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Academic knowledge practices and quality of higher education

Introduction

The purpose of this paper is to discuss the quality of higher education from the perspective of academic knowledge practices, that is, the shared practices of working with knowledge in the contexts of learning, teaching, and researching. I am here using the term «knowledge» in the broadest sense, to include what is explicit or stated in official discourse (e.g., approved texts), to what is implicit, informing one's habits (perhaps pre-reflectively) of expert working, and further yet, to that which underlies the competencies of experts, for example, the so-called «procedural knowledge.» Knowledge practices, while sometimes just supporting routine learning (transmission), at their creative edge diverge from other routine social practices in that they take place in specific purposefully dynamic and fluid settings designed for the furtherance of innovation and knowledge. Rather than relying merely on mundane habits or repeated routines (which may also be needed), such practices are aimed at solving emergent problems and constantly pursuing novelty and innovation. I do not consider myself a researcher of the quality of higher education; quality is a rather hard concept to define, and I have not worked much on this concept beyond writing this paper. Yet, my efforts inpursuing research and development of technology-mediated learning environments have focused on improving the quality of education and I have addressed many foundational issues relevant in this regard (Hakkarainen, Palonen, Paavola & Lehtinen, 2004; Muukkonen, Lakkala & Hakkarainen, 2005). Being a psychologist, I am interested in the personal learning and transformation that people go through while participating in higher education. Consequently, my approach may be closer to the micro- than the meso- or macrolevels of considering quality of education.

In this chapter, I address the quality of higher education from the perspective of the following five questions: First, what is the role of the different metaphors of learning in current practices of higher education? Second, how do technology-mediated knowledge practices in

general and epistemic mediation in particular affect the quality of higher education? Third, how may the quality of higher education be improved by rooting investigative practices of learning and instruction in university education? Fourth, what are the challenges and constraints to transforming academic practices as well as appropriating technology-mediated practices of learning and instruction? Finally, how can the collective practices of learning and researching that allow intellectual socialization of students to cutting-edge knowledge practices of research communities be related to collective creativity of academic activity?

Three metaphors of learning and quality of higher education

A central aspect of my research over the last decade or so has been working, together with my colleague Sami Paavola, with metaphors of learning and expertise (Paavola, Lipponen & Hakkarainen, 2004; Hakkarainen et al., 2004). The metaphors represent, simultaneously, three generations of research in my community (Hakkarainen, 2009a). The traditional *knowledge acquisition metaphor* examines learning as an individual and mental process; the human mind is seen as a kind of container and learning the process that fills the container with knowledge (Bereiter, 2002). *Participation metaphor*, in turn, examines learning as a process of socializing to cultural practices (Lave & Wenger, 1991; Sfard, 1998; Wenger, 1998). Socio-culturally oriented researchers have argued since the 1980s that, ultimately, learning is a process of growing up to a community and learning to function according to its norms, values, and practices. It not only is an epistemic process but also involves identity formation when initially peripheral participation transforms to a central one.

It appears that learning taking place in an advanced knowledge society can neither be reduced to assimilation of already existing information (as assumed by the acquisition metaphor) nor evolve to prevailing community practices (as often assumed by the participation metaphor). We have argued that to understand learning relevant for our time, we need a third metaphor of learning, namely, *knowledge creation* (Paavola et al., 2004). Accordingly, learning is seen as a process of deliberately creating new knowledge or transforming social practices in interaction between individuals and communities. It is a collaborative process of working with a shared object and growing through the process. This kind of learning has become accessible even to elementary school students whose intangible ideas are transformed by ICTs to shared artifacts that can jointly be elaborated and extended (Hakkarainen, 2004, 2009b). Knowledge creation through learning appears especially important for universities and higher education institutions that are expected to cultivate corresponding creative and cognitive skills and competencies.

