
Socio-cultural perspectives on collaborative learning: Towards collaborative knowledge creation

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Abstract. The present chapter introduces a specific way of approaching a variety of socio-cultural perspectives. We present a knowledge-creation approach to learning by separating it from acquisition and participation perspectives. We examine collaborative learning as an object oriented process involving sustained collaborative efforts in creating and advancing epistemic artifacts and practices. Such learning is embedded in the creation of collaborative inquiry communities supported by technology-mediated learning environments, and providing material agency needed for sustained pursuit of collaborative inquiry. Technology enhances learning, however, only through transformed social practices. Successful collaborative learning communities rely on expansive iterative cultivation of shared knowledge practices that channel and guide the participants’ activity in a way that elicits advancement of inquiry.

Keywords: Acquisition metaphor, Collaborative learning, Epistemic artifact, Knowledge-creation metaphor, Learning through collaborative design, Participation metaphor, Trialogical inquiry, Knowledge practices.

Introduction

The term ‘socio-cultural approaches’ to learning is quite widely used. It refers especially to approaches which have been influenced by L. S. Vygotsky’s (1978) seminal work on understanding human development and learning. Vygotsky’s and his co-workers’ texts, and later interpretations and developments (e.g., Cole, 1996; Engeström, 1987) have had a great influence on our understanding of human learning. Although socio-cultural approaches are widely adopted, they still challenge many deeply rooted preconceptions of learning and human development. The basic locus of human learning is social interactions, cultural practices, and reciprocal personal and social transformations rather than individuals and individuals’ minds. Within socio-cultural approaches the meaning of language and semiotic mediation is often emphasized as a basis for understanding activities of human beings.

In this chapter, we are not trying to give an overview of various strands and different ways of interpreting the socio-cultural approach. Instead, we concisely analyze a distinction that we maintain cuts across many socio-cultural approaches, that is, a
distinction between approaches emphasizing participation and social interaction, and approaches emphasizing collaborative knowledge creation. First we introduce the idea of three basic metaphors of learning, that is, as individualistically oriented acquisition, as participation, and as collaborative knowledge creation. Then we analyze some basic elements important for the knowledge creation approaches. At the end we delineate a “trialogical” approach to learning which focuses on those activities where people are organizing their work for developing shared artifacts and practices. While our approach emerges from studying technology mediated collaborative learning in institutional education, we maintain that it applies more generally to collaborative learning in a variety of settings, e.g., business and government entities devoted to research or development of products, processes, and technologies.

Three approaches to collaborative learning

There appear to be three prominent approaches to learning within the domain of learning theories; the knowledge-acquisition metaphor, the participation metaphor, and the knowledge-creation metaphor. The knowledge-acquisition metaphor examines knowledge as a property or characteristic of an individual mind (Sfard 1998). The acquisition metaphor may be based on the traditional assumption of the transmission of knowledge to the student, or, as Sfard emphasizes, also active and “constructive” (but individual) process. Acquisition approaches emphasize the learning of individuals, but it can be applied also in collaborative learning (CL). CL is then interpreted as a peer-interactive process that facilitates (or sometimes hinders) an individual’s personal learning, belief revision, and conceptual change by provoking, for example, cognitive conflicts (Mugny & Doise, 1978). Collaboration, however, does not in itself play a foundational role in this kind of learning although collaboration between individuals is an essential part of this type of approach. An alternative approach, according to Sfard (1998), is the participation metaphor for learning, which examines learning as a process of growing up and socializing in a community, and learning to function according to its socially negotiated norms (Lave & Wenger 1991; Brown, Collins, & Duguid 1989). From the participatory perspective, learning is the process of growing to become a full member of a community, in which there gradually occurs a shift from peripheral to full participation. From this perspective, knowledge is not a thing in the world itself or within the mind of an individual, it is simply an aspect of cultural practices (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991). Rather than focusing, for example, on a body of knowledge in the traditional sense, the emphasis is on interaction, shared practices of meaning making (knowing), and learning from joint efforts of solving problems. Collaborative activities involve intensive inter-subjective interactions and shared making of meaning (Stahl, 2006).

We have maintained that besides these two metaphors, a third metaphor of learning is needed as a basis for theory and empirical investigation of collaborative learning. We call it the knowledge-creation metaphor (Paavola, Lipponen, & Hakkarainen, 2004; Hakkarainen, Palonen, Paavola, & Lehtinen, 2004). The idea is a basis for several theories of collaborative learning which, despite their clear differences, also have a common aim of explicating collaborative processes of creating or developing something new. As representative theorists of the knowledge-creation metaphor, we ourselves have analyzed especially Bereiter’s (2002) knowledge building, Engeström’s (1987) expansive
learning, and Nonaka & Takeuchi’s (1995) organizational knowledge creation (Paavola et al., 2004). These theories have clear affinities with theories representing the participation metaphor of learning but still diverge from them in respect of being explicitly focused on addressing collaborative work for creating or developing novel things as a central aspect of collaborative learning. The knowledge-creation metaphor is not meant to be a specific theory of collaborative learning, but more like an umbrella term for otherwise quite different theories and approaches to collaborative learning. Many socio-cultural approaches have elements both from the participation and the knowledge creation metaphor of learning.

