Chapter 11

Learning with Computer Tools and Environments: A Sociocultural Perspective

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11.1. Introduction

Until quite recently, teaching in schools was dominated by the use of textbooks and information and ideas provided by teachers and other students. Today, in addition to more traditional learning resources, the introduction of computers and other networked and digital technologies has created new conditions for teaching and learning (see also chapter by Jewitt, in this volume). Students and teachers now have access to a vast variety of images, information and ideas, and to new ways of interacting and communicating, and a range of tools and environments has been developed with the aim of enhancing learning. As with earlier technological innovations, these new tools have been, and sometimes still are, presented as a solution to problems and challenges in schools. The overly optimistic rhetoric that is sometimes used in the mass media and in national policy documents to describe these innovations creates problems for the everyday work in schools because it generates unrealistic expectations (OECD; Balanskat, Blamire, & Kefala, 2007).

In this chapter, we will put to one side the rhetoric that positions new technologies as the solution to problems and argue that to generate insight in this area, researchers of learning cannot take the technology itself as the analytic starting point, but rather they need to examine how different types of tools are used as part of school activities. This includes investigating what becomes relevant use of computer tools in relation to other concerns that teachers and students have to manage in schools, such as, expectations towards how learning should be performed in schools, goals set in the curriculum and the handling of different kinds of contains and priorities. To do this, we need to identify whether there are recurrent and common issues across studies of learning with computers in schools. The question that has most often been posed in respect of such studies is, what is the impact of computer tools and environments on
learning? We shall therefore look first at studies that have attempted to answer this important question.

Some things are easier to measure than others. The increase in access to both computer hardware and software in schools has been documented in many countries (Arnesth, Hatlevik, Kløvstad, Kristiansen, & Ottesen, 2007; Condie, Munro, Seagraves, & Kenesson, 2007). Moreover, it has been recorded that the choice of technologies has implications for the structure of classroom activities (Schofield, 1995; Säljö, 2002). However, when studies try to measure the impact of different types of computer-based software on learning outcomes, the case is not so clear. For example, in the United Kingdom, one review found an improvement in learning outcomes in English, mathematics and science (Harrison et al., 2002). In other reviews, no conclusive results are reported (Arnesth et al., 2007). The main finding seems to be that to measure the impact on students’ learning by isolating technology as a single standing factor is difficult, if not impossible. Different types of computer tools do not of and in themselves create better learning processes and outcomes. Rather, a general conclusion across studies is that to understand learning with computers in schools, it is important to measure more than the impact of the use of computer software for teaching specific subjects. It is equally important to be sensitive to how students orient their talk and activities towards more or less explicit norms, expectations and values embedded in the educational setting (Furberg & Ludvigsen, 2008).

The importance of the normative institutional framework and how this has developed and how it impacts on learning is especially brought to our attention in studies conducted from a historical perspective. For example, Larry Cuban’s analysis of the classroom use of technologies in the United States since the 1920s has revealed that, despite continuous policy reform attempts, everyday practices in schools and at universities remain very stable and computers have not altered this pattern in any revolutionary way (Cuban, 1993). More recent studies lend weight to Cuban’s findings (Becker, 2000; Ravitch, 2000). Hence, Cuban’s historical analysis reminds us that unrealistic expectations regarding the introduction of new technologies are not only tied to modern computers (see also chapter by Crook and Lewthwaite, in this volume).