The quality of university education may be examined from the perspectives of these metaphors (Hakkarainen et al., 2004; Lakkala, Muukkonen, Paavola & Hakkarainen, 2008; Muukkonen et al., 2005). Traditional practices of university education appear to do a decent job only in terms of transmitting satisfactorily basic disciplinary knowledge to students. Further, acquisition-oriented university studies do not give students opportunities to participate and socialize to practices related to professional and academic communities (Mandl et al., 1996); this may be an especially severe limitation of university education; polytechnics with many workplace-oriented courses and activities may do better. If the practices of lear-

ning and instruction are too far away from experts' practices, students are likely to have a hard time coping with the requirements and challenges of professional or academic life (Hakkarainen et al., 2004). Finally, I find it problematic that university students do not have much experience of taking part in knowledge creation efforts before their bachelor's or master's theses; students are usually excluded from academic knowledge creation communities. This state of affairs does not appear to correspond with the classical ideals of university education, such as the unity of teaching and researching, that aim at intellectually socializing students to members of disciplinary communities (Hakkarainen et al., in press a; Pyhältö et al., 2009; Walker et al., 2008).

Using ICTs to promote participatory and knowledge creation practices of academic education

My own efforts in research and development of technology-mediated learning environments have focused on promoting knowledge-creating practices from the very beginning of university studies (Hakkarainen, 2009b; Ritella & Hakkarainen, 2012). Toward that end, I have taken part in research and development of three collaborative technologies, Knowledge Forum (KF, www.ikit.org), Future Learning Environment (FLE, www.fle3.uiah.fi), and Knowledge-Practices Environment (KPE, www.kp-lab.org). These are groupware systems providing a collaborative notebook for students in order to support and facilitate engagement in personal and collaborative creation and building of knowledge. It is psychologically essential to have the participants themselves creating, elaborating, discussing, extending, and building on their ideas through writing and visualization rather than merely recycling ideas presented in their textbooks (Scardamalia & Bereiter, 2006; Ritella & Hakkarainen, 2012).

I am interested in technology-mediated learning because the Information and Communication Technologies (ICTs) provide «cognitive prostheses» (Clark, 2003) that promise to extend the participants' intellectual resources. As I see it, intelligence does not take place only in your minds or inside your skin, but it is also materially distributed between minds and culturally and historically developed tools and practices (Hutchins, 1995; Pea, 1993; Vygotsky, 1978). Human beings are extreme «cognitive overachievers» (Donald, 2000) whose intellectual achievements piggy-back on cultural inventions related to externalization, objectification, and materialization of ideas to shareable epistemic artifacts. We are collective cyborgs whose intelligence is adapted to capitalize on extended cognitive circuits crossing boundaries between mind, body, and the environment (Clark, 2008). The emergence of literacy transformed human cognitive architecture as profoundly as earlier leaps in biological evolution (Donald, 1991; Vygotsky, 1978). It opened various external memory fields for writing and visualization that assist in solving significantly more complex problems than can be done with the unaided human mind. The other aspect is the social distribution of intelligence. Human beings are ultra-social (Rogoff, 2003) and hyper-collaborative (Tomasello, 2009) beings in nature who are able to merge and fuse intellectual efforts and create collective cognitive systems together.

The revolution of ICTs is the continuation of the same cognitive transformation that accelerated the development of human civilization bringing about radical collectivization and externalization of intellectual activity. Technology may be seen as the continuation of human evolution by other means (Donald, 2000). ICTs may be considered as epistemic technologies or tools of mind that radically transform our personal and collective cognitive characteristics enabling us to solve qualitatively more challenging tasks. The human cognitive evolution has not ended but continues in the form of massively distributed knowledge networks in interaction with which our learning and working take place. The nature of problem solving changes radically when 'googling' allows you to consult vast databases with a few clicks, faster than activating knowledge stored in a biological memory. In order to affect our psychosocial processes, ICTs have to be fused as integral aspects of our «cognitive–cultural operating system» of activity (Donald, 2000). Only when technology becomes your second nature, you are able to stretch it toward supporting your own intellectual activities (Ritella & Hakkarainen, 2012).