An ancestor of ‘knowledge creation’ is the theory of knowledge building, and we have ourselves tried to see connections between this theory that emphasizes development of ideas together and the cultural-historical activity theory (emphasizing collaboration around practical issues). Knowledge building is a pedagogical approach that is focused on transforming school classes to inquiry communities focused on improving their shared ideas understood as conceptual artifacts with assistance of collaborative technologies (Scardamalia & Bereiter, 2006). While knowledge building clearly represents the knowledge-creation metaphor it would benefit by being more anchored in social practices and material artifacts emphasized by activity theory and practice theories, which lie at the base of knowledge creation approaches. Activity theory builds on the idea that human activities are mediated by artifacts, used and modified by succeeding generations of human beings and grounded on practical, everyday activities (Cole 1996, 108-110).

Praxis, or practices, and cultural artifacts are developed in interaction with one another in historically situated and evolving processes. Human activity, especially knowledge creation activities, are “object-oriented” (Engeström 1987; Knorr-Cetina 2001) meaning that collaboration is organized around long-term efforts to develop shared, tangible objects, such as articles, models, and practices. It appears that activity theory could be advanced by a more comprehensive account of sustained epistemic mediation (i.e. work with various kinds of artifacts where knowledge is emphasized) involved in technology-mediated learning; collaborative learning entails that even elementary school children are engaged in deliberate construction of knowledge artifacts (texts, graphs, models, concepts, etc.) as psychological tools (Vygotsky, 1978) for re-remediating their activities. Rather than being mainly guided to discuss and share their opinions of the issues and themes inquired, they are deliberately engaged in crystallizing, externalizing, sharing, and developing knowledge artifacts embodying their ideas (Scardamalia & Bereiter, 2006).

We consider the three metaphors as heuristic tools that assist in examining various aspects of learning. If the knowledge acquisition metaphor is monological in nature in terms of within-mind processing of knowledge, and the participation metaphor highlights dialogical interaction, the knowledge-creation metaphor is said to emphasize trialogical processes because it focuses on activities organized around systematic and deliberate pursuit of advancing shared “objects” (Paavola et al., 2004), with the understanding that the latter may be epistemic, not having ‘tangible’ or material form.
A case example: Learning through collaborative designing (LCD)

In this chapter our discussion of the knowledge-creation approach to collaborative learning is organized around an empirical case regarding Learning by Collaborative Design (LCD). Collaborative designing appears by definition to be a knowledge creation process that involves joint efforts in creating design artifacts. Such a process involves students actively communicating and working together to create a shared view of their design ideas, make joint design decisions, construct and modify their design solutions as well as evaluate their outcomes through discourse (Hennessy & Murphy, 1999). Fostering learning through collaboration requires teachers or tutors to design, enact, and evaluate a specific kind of teaching and learning setting, paying attention to the nature of the design task, its context and supportive pedagogy (Viilo, Seitamaa-Hakkarainen, & Hakkarainen, 2011). Successful collaboration is based on open-ended and authentic design tasks that allow students to confront the multidisciplinary or user-centered characteristics of design practice. The present investigators have investigated design processes from elementary-level education (e.g., design of lamps) and higher education (e.g., designing clothing for premature born babies) to professional level (designing various industrial products).

Seitamaa-Hakkarainen and her colleagues (2010; Kangas et al., 2007) have developed the Learning by Collaborative Designing model, which highlights collaborative interaction among teams of students and between students and teacher and/or external domain experts of the design field. It examines the design process as a cyclical and iterative process in which workable solutions arise from a complex interaction between conceptualization, sketching, construction of materially embodied artifacts, explorations in which design constraints and ideas are revised and elaborated. The model illustrates relations between the following elements of design process: 1) creating the design context, 2) defining the design task and related design constraints, 3) creating conceptual and visual (physical) design ideas, 4) evaluating design ideas and constraints, 5) experimenting and testing design ideas by sketching, modeling and prototyping, 6) evaluating functions of prototypes, and 7) elaboration of design ideas and redesigning. However, these phases should not be understood as a prescription for a rigidly specified sequence of design stages. The model merely illustrates the relations between elements of the collaborative design process (see Figure 1).