The somewhat conflicting findings that emerge from ‘impact’ studies and historical analysis are further complicated if we also include findings from studies that conduct detailed interactional analysis of computer use in education. This third line of studies has stress that is not easy to shift focus between online and offline interactions and activities more or less simultaneously, and at the same time know how to detect, select and integrate information and ideas from different types of resources when learning about a new topic (Kozma, 2003; Lund & Rasmussen, 2008). This social and cognitive challenge is historically new, and acquiring the skills and competences necessary to deal with it is central if learners are to take advantage of computers in school tasks (Sutherland et al., 2004). Studies frequently report that there are individual differences in the capacity of learners to take advantage of computers because the complexity becomes too great for some, both in terms of the amount of information and in terms of the increase in ways of interacting and...
communicating (Hartley & Bendixen, 2001). Also, studies repeatedly find that teachers struggle to participate in and follow up activities that are enacted both online and offline (Lund, 2006). Often, teachers resort to their traditional offline way of working, leaving the online activities to learners to complete alone. This is problematic because the teachers’ presence and participation are vital for learners to progress (Darling-Hammond, 1999; Krange, 2007). But importantly, interactional analyses often find that learners do in fact gain something useful from using computer tools (Mercer & Littleton, 2007; Stahl, 2006). These gains seem to be connected to the use of computer tools that are added to direct or assist learners’ activities, including their talk and collaborations, reminding them about vital categories in a school subject or encouraging certain activities or sequences of actions (Mercer, Wegerif, Dawes, Sams, & Fernandez, 2007; de Jong & Jules, 2005). Some examples of such tools are Knowledge Forum, Co-Lab, Knowledge Integration Environments (KIE)/the Web-Based Inquiry Environment (WISE) and the Thinking Together Web resources.¹

The differences in findings between impact studies and naturalistic studies, including both historical and interactional analyses, suggest the need to rethink our understanding of effects and impacts. The question is, how are we to distinguish and recognise changes within an institution that tends to remain stable? Whereas the measurement approach aims to locate the variables that create the differences, naturalistic studies aim to understand how and why students learn within social practices and how social practices change or remain stable. We therefore need studies that can both explain how and why certain features create effects and specify under which interactional conditions specific features in the technology resource and enable productive learning processes and outcomes, also accounting for students’ agency. This cannot be measured through effect studies alone. Our response to the call to rethink effects and impacts in reviewing studies of learning with computers is to focus on interactional analysis. We argue that by analysing interaction, we can understand how and why students orient themselves in computer environments and we can specify how learning in different knowledge domains occurs and under what kinds of conditions interaction learning becomes productive.

Another challenge in reviewing studies about learning and the use of computer tools and environments is that because impact studies and naturalistic studies are based on different approaches, we cannot expect the results to converge directly. Still, if we look broadly across findings, it is reasonable to conclude that computers do have a positive impact on certain skills and competencies, but that this is dependent on how the schools work to promote these skills. This underlines the key point that productive use of technology is dependent on the social organisation of the learning activities. In other words, as important as it is to realise the potential of computer

technology to enhance education, it is just as important to understand how the social organisation of schools and classrooms influences the use of computers and in turn is affected by that technology in unanticipated ways. In this chapter, we will take into account the above concerns by addressing the following two questions:

- Do computer tools designed to improve school learning manage to alter and change school activities?
- How are computer tools designed to improve learning employed within everyday school settings?

An important premise for this chapter is that, without a well-theorised stance, we cannot understand the complex and multifaceted nature of the topics of computer-mediated learning in schools. Section 11.2 will help to frame the challenge of how to understand the use of computers and how to draw out significant findings in a meaningful way.

Within learning theories, theoretical concepts, metaphors and models play a central role in understanding and describing how humans learn. We argue that we cannot have an adequate understanding of the relationship between technology and learning without a realistic model of how humans make use of different kinds of cultural tools. This argument is connected to more historical and theoretically defined issues concerning how technologies are part of cultural developments and how individuals create responses in interaction. These issues are ‘classical’ in the sense that tool creation and tool-based enculturation is a human characteristic, and they are contemporary in the sense that new tools, in particular, new digital technologies, increasingly change conditions for human communication and learning. The section that follows will help frame these challenges in relation to research about computer-mediated learning in schools. To guide our examination, we ask,

- How can a theoretical perspective contribute to our understanding of the use of computer tools in schools?