The impact of ICTs on human cognitive processes depends on the individual's history of intellectual socialization. Digital natives are persons who have been born to a world that enabled intensive ICT usage from the very beginning of their lives (Prensky, 2000, 2012; Palfrey & Gasser, 2008; for a critical views, see Bennett & Maton, 2010; Thomas & Brown, 2011). They have a very different relation to ICTs compared to digital immigrants (older generations) who have learned to use ICTs later on in their lives (see Wexler, 2006, for cultural adaptation of cognition across generations). Although each generation's practices of using ICTs are heterogeneous and only some young people represent advanced practices of using ICT (Ito et al., 2010), there appears to be a discontinuation or gap between different generations' practices of using ICTs. The quality of higher education may be considered from the perspective of the discontinuation or gap prevailing between the practices of digital natives and the practices of higher education. Many digital natives rely on intensive use of ICTs in their personal and peer-collaborative activity while traditional media still dominate higher education institutions. Digital natives are said to function effectively in streams of multiple media (multitasking) whereas serial or linear functioning characterizes educational practices (Veen & Vrakking, 2006). Finally, many young people take part in co-creation in interest-driven extended networks whereas educational practices still rely on traditional reproductive use of knowledge and tight external performance requirements (Gee & Hayes, 2011; Ito et al., 2010; Jenkins et al., 2009). Because the ICTs in general and social media in particular have, however, developed very rapidly, we do not yet have sufficient information on the actual evolving media practices of digital natives (see, however, Ito et al., 2010; Willett & Buckingham, 2008). Because of this, it is hard to say what is a fact and what a mere artifact (i.e., hype) concerning the claims of digital natives.

Although ICTs provide novel educational possibilities, there are no reasons to assume that all ICT-mediated practices would be educationally beneficial. Some investigators, such as Nicholas Carr (2010), are worrying that intensive use of ICTs, which involves constant interruptions, will corrupt disciplined thinking. From the perspective of quality of educational experience, it is worrisome that young people do not read whole books any more, as many professors complain. Are young people developing «a grasshopper» mind (Papert, 1994; c.f., by Carr, 2010) because of being socialized by Google to jump from one piece of

information to another? A limitation of Carr's otherwise illuminating approach is, however, that, in accordance with the acquisition perspective, he examines ICTs mostly from the perspective of consumption of knowledge. Together with Marlene Scardamalia and Carl Bereiter (2006; Bereiter, 2002; Bereiter & Scardamalia, 2003), I maintain that ICTs are most likely to improve the quality of education only when students are engaged in building and creating knowledge with the assistance of technology-mediated collaborative learning environments. From a psychological perspective, it is critical to engage students in using ICTs for facilitating epistemic mediation. By epistemic mediation, I refer to a process of deliberately re-mediating personal or collective inquiry by creating shareable epistemic artifacts, such as texts, graphs, and models (Ritella & Hakkarainen, 2012).

Epistemic mediation involves deliberate efforts at externalizing and objectifying, crystallizing, and synthesizing one's view at the edge of knowing and using the resulting epistemic artifacts as stepping stones for reaching a higher-level understanding at subsequent cycles of inquiry. The principal vehicle of epistemic mediation is writing. If students do not learn to write, they do not learn to think (Olson, 1994). Consequently, in epistemic terms, writing is gold and talking is silver: Serious inquiry cannot rely on mere oral interaction but must capitalize on epistemic mediation involved in systematic production of knowledge artifacts. From a psychological perspective, it is essential that when constructing external artifacts, knowledge builders not only create cultural knowledge but also shape, build, and massively restructure their minds. I believe that sustained processes of epistemic mediation lead to formation of the so-called Long-Term Working Memory (Ericsson & Kintsch, 1995), that is, a virtual memory system based on fully internalized cultural knowledge. Representational redescription is likely to play an essential role in the dynamic emergence of usable knowledge structures (Karmiloff-Smith, 1992). I see epistemic mediation as a critical knowledge practice whose appropriation improves the quality of higher education. Many students have spontaneously cultivated corresponding practices. Making notes and documents has played a central role in university education for ages; the development of social media enables externalizing and collectivizing epistemic mediation, in terms of producing bloges and wikies. The learning environments that my colleagues and I have developed capitalize deliberately on epistemic mediation. Only intensive participation in practices of epistemic mediation over sustained periods of time is likely to bring about the desired developmental–cognitive effects.