![Figure 1: Learning by Collaborative Designing (LCD) model.](image)
In collaborative-design learning settings, the design context and the design task are defined through joint analysis; all participants have to learn to understand the external and internal constraints related to the problem or solution. In this phase, the teacher or external domain experts have an important task to help students to define the diverse cultural, social, psychological, functional and emotional aspects essential to the design of the product. During the outlining of the design constraints, conflicting issues that have an effect on the design process and its requirements sometimes need to be taken into consideration. By acquiring deepening knowledge, sharing that knowledge socially, producing varying design ideas and evaluating those ideas, the design process moves forward cyclically. Thus, constant cycles of idea generation, and testing of design ideas by visual modelling or prototyping, characterize the LCD process. Moreover, the critical role of the teacher or the external domain experts underscores the value of the physical context (i.e., diversity of concrete objects or material artifacts, interaction with tools) and social interaction in order to make design tasks shareable.

In what follows we will introduce one case of elementary level students’ collaborative design project that is, the “Artifact project”. The project was designed together with the classroom teacher and took place in her classroom in Laajasalo Elementary School, Helsinki, Finland. It was based on the following ideas: 1) intensive collaboration between the teacher and researchers, 2) engagement of teams of students in design practices by collaborating with a professional design expert, 3) integration of many school subjects, such as history, mother tongue, physics, chemistry, biology and geography, visual arts, technology and craft education, for solving complex real-world problems, and 4) pursuit of collaborative design across an extended period of time. The Artifact project started with 31 elementary school students at the beginning of their second term of fourth grade and continued across 13 months until the end of their fifth grade. Altogether, the Artifact project took 139 lessons (in Finland one lesson lasts 45 minutes) across three terms. The project highlighted the authentic design problems and the variety of conceptual and material aspects in designing. The technical infrastructure of the projects was provided by Knowledge Forum (KF, Scardamalia & Bereiter, 2006) designed to facilitate collaborative building of knowledge. The phases of the project, their duration and main content, as well as the number of KF notes produced are presented in Figure 2. During the project, the students analyzed artifacts within their historical context, studied physical phenomena related to artifacts, examined designs of present-day artifacts, and finally designed artifacts for the future.
In the first phase of the Artifact project - The Past - an exploration of historical artifacts was conducted by looking into the evolution of artifacts as cultural entities. The item had to 1) be used daily, 2) have a long history, 3) be originally made by hand and 4) be used by hand. Students chose items which most of them had used and which they found interesting: a clock, a spoon, money, a lock and a key, a jewel, a ball, and a lamp. According to students’ ideas the historical aspects of the artifacts were researched by visiting the Finnish National Museum, gathering offline and online reading materials, and interviewing grandparents.

In the second phase of the project – The Present – the physical subject domains from the curriculum were integrated to the project. The teacher guided the students to investigate and ask research questions regarding the phenomena related to the chosen artifacts. The students planned, conducted, and reported their own experiments, or used ready-made tool kits to conduct expert-designed science experiments. In addition, the teacher arranged visits to a blacksmith’s shop and the Clock Museum.

The third phase of the project – The Future – addressed the designing of artifacts. First, the design process was rehearsed by designing a lamp. The leadership for this phase was provided by a professional designer together with the teacher. Beyond conceptual design relying on writing, the students supported their design through sketching and prototyping. The investigation of the lamp design led the students towards the last stage of the project focused on projecting, in terms of design, how their chosen artifacts would look in the year 2020 (for a detailed description of the project, see Kangas et al., 2007; Seitamaa-Hakkarainen et al., 2010).

We now outline four aspects that we see central for the knowledge-creation approach on collaborative learning: 1) CL is an object oriented process taking place across long periods of time, 2) the subject of CL is an inquiry community, 3) CL is mediated by
collaborative technologies, 4) CL is a matter of expansive transformation of shared knowledge practices.

**Object-centered approach to collaborative learning**

According to the knowledge creation perspective, collaborative learning, particularly where innovation is involved, cannot be properly understood without addressing knowledge objects (i.e., symbolic-material artifacts, such as questions and theories, or practices) that are created, elaborated, advanced, built on, and which arise during the process. Instead of focusing on narrow textbook problems and transmission of pre-determined rules and procedures, successful CL projects engage a learning community in a pursuit of challenging inquiry objectives, such as building knowledge of natural or societal phenomenon and designing artifacts, and induce students to commit to sustained efforts in attaining them. Independently finding solutions to complex problems is the only known way of preparing students to solve unanticipated problems encountered in the future (Marton & Trigwell, 2000). From the activity-theoretical perspective, such an approach may bring spatial and temporal expansion of the object of educational activity about in terms of working with objects across multiple lessons, diverse contexts, and extended periods of time (Engeström, Puonti, & Seppänen, 2003).