### 11.2. A Sociocultural Framing

‘Behavioural’, ‘cognitive’ and ‘sociocultural’ are terms used to describe central paradigms within theories of learning. The main shift away from behavioural dominance within this field is often dated to the 1950s (Greeno, Collins, & Resnick, 1996). This shift was connected to the introduction of introspection as an alternative method to the behavioural ‘input–output’ approach. Introspection in cognitive research involves the development of models of how the mind works based on talk and other external representations. The unit of analysis is mental structures and processes and how these change and develop over time. The object of inquiry is generally the relationship and interaction between individuals and their physical environments, which may include collaboration and institutional contexts. However,
the evidence of learning should, from a cognitive perspective, be described at the level of mental processes and structures (Anderson, 1993).

Both historically and in the present discussion, sociocultural perspectives arose out of the discontent with behavioural and cognitive research. The sociocultural argument is that the evidence presented within these perspectives has not, to a sufficient extent, supported claims concerning how humans learn. Increasingly, the criticism has been that behavioural and cognitive research does not investigate the essence of the activity of learning. Typically, socioculturalists argue that an individual test is a poor tool to find out about a person’s capability to find solutions and to solve problems together with others (Säljö, 2004). The essence of this argument is not that it is uninteresting to investigate individual performance. Such studies have obviously brought insight into how humans learn (Bransford, Brown, & Cocking, 2000). Rather, the argument is more wide reaching: It is claimed that to understand learning, we need to capture how humans interact and make use of different kinds of cultural tools in different kinds of settings, or, to put it differently, how the social organisation of learning is played out. Behavioural and cognitive research has, in other words, been looking and searching for answers with too limited a scope for the object of inquiry.

We argue that the problem with behavioural and cognitive positions is that individuals are often seen as self-sufficient and not in need of cultural context to exercise their agency. In relation to computer-mediated learning, this becomes problematic because the connection between technology use, learning and schooling becomes blurred and impossible to unpack and scrutinise. By contrast, the sociocultural perspective takes on this challenge by broadening the scope and including historical and institutional aspects of human learning and cognition. Hence, our sociocultural perspective rests on the assumption that individual agency can only develop in and through relations and interactions with others, in societal institutions and in different settings and contexts in society. A central assumption, then, is that human thinking, reasoning and problem solving is socially constituted (Valsiner & van der Veer, 2000). This postulation regarding the socially constituted human is not meant to exclude the biological human. Rather, it emphasises the importance of congruence between the object that is studied and the activity that is actually investigated. Therefore, in terms of understanding the relationship between technologies in learning, the analytical focus should be on the intersection between the individual and his or her surroundings, including the use of technologies. Interdependency therefore becomes a critical concept to capture the intersection between the intermental and the intramental activities (Vygotsky, 1986) and is at the core of what we will refer to as ‘sociocultural perspectives’. We argue that this concept has provided new insight into the relationship between historical and present aspects of human activities, cultural tool use and human agency (Valsiner & van der Veer, 2000). However, interdependency is a broad concept, which needs specification to gain analytical power. Accordingly, we will define interdependency using the concept of mediation, scaffolding and trajectories of participation. Throughout the chapter, these three concepts will be used to interpret research findings.
11.2.1. Emphasising and Investigating Interdependencies

The first aspect of interdependency that we focus on concerns how human interactions and activities relate to different kinds of cultural tools, both linguistic and material, which have developed over generations. This means that knowledge accumulated over longer periods can be embedded within cultural tools of the current time and that cultural tools can constitute infrastructures for activities. The sociocultural view is that cultural tools connect humans to their past and to how knowledge has been socially organised and accumulated. The concept of interdependency is thus used to take into account the potential for change when new forms of tools are introduced into practices and societal institutions such as schools. Therefore, when cultural tools change, so too does our object of inquiry, along with our unit of analysis. To exemplify interdependency between cultural tools and learning, we can point to changes in the content that students learn today compared to, say, that learned in the 1960s. Reproducing the ‘canon’ of a field of knowledge is now no longer regarded as sufficient performance. Students today are expected to make given or canonical knowledge relevant for solving current problems without predetermined answers (e.g. Norwegian Ministry of Education, 2006). We can see this, for instance, in tasks concerning environmental issues or multicultural societies that have become increasingly common topics in schools (Rasmussen, 2005). Both the content that students learn from working on such tasks and their collaboration skills are seen as necessary for managing productive participation in contemporary societies.