From content delivery to investigative practices of learning

Investigators are criticizing university education for being too much focused on transmitting content knowledge to students (Gee & Hayes, 2011; Schank, 2011; Thomas & Brown, 2011). The object of students' activity is too often mainly to assimilate information embedded and crystallized on printed media. Moreover, each discipline constitutes its own information silo that has relatively little to do with that of other disciplines. Students assimilate information, often factual in nature, and learn to effectively solve familiar textbook problems within their silo, but have only limited skills and competencies to contextually apply and use their knowledge for analyzing complex and novel phenomena. Simultaneously, however, the

development of global information networks has led to a situation where a significant proportion of experts' knowledge is available to ordinary students (Gee & Hayes, 2010; Rheingold, 2011; Weinberger, 2011). Access to collective knowledge networks in the age of the Internet is not determined anymore by academic education, special training, or achievement of a formal professional competence. Today, novices (e.g., hobbyists, amateurs, patients who suffer from a disease) who are interested in a theme or topic may connect with one another through social media and start functioning as a community in unparalleled ways (Rheingold, 2002, 2011; Shirky, 2010). The problem is that textbook content provides a simplified and outdated picture of a field or discipline and mastering the content without methods does not lead to in-depth understanding or effective knowledge application. Although many students take part in knowledge creation in interest-driven communities outside of educational institutions (Ito et al., 2010), they are required to assimilate pre-packaged pieces of information at education. The core of scientific activity is, however, to solve problems for pursuing novelty and innovation rather than merely recycling already existing information.

As investigators of academic literacy have pointed out, the current educational practices, often fail to provide the skills and competencies of critical literacy to the students. Even the best students' attention appears to focus on the content of textbooks and the object of their activity is blind memorization and assimilation of the knowledge artifacts of concern (Geisler, 1994; Wineburg, 2001). When evaluating a text, an expert always asks who has written it, for what purpose, and in what kind of situation. Wineburg's (2001) studies indicate that students tend to consider as most reliable texts that experts regard the least reliable, which indicates a complete inability to understand the rhetoric context of texts. Accordingly, an expert functions, in a parallel fashion, in a content and rhetoric space whereas novices (students) function only in the content space until they are very far advanced in their academic studies. The opening of massive global knowledge networks is melting the frozen bodies of information and producing a huge flood wave of content that requires each student to learn to work meaningfully and critically with extended bodies of information. As Rheingold (2011) argued, «crap detection» is an essential aspect of the network intelligence of the digital age. Moving from content space to the appropriate skills and competencies for navigating meaningfully in the rhetoric space is not, however, sufficient for answering the epistemic and intellectual challenges of the future.

Many investigators (Bereiter, 2002; Gee & Hayes, 2011; Hakkarainen et al., 2004; Paavola et al., 2004) forcefully argue that we should improve the quality of higher education by emphasizing methods and practices of knowledge creation rather than mere content. Citizens of a knowledge-creating society need intellectual, socio-emotional, and cultural competencies related to deliberate collaborative creation of knowledge. As long as students function only in the content space memorizing and assimilating information embedded in their textbooks, they will have only a very limited understanding of academic knowledge. Engaging students in actual investigations in which they have to apply academic research instruments and methods is likely to improve the quality of higher education. We need to bring the culture of knowledge making to universities rather than merely talking and reading about it; we have to cultivate academic «maker cultures» (Anderson, 2011), that is, a more active, productive, and expansive hands-on orientation as regards academic learning and knowledge production. In order to improve the quality of higher education, it appears essential to

expand the object of educational activity (Engeström, 1987), namely, the pursuit of more challenging and varying open-ended objects (Marton & Trigwell, 2000). University education is too often focused on short-term textbook tasks that require only reproductive use of knowledge, and no collaboration or use of ICTs (Mandl et al., 1996). In-depth learning comes about when learners work with complex open-ended problems, problems that are extended in space and time and involve collaborative building of knowledge. Because educational institutions are bureaucratic organizations, even the best students tend to work on reproductive learning tasks, if they are not otherwise challenged (Norrena, Kankaanranta & Nieminen, 2011; Shear, Novais, Moorthy & SRI International, 2010).