The knowledge creation approaches guide educators to engage students in collaborative pursuit of varying complex and multifaceted problems that often come from outside of educational institutions and, thereby, break the epistemic boundaries of school learning. In the case of the Artifact project, these objectives were related to understanding the historical evolution of cultural artifacts, scientific principles of designing these kinds of artifacts, and the actual design process of novel artifacts. Common awareness about the shared assignment of the learning community can be promoted with the help of classroom discussions. In collaborative classes, the students regularly work in groups, and joint inquiry can be supported by a shared screen that is projected on the wall (a blackboard, posters, or a smart board could be used as well), in which shared works can be presented and pondered and which assists in sharing the research results of all student teams; this was, indeed, a central aspect of the pedagogical practices of the class teacher organizing the Artifact project (Viilo et al., 2011). Joint discussions in front of the shared screen may be supported by a networked learning (software-based) environment, such as Knowledge Forum (Scardamalia & Bereiter, 2006). Such environments provide a shared database for which the participants may produce knowledge.

Although the nature of knowledge objects cannot be fully determined before inquiry, and are collaboratively emergent (Sawyer, 2005) in nature, their basic size and shape is usually known. As we see it, the objects of CL can be concrete (yet non-material) artifacts that can be manipulated, shared, extended, and transformed. Such objects may come in multiple forms. Such objects involve conceptual artifacts (Bereiter, 2002) or ideas, such as questions, hypotheses, and working theories as well as plans and conceptual designs. The processes of creating epistemic artifacts by writing, visualization or prototyping may be called epistemic mediation. Such processes allow re-mediating one’s activity by externalizing, and materializing inquiry processes to shareable knowledge artifacts. Re-mediation even involves ideas and conceptions that have to be externalized and materialized so as to be shared and jointly developed. In design activity, students are concerned with the usefulness, adequacy, improvability, and developmental
potential of ideas (Scardamalia & Bereiter, 2006). It is essential to provide students with experiences of solving complex design tasks, tasks that engage them in iterative improvement of their ideas and the artifacts embodying them.

In the context of the Artifact project, the objects were shared problems and design tasks that the participants were working with. Students' sketches, from the first drafts of ideas and general visualizations to construction details, played an essential role in the design process. Through this externalization, ideas became visible and improvable, enabling their collaborative advancement. With Knowledge Forum students developed knowledge and skills to model, design, and construct ideas into physical artifacts through interactive process. For example, the professional designer described his own design process and drew students' attention to the essential points of lamp designing. The students were given a task to pick a well or badly designed lamp from one’s own environment and present an analysis of that particular lamp to the whole class. The analyses were also saved in the Knowledge Forum database (Figure 3):

**Presentation (student A): Flashlight**

My lamp lights up relatively small part of the darkness, but you can point it where you like. The light is quite bright, but bad quality. It didn’t cost very much. A flashlight can be carried easily anywhere. I think it’s handmade.

Good:
- covered with wood
- can be carried easily
- rather affordable
- exclusive

Bad:
- bad quality of light
- lights up a small spot

**Presentation (student B): Flashlight**

The bad thing about flashlights is the fact that the batteries will come to an end at some point. Good things are:
- you can direct it where you want to
- lights up short or long distances
- can be carried with you

**Figure 3: Analysis of flashlights in the KF database (students’ notes #1811, #1827)**

After the analysis of existing flashlights, these two students started to design collaboratively and stated their aim to improve the flashlight in the following way: “New flashlight. The lamp could be improved by adding 2 batteries, so the power would not end so quickly. Still it would be easy to carry. It would be easy to point it anywhere. Main measurements: 16cm x 3cm. Carrying tape at the end (#1833)”. The designer commented on the students’ notes by writing annotations: Are there any other options than adding batteries, to prevent the power from ending? What shape of lamp would be the easiest to use? Do we need other than pointing light from a flashlight? (#1903). It was crucial for the students to understand the important constraints and specific features of a flashlight,
i.e. functionality of the particular type of the lamp, in order to improve their preliminary design. They produced variety of conceptual and visual design ideas (for example, replacing the batteries with an accumulator, and adding folding legs in order to keep the flashlight standing in vertical direction) leading to a final presentation and evaluation of the new lamp (Figure 4).

**Conclusions:** We designed “The Calamar” on the basis of the flashlight. We wanted the lamp to have soles. The goals were attained. There were no problems. The lamp is a bit too large, but still it fits in a backpack, for instance. The carrying tape is not needed, otherwise it’s all right. “The Calamar” is a good lamp for expeditions or usage at home. Main measurements: 16 x 3 cm.

