona – geography, history, architecture, finances, marketing, politics, sociology, social psychology, etc. – especially as digital technology allows us to 'spice up' real life issues with new intriguing aspects, imagined problems that we know will pique the interest of a pupil of a particular age and background. In some cases the end result might be just as engaging and entertaining as any recreational adventure game (see also Chee 2011, 2013, 2015).

Let us also keep in mind that educational systems maintain not just the 'qualification' function but also a 'socialising' function, including the 'hidden curriculum' mechanisms that lead children to incorporate such customs and time-space rituals as habits that would prepare them for adult roles in society. That the school institution cannot but have a socialising function besides the cognitive and knowledge-related qualification function stems already from the fact that the educational system is expected to 'take in' a new age group of young children each year, to 'pass them on' to the next grade year after year, and finally, after all the school years, to 'send them out' as would-be citizens capable of choosing amongst and adopting a diversity of roles and more generally to function as productive members of twenty-first century society – capable of collaboration, communication, and coordination of activities with others.

The use of ICT will cultivate children's habits that they need as members of twenty-first-century society. This is important because the ICT skills of the so-called 'Digital Natives' (Prensky 2001; cf., e.g., Selwyn 2009) actually vary to a high extent and may in some cases be poorer than those of an average middle-aged person (see, e.g., Hargittai 2010; Livingstone & Helsper 2010; Calvani et al. 2012; Kaarakainen 2014; Kaarakainen & Kivinen 2015). Moreover, alarmingly, poor ICT skills seem to correlate with an increased risk of becoming marginalised, an outcast of society (Kaarakainen & Kivinen 2015). In that light, equality of opportunity would seem to necessitate that everybody, regardless of one's socioeconomic status, place of residence etc., should be given the opportunity for adopting decent ICT skills; one would expect it to be an integral part of the very role of our educating system to guarantee this (see also Livingstone 2012, 14–16, 21).

There are challenges to overcome, certainly. For one thing, many teachers still unfortunately lack adequate IT skills, let alone the skills to make the best use of ICT in assisting pupils' learning; in too many classrooms the old-fashioned teaching methods of lecturing, dictation, and rote learning are still the norm. Meanwhile, some theorists, like Sonia Livingstone (2012), would point out that 'the jury is still out as regards evidence that ICT supports learning' (p. 19) – in particular, as regards whether the fruits of ICT use should be harvested through a traditional approach to education, or through a more radical change in the educational agenda. Our answer to this question is: the harvesting of the best fruits of ICT does call for a change of educational outlook and practice, because the usefulness of any tools depends on how they are used in practice, and practice will need to be thoughtfully revised in order to make the best use of the new technology.

In that regard, we have argued, it is still a good idea to take heed of Dewey's hundred-year-old advice and tie education to the pupils' own interests. Digital learning environments could spell remarkable benefits like personalisation of education, monitoring and encouraging each student's progress. New technologies certainly open new kinds of opportunities for the teachers to communicate with their students, as well as for the students to communicate and cooperate among themselves. Moreover, they offer novel opportunities for learning-by-doing in specifically designed virtual environments, from imaginatively developed problem-fields that address the students' interests and might have been absolutely impossible to realise outside virtual environments. Some of these tools and environments might interest also the kind of pupils, statistically speaking mostly boys, who do not feel comfortable in traditional classroom situations and have, therefore, tended to fare badly in the educational system, even ending up as school drop-outs. ICT and other digital tools might just offer some 'tools-to-learn' for them, as well.

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