However, if interdependency between cultural tools and human cognition is to be more than a claim, then what is needed is a concept that captures analytically the dynamic processes by which different types of tools provide an individual with ways to accomplish goals. From a sociocultural perspective, the concept of mediation serves this purpose. The term mediation implies that humans do not act directly with the environment, rather that our actions and activities are mediated by mental and material tools (Wertsch, 1991). This mediated connection to the world is central for understanding the relationship between humans and their surrounding world as dynamic and mutually constitutive. Mediation implies that the relationship between individuals and the world is not perceived as direct and unproblematic but as interdependent and actively performed by the individual in activity. The functional aspect of tools has to be created; it is not there by nature. Humans have to assign meaning to tools to create a mediating function in activity. This is why socioculturalists argue that how humans think and interpret the world is revealed in how we use the tools available to us.

‘Scaffolding’ is a core concept that is commonly used to specify human development as an interdependent process (Mercer & Littleton, 2007). The concept draws upon Vygotsky’s (1986) classic idea about the ‘zone of proximal development’. Broadly speaking, both terms relate to how more competent partners or artefacts can help a learner to go beyond his or her capacity. The term scaffolding was introduced in an article by Wood, Bruner, and Ross in 1976 and was developed to analyse the structuring that adults provide in the first phase of a child’s language learning.
(Wood, Bruner, & Ross, 1976). However, the concept of scaffolding was developed to analyse contexts that did not involve complex technologies, and it is important to consider its significance in relation to this new context. Pea (2004, p. 423), for example, writes,

I am perhaps not the only one who feels that the concept of scaffolding has become so broad in its meaning in the field of educational research … scaffolding has become a proxy for any cultural practice associated with advancing performance, knowledge, and skills whether social, material, or reproducible patterns of interactivity (as in software systems) are involved.

The structuring that was initially described as scaffolding characterised the phase before a child could perform activities autonomously. The following phase, called ‘fading’, referred to the ability of a child to master the task with less support and help from others or artefacts. However, this aspect of scaffolding is not necessarily relevant in relation to the use of new technologies where activities may be enabled by interaction with the software itself. In other words, some activities exist because of the new technologies and ‘fading’ is no longer a necessary part of the process. Other key aspects of scaffolding are channelling, focusing and modelling. Channelling and focusing refer to how a learner is directed to complete a task, and modelling refers to ways of describing and demonstrating how a task can be solved. This differentiation of the concept of scaffolding makes an important contribution to how we can design for learning and analyse how students choose to interact and take part in an environment (de Jong, 2006; Quintana et al., 2004). They may enable us to analyse how interdependency is constituted as part of a social practice. Environments such as KIE/WISE and its Norwegian counterpart Viten.no aim to represent and visualise complex science topics, such as climate change, DNA and protein syntheses, in new and original ways. Environments like these, that model abstract and complex knowledge and make possible new ways of engaging with it, do not aim to make use of fading. Hence, channelling, modelling and focusing seem more appropriate methods than fading if we want to investigate whether or how these tools scaffold learning.