**Figure 4: Conclusions of the design process of a flashlight (student team’s KF note #2047)**

Rather than seeing objects only as conceptual ideas, those undertaking a knowledge-creation approach examine them as hybrids (Latour, 1999), being both knowledge-laden and physically embodied as digital or other types of artifacts. The role of materials and artifacts in the design process is crucial. Designers are “working with things”; they express their ideas in “things themselves” rather than merely words (Baird, 2004, p. 148-149); designed artifacts literally carry, bear, and embody knowledge. In order to understand and improve the ideas being developed, they have to be given a material form by means of practical exploration, prototyping, and making. Learning to work with thing knowledge (Baird, 2004) involved, for instance, in modeling and prototyping, is an essential aspect of appropriating design practices. The Artifact project was explicitly oriented toward parallel working with conceptual and materially embodied artifacts. Concrete materials and tools, as well as testing with models and prototypes, supported the development of ideas by adding the material aspect to the conceptual ideas. Students thought with different materials during the design activity; they formulated ideas with the help of tools and machines mediating the meaning making process. Consequently, in design settings, material artifacts and tools have a central role in mediating the learning processes.

**Creating knowledge community for supporting collaborative learning**

In order to elicit knowledge creation processes, it is essential to build an inquiry community that structures and directs the participants’ collaborative epistemic activities. Collaborative inquiry learning appears to represent a special kind of cultural practice that can be appropriated by learners through organizing classrooms as inquiry communities (Brown et al., 1993, Scardamalia & Bereiter, 2006). Ann L. Brown’s distributed expertise and Scardamalia and Bereiter’s knowledge building community focus on transforming
classrooms toward collaborative-learning communities through facilitating the same types of social processes, such as public construction of knowledge, that characterize progressive research communities. The community of practice approach (Lave & Wenger, 1991) and Engeström’s (1987) expansive learning framework, in turn, focus on integrating school learning with authentic cultural activities taking place in the surrounding society. All of these approaches are relevant from the knowledge creation perspective, because each of them underscores the importance of community building.

Brown and her colleagues’ (1993) distributed-expertise approach relies on an assumption that collaborative learning requires the creation of a shared object for working and the setting of distributed tasks which support it. This approach highlights the importance of organizing students to work in heterogeneous teams so as to capitalize on their complementary knowledge and expertise and jointly achieve higher-level collaborative objectives. Such pedagogy was utilized in the Artifact project. In the first phase of the project, the students worked in the “home teams” (about 4 students per group), which investigated chosen artifacts specific to each group and produced knowledge to the team views of KF. In order to capitalize on complementary knowledge and expertise, the teams were heterogeneous, consisting of boys and girls, as well as less and more advanced students. Distributed regulation of inquiry involves the teacher, students, or specifically nominated team members to follow and assess advancement of CL and providing encouragement and guidance when necessary; CL does not produce good results without such a meta-level activity. Distributing expertise does not always produce the best results; consequently there is reason, once in a while, for the whole CL community to study some particular problem or subject domain (Hakkarainen et al., 2004). In this case, the thematic groups temporarily suspend their action and everyone focuses on solving a single group’s problem or challenge. Accordingly, the composition of the home teams of the Artifact project was changed when the investigations concerning artifacts of the present time, began. During this phase, all students were requested to work with the same topics and created Knowledge Forum views collectively shared by the whole class. This method allowed bringing everyone up to the same level of knowledge required by the distribution of expertise; this way helps the whole learning community work at the same pace. In the last phase, the student teams were formed on the basis of their presentations of existing lamps. Those who presented table lamps, formed table lamp teams, those who presented pendants, formed pendant teams, and so on. For the designing of future artifacts, the students returned to their original home teams that had been formed in the beginning of the project, and all students worked in the same views (Kangas et al., 2007; Seitamaa-Hakkarainen et al., 2010).