My colleagues and I have carried out many investigations at universities in which technology-mediated collaborative learning is being promoted (Muukkonen et al., 2005; Lakkala et al., 2008; Lahti et al., 2004; Seitamaa-Hakkarainen et al., 2005). Here, I present a brief comparison between two courses that relied on Knowledge-Practices Environment (KPE) and Knowledge Forum (KF). The results of these design experiments were different in a way that appears relevant for the purpose of this discussion. The former course engaged 30 students in practicing *virtual project work* rather than merely lecturing on it; there were a few lectures, but the course relied mostly on the students' self-organized project work (Nikko, Muukkonen & Hakkarainen, submitted). We wanted to give the participants a personal experience of taking part in virtual project work rather than getting them to merely lecture and read about it. The participants, who came from two universities, represented psychology and business studies, and their interactions were mostly virtual other than their meetings at the lectures. The focus of the course was to examine the future challenges of taxation for an external customer request (Finnish tax administration). The participants functioned in teams comprising five to six members each. They relied on the first release of Knowledge Practices Environment that was not completely stable at the time. The teams were allowed to decide how to work with and use the collaborative KPE-technology. There was a short orientation concerning the use of KPE as well as a support person available who could be contacted in case of any technological problem. The project covered pre-defined stages that involved defining, implementation, and reporting stages.

The theme of the second course was introducing instruments and practices of *educational technology to teacher students.* Altogether 54 students took part in the course; our study focused on 30 randomly selected students who functioned in teams of five to six persons. The pedagogical design of this course corresponded to the former in terms of focusing on giving the participants a personal experience of taking part in computer-supported collaborative learning (Hakkarainen & Salmela, in preparation). Toward that end, there were 24 h of teamwork using KF within a computer laboratory (organized to support group work), in addition to 10 h of lectures. The participants were asked to take part in fieldwork, that is, going to teacher-training schools to interview teachers and observe their classroom. In addition, they were asked to search the Internet for, and analyze, applications of educational technologies and report their investigations in KF. The course was conducted over a period of four to five weeks, so it required very intensive participation. Accordingly, both the courses engaged students in personally and collaboratively appropriating knowledge practices relevant to the target phenomenon rather than merely lecturing about them.

Both the courses may be regarded as successful in terms of meeting the main instructional objectives. Participants of the virtual project work made offers to the customer, selected certain topics that were considered useful, and carried out investigations, producing reports that satisfied the customer. The educational technology course engaged the participants in a meaningful investigation of technology-mediated learning and teaching, providing a comprehensive understanding of many relevant issues. When examining the mode of operation of the two courses, however, the contrast is very striking. Only two out of the six groups of the virtual project work course used KPE intensively; the others only uploaded a few necessary documents and coordinated their activities through email. Overall, there was very little, if any, knowledge building going on in KPE. In the case of the educational technology course, however, virtually all participants participated very intensively in Knowledge Forum activities, producing a large number of notes, study logs, and reports of remote assignments. Because of the joint KF working sessions, all teams produced approximately the same amount of Knowledge Forum notes. Both the courses were relatively strongly structured with rather strict pre-specified milestones and deliverables. Participants of both the courses appeared to have tried to limit their activity to meeting the milestones and producing the required deliverables. As Ng and Bereiter (1991) have noticed, task completion goals often take over knowledge building goals. In the case of the educational technology course, only the intensive and provocative efforts of the lecturer (i.e., the investigator present) made the group engage in intensive knowledge-building discourses; toward this end, I shared with the participants Ray Kurzweil's (2005) wildest dream about the future of human cognitive evolution. This resulted in a lively and intensive discussion, but it was quite hard to be elicited.