The third key concept related to interdependency concerns the temporal aspects of learning: trajectories. Generally speaking, the prototypical classroom study tends to focus on either the teachers or the pupils (Mercer, 2008). Teaching and learning is an interdependent process that evolves over time, but relatively few classroom studies have followed the process of specific activities over time (see Mercer & Littleton, 2007). One explanation for this might lie in the challenges involved in following specific sequences of activities and participation structures across settings. One

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proposed theoretical solution to this methodological challenge can be found in the concept of participation trajectory (e.g. Lave & Wenger, 1991; Rasmussen, 2005). Previous sociocultural studies have included different timescales and levels of social organisation in studying learning and used the concept of participation trajectories for such a purpose. Typically, such studies have started by investigating activities within institutional contexts and by asking how such systems function. With regard to school institutions, this kind of approach leads to conclusions about the principles of the functioning of the institution: the consequences of this for the participants, the structures or the patterns of participation, and the type of knowledge and activities that are favoured within the institution. We may say, therefore, that defining learning in terms of participation trajectories involves going beyond recognising that social practices provide a context for learning. Instead, learning is situated in participation trajectories within which it assumes meaning.

Having presented a perspective that can enable us to understand and conceptualise the changes in learning and teaching when computer tools become part of the classroom, we will now use this perspective, and the associated concepts, to interpret and discuss research. In the sections that follow, we present issues that recur across studies of computer tools designed to improve school learning. We will start with the classic studies of computer environments designed to scaffold students’ subject inquiry and then we will look at later attempts that draw on more recent features within Web 2.0 developments.

11.3. Computer Tools for Inquiry and Participatory Production

The design of computer tools and environments has been influenced by technological advancements and also by progress in our understanding of processes of teaching and learning. In terms of theory, mediation as an analytical tool implies that we cannot approach all tools as some kind of single unified whole, nor can we separate functions and impacts from institutional context and practices. Rather, in investigating the use of tools from a sociocultural perspective, we should ask why one tool is chosen in preference to another in carrying out a particular form of action. Likewise, the specific features of the tool that are made relevant through established institutional activities should be analysed. How different institutional learning practices actually change in relation to the use of specific tools such as computer applications can then be accounted for empirically. We might also be able to detect how new practices emerge and perhaps shift well-established institutional learning practices.

To distinguish different types of computer tools and environments, we will examine and classify their characteristics and analyse how students and teachers work in these learning environments. To do so, it will be helpful to distinguish between generic and domain-oriented applications (Mørch, 1997). A generic application (e.g. many Web 2.0 applications or mobile phones) is often designed to be used for many different goals/purposes, whereas a domain-oriented application is
more specialised so that it can support a specific task (e.g. essay writing, searching the Internet or environments that prompt students to classify and discuss utterances).

The majority of commercial and Web 2.0 software, such as MS Office or wiki, is generic in the sense that their features apply across domains, and the content is often user-generated. The content is in such cases not developed by domain experts but emerges in a ‘bottom–up’ fashion. Still, generic does not mean that the content is unaffected, but rather the application sorts and classifies the content as it emerges. These applications may also be adapted and customised into domain-oriented tools (Mørch, 1996).

On the contrary, domain-oriented software can be characterised in terms of its content. Knowledge Forum, Co-Lab, the Thinking Together web resources or the WISE are computer environments where the user is prompted to follow specific sequences of action and to interact with the content in specific ways. Virtual reality and visualisation environments are also often domain-oriented. In the current world of construction, for example, such environments are widely used. However, only a few of these environments have been developed and tried out in school settings (Krøg, 2007). WISE and its Norwegian counterpart Viten.no are examples of visualisation environments developed for school use, and they approach complex science topics in new and original ways.

Despite these differences, it is important to emphasise that both types of tools and environments are generally grounded in various versions of constructivist or sociocultural perspectives. Designers of such tools typically state that their goal is to overcome the limitations in traditional instructional environments in which the teacher does most of the talking and where the emphasis is on fact-finding or reproducing given knowledge rather than constructing it. Although individual learning of factual knowledge is important, the features added are designed to scaffold students to be active and engaged in problem solving and the inspection of ideas — or, to put it differently, the core normative design idea that underpins these environments is that active engagement will help learners construct subject knowledge themselves, and by so doing, the knowledge will become meaningful to them (de Jong, 2006; Quintana et al., 2004; Arnsëth & Säljö, 2007).