Socio-emotional processes also play an important role in CL focused on collective creation of knowledge. The participants (students and the teacher) have to be willing to take the risk of a jump into the unknown and to engage in improvisational efforts of pursuing novelty. Students may be afraid of unavoidable mistakes and fear failure in front of their peers if a very competitive culture prevails within a classroom; this is likely to hinder and constrain their participation in CL. The teacher and researchers put a great deal of effort to creating an encouraging atmosphere at the classroom community carrying out the Artifact project and developed practices of constructive feedback. This effort is important because there are large differences between students’ cognitive capacities due to heterogeneous cultural, social, linguistic, and financial resources of their
families in which cognitive growth and intellectual socialization take place. Constant assessment and competitive relative grading are likely to empower high achieving students and make other students feel inferior and perform less than optimally. The knowledge of students coming from socio-economically advantaged homes is often recognized by prevailing educational practices, whereas knowledge and competence of the others are disregarded or underestimated (Both & Barton, 2004). During the Artifact project, a number of students with special educational needs were successfully integrated with knowledge-creating learning. It is beneficial to work in heterogeneous groups consisting of participants representing various levels of educational achievements and providing multiple zones of proximal development. Collaborative inquiry provides social structures that channel educational activity in a way that also engages disadvantaged students in more intensive meaningful learning efforts than otherwise would be the case. Pursuit of challenging epistemic objects becomes attainable when working as a team. Comprehensive supporting structures for eliciting focused inquiry, and the construction of a presentation or research reports are likely to assist in focusing on meaningful epistemic activities. A crucial role in classroom learning communities in general, and supporting disadvantages students’ learning in particular, is played by the teacher who, together with students, sets up higher-level inquiry objectives and shared milestones in negotiation with students, closely follows students’ advancement, and directly instructs students when necessary. Overall, it is essential to allow students to build on their strengths, provide many paths to common educational objectives, and tailor pedagogical and rehabilitation efforts according to specific characteristics of students (what he or she knows and does not know, understands and does not understand) (Clay, 1998; Olson, 2003).

Breaking boundaries between educational institutions and the surrounding society and providing experiences of taking part in genuine communities, networks, and social movements outside of school may provide experiences of CL and assist overcoming of learning difficulties. The rationale of engaging students in collaborative designing in the context of the Artifact project was to cross-fertilize educational practices with those of professional designers. For example, the students were repeatedly asked to present their on-going lamp designing processes in front of the whole class, as professional designers present their ideas to clients. Situating the emerging ideas subject to collective evaluation, using expert practices and language, encouraged the students to reflect and justify their ideas and make their reasoning clear. In addition, listening to other students’ presentations helped in developing collaboration skills, such as turn-taking, listening, and respect for other’s opinions. Roth and Baron (2004) have developed a novel approach to science education that involves engaging school children in actual collaboration with various external communities rather than merely simulating such activities. They argued that we need to rethink scientific literacy as a capacity to take productive part in solving of the strategic challenges of our time, such as protection of the environment and survival of the Earth. Roth and his colleagues have pursued a project during which students take part in protecting local waterways in collaboration with native communities of British Colombia, Canada. Accordingly, students take part in collecting and analyzing samples, improving river bends, and reporting results in meetings of local environmental activists. Many students who do not show any visible promise within a school class, start shining and sparkling ideas when engaged in a completely different type of educational activity.
involved in social movements (Roth & Barton, 2004); this observation also characterizes our experiences of the Artifact project. Expanding focus from classroom learning to the authentic cultural activities appears essential for deepening CL approaches. Educational researchers often used of the concept of “community” in very shallow way, frequently without any deeper theoretical foundations whatsoever; they assumed that classrooms as such constitute learning communities; whatever group of agents (e.g., students) that was brought together for a short time was considered to represent a community (Roth & Lee, 2006). In order to be considered a community of learning, a group of students needs to have a shared object of activity. While this is likely to be the case in the most innovative pedagogical experiments involving iterative cultivation of classroom practices across extended periods, it is something that has to be shown, case by case.

**Technology-mediation of collaborative learning**

What is the specific role of computer technology in knowledge-creating approaches to collaborative learning? As indicated by the very term, Information and Communication Technologies (ICTs) have, for long, emphasized either the information genre or communication genre with monologues and dialogues as respective social activities (Enyedy & Hoadley 2006). The main uses have been either to deliver knowledge and provide access to learning materials or opening up networking and communication possibilities, instead of deliberately facilitating collaborative advancement of epistemic artifacts. It appears that knowledge-creating practices have become available for educational institutions because of new technologies specifically designed to facilitate shared knowledge advancement. Bereiter’s (2002) theory of knowledge-building emerged from efforts of conceptualizing computer-supported collaborative learning practices, mediated by *Knowledge Forum*, a specially designed environment for knowledge building, that could not be understood in terms of mere individual learning. The success stories of Wikipedia and open-source development communities give reasons to believe that new technologies play a crucial role in facilitating collaborative creation of knowledge. Knowledge creation typically relies on support provided by collaborative technologies involved in transforming various ideas of participants to shareable digital and yet material artifacts with which participants can be in interaction. This makes it feasible for elementary-school students to collectively work with objects that extend across space and time and heterogeneous networks of people and artifacts. These tools also allow the participants to record and capture many aspects of their inquiry processes for subsequent reflection. Rather than relying only on here-and-now oral discourse, a technology-enhanced shared space mediates the participants’ activity and assists in externalizing, recording, and visually organizing all aspects and stages (question generation, theory formation, prototype designing and so on) of their inquiry process.