I believe that these are not isolated instances but represent a crucial aspect of socializing students to technology-mediated practices of learning and knowledge creation. Investigators of technology-mediated learning have consistently been too optimistic concerning ICT-mediated educational transformations. After 20 years of effort, very little has happened in Finnish educational institutions in terms of using ICTs. We have too often assumed that merely bringing technologies to educational institutions will change pedagogical practices (technological determinism) and that sharing pedagogical ideals, such as knowledge building or investigative learning will bring about educational transformations (overemphasizing the strength of mere ideas). My experience indicates that technology enhances learning only through transformed support of social practices (Hakkarainen, 2009b). Learning to use technology-mediated learning environments productively necessitates instrumental genesis (Beguin & Rabardel, 2000; see also Ritella & Hakkarainen, 2012), that is, going through a developmental process of making a digital tool an integrated instrument of one's own activity. Only when digital technologies become one's second nature will emerge a sufficient level of technological fluency to stretch ICTs for supporting genuine knowledge-creating inquiry (Barron, 2006).

Although learning to use digital technologies fluently is very hard, discourses of ICTs focus mostly on information genres (information connectedness) and social interaction genres (social connectedness); this is evident in Nova Spivack's (http://www.novaspivack.com/science/new-version-of-my-metaweb-graph-the-future-of-the-net) otherwise illuminating but «flat» vision of collectively intelligent metaweb (see Hakkarainen et al., 2009). While it is easy to acquire information or talk about ideas, it is difficult to change one's tech-

nology-mediated practices. I would like to argue that social practices constitute the third dimension, the extremely rough topography of technology-mediated activity (Ritella & Hakkarainen, 2012). The process of re-mediating one's activity by new technologies so as to engage in knowledge-creating learning, may be compared with an extremely challenging climb to a mountain peak. The specific challenge of computer-supported collaborative learning is getting a whole, oftentimes unwilling, community to climb to the mountain peak rather than doing it only by yourself. Human beings do not have ready-made mechanisms for changing their social practices. They have to engage in practical exploration of changes, examine what works, and selectively try to consolidate new practices (Engeström, 1987). Because of this we cannot jump immediately to innovative technology-mediated knowledge practices but have to cultivate creative practices iteratively step by step through a series of design experiments. It is critical to have sufficient opportunities to jointly practice, reflect on, and transform ICT-mediated activities. I believe that all successful knowledge-building cultures are also expansive learning cultures focused on a deliberate refinement of shared knowledge practices (Hakkarainen, 2009b). Yet, it is most challenging to engage in changing one's customary ways of working with knowledge (knowledge practices) and appropriate novel technology-mediated tools and instruments parallely. Because of this, there cannot be short-cuts in improving the quality of higher education.

Collective creativity of academic research

My final point is to argue that the same kind of in-depth socialization process that is needed for adopting novel technologies may play a central part in the learning of advanced, cutting-edge academic practices. These ideas relate to my research on doctoral education, but appear relevant for considering the quality of higher education in general. The process of growing up to be a professional researcher has also been considered a process of seeking a mountain top in difficult conditions and limited visibility (Holmes, 2004). While the natural sciences involve a collective pursuit of mountain hiking, the social sciences tend to rely on individual efforts and experiences of seeking mountain tops (Becher & Trowler, 2001). Many solo inquirers succeed in stumbling through the process by relying on exceptional efforts. Impressive agency develops when a participant is able to reach the top. The highest mountain tops are, however, seldom reached when capitalizing merely on personal learning. In comparison with trying to climb to the mountain top on one's own, the collective approach involves taking part in an organized mountain hike and following trails and paths already examined by earlier inquirers (Hakkarainen et al., in press a; Hakkarainen et al., in press b). Although academic research is always a risky business, success is more likely when sharing experiences of competent researchers and relying on their facilitation and support in difficult parts of the trail. While doctoral students of the natural sciences are acculturated through coauthoring to write like scientists and learn to publish in high ranking journals (Florence & Yore, 2004), most students of social sciences have to learn it through personal trial-and-error efforts (Kamler, 2008). Co-authoring may be seen as a critical academic practice that assists in socializing doctoral students to international publication; toward that end, it appears crucial to expand the collective practices of doctoral education from the natural to the social sciences

based on dissertations consisting of international journal articles co-authored by students and their supervisors. Solo-publishing social-science students feel very vulnerable when being critically evaluated by external investigators; as a consequence, publication of refereed journal articles may not take place at all in the absence of co-authoring (Kamler, 2008). By guiding and supporting students' publications, the senior colleagues carry a significant part of the work of establishing authority, and thereby, make the process less threatening.