If we draw on this distinction between domain and generic applications, two groups of environments emerge as particularly interesting to focus on. These are domain-oriented inquiry environments and environments developed for participatory production. We will start with the more classic studies of computer environments designed to scaffold students’ scientific inquiry and then we will look at later attempts that draw on more recent features within Web 2.0 developments.

11.3.1. Inquiry Environments

Scaffolding students to make inquiries about information, and to discuss and to create products, is at the core of what we term inquiry environments. A common aspect of inquiry environments is that they are designed to scaffold pupils’ and students’ activities so that these can more closely conform to the ideal practices of
scientific inquiry performed by researchers (Furberg, 2009; Quintana et al., 2004; Zhang, Chen, Sun, & Reid, 2004). Examples of such scaffolding features inscribed into computer environments include questions or sentence openers to enhance students’ knowledge integration (Davis & Linn, 2000; Davis, 2004), scaffolding students in constructing and articulating scientific ideas (Scardamalia & Bereiter, 1996) or scaffolding students’ reflection by means of predefined categories (Arnseth & Säljö, 2007).

The computer-based environment Knowledge Forum, earlier known as Computer-Supported Intentional Learning Environment (CSILE) (Scardamalia & Bereiter, 1996), is one of the earliest inquiry environments that has been widely used in everyday educational settings (Miyake & Koschmann, 2001). There are also a substantial number of research projects and studies from various countries concerning the use of computer-based inquiry environments (Hewitt, 2002; Hakkarainen, Palonen, Paavola, & Lehtinen, 2004; Arnseth & Ludvigsen, 2006). One example is the Norwegian DoCTA (Design and Use of Collaborative Telelearning Artefacts, Natural Science Studios) project (Wasson & Ludvigsen, 2003). In contrast to the DoCTA project, studies of Knowledge Forum have not included analysis of video-recorded interactions among students and between students and teachers (Sawyer & Bernson, 2004). We will draw on studies of the DoCTA project because it provides both opportunities to consider interactional practices with computer tools and it is a suitable point of departure for a broader international review.

A core design idea behind inquiry environments is that learners need to work with some kind of conceptual object to progress in a domain. These objects are made public through talk, writing, drawing and other kinds of representation. Computer environments therefore offer features for writing, discussing and classifying knowledge. Generally speaking, the students make inquiries into a domain topic (e.g. ethical aspects of bio-technology, which is the topic in the following case), and based on this, select, write, classify and discuss the knowledge they discover. The design idea is to prompt students to reflect upon the knowledge that they encounter in a scientific manner.

The DoCTA project was set up as a distance collaboration project between two classes at two schools in Oslo and Bergen in Norway. The data were collected by video recordings, log files and interviews. The pupils were divided into groups and paired with a counter group in the other school. The DoCTA environment provided the students with access to a range of information sources, including the Internet, and with technology for sharing and discussing resources with peers (Arnseth, 2004).

For the purpose of the present illustration, we will focus on how the students categorised or labelled their messages before posting them to their counter group. The categories focused specifically on prompting the students to distinguish between

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knowledge that was trustworthy and unsubstantiated statements. In the Norwegian national curriculum, as well as in other national curricula, such skills are seen as increasingly central when students are exposed to a range of different resources and types of texts (Ministry of Education and Research, 2006; Balanskat et al., 2007).

The categories that they could select were listed on the top of the computer screen: problem, tentative working theory, reliable knowledge, uncertain knowledge, comment, summary and process summary.

We have selected three excerpts that show how this list of categories affected the student–student and student–teacher interactions. As mentioned, the excerpts are part of a large corpus of video recordings that have been analysed thoroughly and they form a valid representation of how this inquiry environment was used. They may therefore also represent a concrete illustration in relation to other studies of inquiry environments that we will draw on.