Accordingly, knowledge-creating learning is supported by flexible technology mediation designed to scaffold long-standing collaborative efforts of creating and sharing as well as elaborating and transforming knowledge artifacts (Muukkonen, Lakkala, & Hakkarainen, 2005). In the Artifact project, we used Knowledge Forum for sharing the collaborative design process. Toward that end, the participants documented, visually (drawings and photos in the background of views and within the notes) and conceptually (text notes), (a) encounters with experts, (b) results of field studies, (c) student-designed exhibitions, and
(d) design of concrete artifacts created by the students (Kangas et al., 2007; Seitamaa-Hakkarainen et al., 2010). Our experiences indicate that KF can be productively used to facilitate materially embodied (“hybrid”) design process in addition to conceptual design.

It appears that the technology as such does not determine the nature of its implementation but coevolves with gradually transforming institutional practices. Only when ICT-based tools in general and collaborative technologies in particular have been fully merged or fused with social practices of teachers and students, are the participants’ intellectual resources genuinely augmented and learning achievements correspondingly facilitated. Appropriating technology as an instrument of personal and collective activity is a developmental process of its own (Beguin & Rabardel, 2000; Jaakko Virkkunen, personal communication). For the success of the Artifact project, it was crucial that the teacher had sophisticated ICT competences, had cultivated practices and methods of using collaborative technology, and well as guided the students of her classroom to use ICTs and KF. This is our evidence that technology enhances learning only through transformed social practices (Hakkarainen, 2009). Meaningful technology-enhanced learning presupposes expansive learning (Engeström, 1987) processes in which novel technology-mediated practices of learning and instruction are iteratively developed. Profound transformation of social practices is called for in the context of CL that aims at reorganizing classroom activities by following the example of scholarly communities. Advancement of the field requires a more comprehensive understanding of the complex and dynamic relations between technologies and social practices involved in educational transformation processes.

**Collaborative learning relies of deliberately cultivated knowledge practices**

Establishing an educational learning community is essential because it carries or bears social structures and practices critical for knowledge creating approaches to collaborative learning. In order to make CL to work, it is essential to create and cultivate shared knowledge practices that guide participants’ activities in a way that elicits a pursuit of shared inquiry. By ‘knowledge practices’, the present investigators refer to personal and social practices related to epistemic activities, such as creating, sharing, elaborating epistemic artifacts, such as written texts (Hakkarainen, 2009). Such practices refer to relatively stable but dynamically evolving shared routines and established procedures, such as question generation, explication of working theories, search for information, and contributing notes to KF, which have deliberately been cultivated within a learning community. Knowledge practices show a range from rigid routines and habitual procedures to deliberate and constant pursuit of novelties.

One basic tenet of the knowledge creation approach to collaborative learning is that innovation and pursuit of novelty are special kinds of social practices cultivated in epistemic communities and their networks (Knorr Cetina, 2001; Hakkarainen et al., 2004). A successful learning community deliberately aims at “re-inventing” prevailing practices (Knorr Cetina, 2001, p. 178) so as to elicit knowledge-creating inquiry. Innovative CL cultures cannot be created from scratch; this requires sustained iterative efforts in transforming social practices prevailing within classrooms toward more innovative ones. This transformation is something that advanced teachers have spontaneously engaged in; all successful cultures of collaborative learning capitalize on long-standing efforts of eliciting directed evolution of prevailing knowledge practices in
a way that advance inquiry. It appears to the present investigators that CL cultures necessarily rely on expansive-learning (Engeström, 1987) cultures, that is, the creation of a local community by teachers, researchers, and students’ efforts that deliberately reflect on and problematize its prevailing practices, envision and practically explore novel ones, and gradually consolidate those aspects of practices that appear productive. By practically exploring various possibilities, getting rid of weaknesses, resolving tensions and disturbances, and promoting the desired characteristics, the teachers are able to promote directed evolution of classroom practices.

Consequently, directing of CL does not only take place only in a top-down fashion from teachers’ guidance to re-direction of students’ activity but involves reciprocal and improvisational efforts of making sense of the situation and finding productive lines of further inquiry. This process may be facilitated by engaging the students themselves in reflecting and re-designing their practices. One of the teachers we are collaborating has established a practice of, once in a while, interrupting all activities in a classroom and asking all students to take part in reflecting on advancement of the overall project and jointly decide how to advance (Viilo et al., 2011). In the context of the artifact project, the students were accustomed to the language of designing in their continuous interaction with the professional designer. He used authentic design terminology that was in many cases naturally adopted by the students in the course of their designing. Then again the designer also appropriated some of the discursive practices of classrooms. He adopted epistemic practices of investigative learning by requesting students to explicate their design ideas and pushed them to do their inquiry in depth. This process shows how successful CL cultures rely on gradual cultivation of knowledge practices that channel the participants’ epistemic efforts towards knowledge advancement (Hakkarainen, 2009).