The collectivization of academic knowledge practices is evident in the systematically increasing proportion of co-authored academic research papers across disciplines. The collectivization of academic research concerns not only the natural sciences but also the social sciences, including education. While it was possible to master all grand theories of learning 30 years ago, theories and methods have become so complex that it is not anymore possible anymore for individual investigators to master all of them. Pursuing educational research requires sharing of expertise in increasingly larger research communities and more and more extensive networks. Professionally organized research groups are able to accumulate knowledge and experience of pursuing challenging investigations and, thereby, capitalize on collective rather than mere personal creativity of academic research. In order to cope with tightening quality standards and external performance requirements, research on social sciences takes place more and more often in competitively funded multi-disciplinary research projects (Green, 2009; Nowotny et al., 2001), which are expected to produce interlinked results and internationally refereed journal contributions. Because of this it is important to try to improve the quality of higher education by developing methods for deliberately socializing students to collectively cultivated academic practices in the social sciences as well (Hakkarainen et al., submitted). Collectivization of doctoral investigations is worthwhile because well-functioning research communities amplify available socio-epistemic resources beyond the sum of individual ones (Hakkarainen et al., in press a; Walker et al., 2008). Ordinary participants in extra-ordinary knowledge practices, cultivated over a long time by innovative research communities, are able to reach academic excellence, provided they have sufficient knowledge-creating drive (Hakkarainen et al., in press a). This appears to be the only known short-cut to excellence; though it requires tremendous personal effort, it provides a significant boost for academic development.

Assuming that a great deal of the intelligence of academic research is embedded in knowledge practices cultivated by academic research communities, there should be more opportunities for students to learn through taking part in such communities, socializing to the most advanced practices, and participating from the beginning of academic education in projects and efforts of pursuing knowledge-creating inquiries (Hakkarainen, et al., 2004). Sustained participation in collective research activity assists in intellectually socializing doctoral students to shared academic practices and eliciting their academic productivity. It appears essential to a) carefully examine knowledge practices critical to learning investigative practices of each domain, b) design university curriculum and develop pedagogies that provide students sufficient support in early and intensive socialization to such practices, and c) develop tools and environments based on ICTs that assist in sharing such practices. In this regard, e-science in association with the increasing presence of academic investigators, their instruments, bodies of data, and manuscripts and publications on the Internet provides good opportunities (Weller, 2011).

Concluding remarks

It is critical to facilitate, beyond knowledge acquisition, participatory processes and knowledge-creation (opening access to academic research cultures). From a psychological perspective, it is essential to engage students in a collaborative building of knowledge. Investigative practices that assist in adapting to different methods of research and knowledge formation should play an essential role in higher education. Students have to be socialized to use ICT by engaging them in joint activities that bring about instrumental genesis. Advanced academic practices are hard to learn on one's own; this is why collective practices and research communities cultivating academic experiences are so important. The development of e-science and e-research is likely to make many aspects of academic activity more open and accessible to students as well as provide them with new opportunities to peripherally participate in research communities.

In order to improve the quality of higher education, it appears essential to provide students earlier access to innovative academic knowledge practices than is currently the case. There should be challenging projects and courses that require students to work with complex and open-ended problems, carry out various investigations, create and build knowledge with their peers and teachers, merge and fuse their intellectual efforts, and break the boundaries of their educational institution, in terms of working productively with customers. New generations of students are emerging who have been deeply socialized to ICTs and social media; this will enable integration of ICTs with university education on a much deeper level than used to be possible.

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