A new teacher should not become discouraged if collaborative learning does not immediately provide expected results. While it may be difficult to change study practices of an already established community, it is possible to intellectually socialize novel student cohorts to advanced collaborative inquiry practices from the very beginning of their studies within a classroom (Hewitt, 1996; Hakkarainen, 2009). Through directed evolution of practices, very advanced inquiry culture can be cultivated to which novel cohorts of students can be socialized without going through similar developmental processes that initiators of the culture went through. It is advisable to engage in multi-professional work with other teachers to create networks of classroom learning communities as well as promote corresponding transformation at the level of the whole school. This project implies overcoming spatial and temporary constraints of prevailing activities by such means as multi-professional collaboration between teachers, integration of instructional efforts initially fragmented according to disciplines, and boundary crossing between the school and the surrounding society (Engeström, et al., 2002); these means are crucially facilitated by the technologies and learning environments. When integrated with iterative efforts in improving and developing the community by overcoming challenges and tensions encountered in classroom practices, it is possible to get into an expansive developmental trajectory of prevailing knowledge practices.

Discussion

In the present chapter, we have briefly reviewed knowledge-creation approaches to collaborative learning. We have started to use terms ‘trialogue’ and ‘trialogical learning’
for those processes where people are organizing activities for developing concrete artifacts and practices (Paavola et al., 2004). While studying collaborative learning, it is, however, important to see a continuum from “participation” approaches to “knowledge creation” approaches, and from dialogical meaning making to trialogues in terms of collaborative work with shared objects (Paavola & Hakkarainen 2009). Dialogic theories typically emphasize such things as communication skills, expressions of different perspectives, having multiple voices, sharing meaning, providing shared understanding (Stahl, 2006). Artifacts such as reports are mentioned, of course, but primarily as means of dialogue. Trialogical inquiry appears to require extended efforts of the participants, going beyond mere dialogues, for developing shared objects across relatively long periods of time. We emphasize that the objects themselves have a causative role. Trialogues of course require dialogue in respect of making and taking perspectives and negotiation their meaning by commenting and discussing. Yet the defining principal feature of trialogical inquiry is creative working with externalized ideas and objectification and materialization of thoughts in respect of creating epistemic artifacts in which subsequent inquiry takes place. Human beings are cognitive over-achievers because they use various cognitive extensions for piggy-backing complex cognitions that could not be implemented without external aids (Donald, 2001). By taking intensively part in CL practices, even very young learners may learn to systematically augment their intellectual resources by crystallizing reasoning processes and inquiries to shareable artifacts; this affect the learners in their joint cognitive processes. The Artifact project involved students learning to systematically capitalize on material-symbolic epistemic artifacts, created by themselves and their fellow learners, in their subsequently epistemic processes.

There is evidence of the educational value of CL in facilitating the development of participating students’ agency and transformation of their identity (Hakkarainen et al., 2004; Engeström, 1999). Productive CL takes place in mediated interaction between personal and collective activities. In many cases, individual agents have a key role in knowledge-creation processes but are not, in fact, acting individually; their activities rely on a fertile ground provided by collective activities and upon the artifacts jointly created. Becoming a collaborative inquirer is a developmental process of its own. Participation in pursuit of complex collective projects in likely to elicit a students’ socio-cognitive growth. Breaking boundaries between school and cultural communities often provides opportunities for appropriating novel roles and developing one’s agency. Novel and more demanding roles become available to students when engaging in extra-curricular activities taking place outside of the classroom. It often happens that new groups of students start excelling when engaged in activities across multiple contexts (Roth & Barton, 2004). Epistemic agency in the form of assuming collective cognitive responsibility for collective inquiry efforts appears to be especially important (Scardamalia, 2002). From a socio-cultural perspective, learning is not, however, a mere epistemic improvement, but also an ontological transformation (Packer & Goicoechea, 2000) elicited by cultivating CL cultures that allow utilizing errors and mistakes safely as collective learning experiences. Collaborative learning is always multi-voiced and heterogeneous in nature. In interaction between teacher and the fresh and unique knowledge and experience of new cohorts of students there emerge practices that neither belong to official school discourse, nor to students’ informal discourse; rather they are
genuinely collaboratively emergent (Sawyer, 2005) in nature (third space, Gutierrez, Rymes, & Larson, 1995). Many aspects of the Artifact project were not anticipated by the investigators and appear to represent such an emergent phenomenon following its own logic (trialogic!). Participants’ activities had deeper meaning and cultural significance that went beyond regular concerns of individual school achievements or a separate school project.

References