Before the interactions in the first excerpt, the students had searched and selected information from the resources provided in the DoCTA environment. They had made inquiries about ethical aspects of bio-technology, the domain topic, and had selected a text. In the excerpt, a group of three students (13–14 years) from the school in Oslo discuss which category to use for a posting to their counter group in Bergen.

Excerpt 1

1. Student A: I wonder ... reliable knowledge (interrupted)
2. Students B: No – it’s not reliable knowledge
3. Student A: No?
4. Student C: Reliable knowledge, sure ...
5. Student A: It’s not, it is not reliable knowledge just because he says so (with temper)
6. Student C: Then, it’s not reliable knowledge
7. Student A: It is different when it’s that kind of statement, that’s a kind of study

The category of ‘reliable knowledge’ was first suggested, but student B disagreed, and the group discussed whether or not the text could be categorised as containing reliable knowledge. In turn, 5, student A explained her view stating that just because a person says something, this does not mean that the knowledge is reliable. However, she said it is a different case when the statement refers to a study (7). Shortly after this, the text was posted to the counter group classified with the category ‘reliable knowledge’.

In this first excerpt, the students problematised the status of a specific text in relation to a set of categories presented on the computer screen, inquiring whether reliable knowledge is an appropriate category to choose. When the students disagreed, they requested and explicated reasons for their views. This discussion made the relation between the text and how to use the categories explicit and shared. Although they seemed to disagree at first, it is worth noting that they reached an agreement rather quickly and moved on to the next task. As is typical in group work, the teacher monitored the students’ work by walking round the class asking how things were going (Lund & Rasmussen, 2008), as demonstrated in the next excerpt.
8. Teacher: How are things going?
9. Student A: Yes, we are working ..., we have already sent one reliable knowledge!
10. Teacher: Have you – where did you find the reliable knowledge?
11. Students (all): In the ‘Atext’ (a search engine for Norwegian newspapers)
12. Teacher: In ‘Atext’, in which newspaper?
13. Student A: In Aftenposten (a Norwegian newspaper)
14. Teacher: Are you sure that it’s reliable knowledge, when it’s written in Aftenposten?
15. Student C: It was a statement from a physician
16. Student B: I don’t know
17. Student A: What can we take as reliable knowledge then?
18. Teacher: No, I’m only asking, how sure you can be of a newspaper ..., is it true when it stands in a newspaper?
19. Student A: No

The first student’s reply ‘we are working’ is interesting in the sense that it reminds us of the social norms for school work: All is considered well when the students are working on their tasks (Bergquist & Säljö, 2004). In addition, student A specified what they had done: They had found a text to share with their counter group and had classified this text as containing reliable knowledge (9). Following this, the teacher asked for the source of this text, to which the students replied ‘the Atext’. Note that they only named the newspaper source on the teacher’s second request.

Throughout the excerpt, the teacher stayed on the topic initiated and asked whether this newspaper was a source they could rely on. Conversely, for the students, the question of trustworthiness of an expert seems to have been the important issue rather than the trustworthiness of a newspaper. They argued that the statement of a physician, an expert, should be trusted (15 and 17). That one cannot always trust the newspapers seems more straightforward and common sense than doubting an expert, as student A stated, ‘What can we take as reliable knowledge then?’ (17). This consideration reflects a culturally accepted convention following the status ascribed to particular professions or jobs in society.

Hence, in excerpt 2, the key point for the students seemed to be the trustworthiness of an expert. As the next excerpt will illustrate, the categories also represented a focal point that assisted the teacher as she continued to elaborate on the issue of how to make sure that resources the students found were trustworthy.

Excerpt 3

20. Teacher: Are things often reported right?
21. Student A: No
22. Teacher: Did it refer to a study? Could you find it?
23. Student A: I don’t think it was mentioned, where it came from …
24. Student B: How come?
25. Teacher: The source was not mentioned, no
26. Student B: It could be that it was mentioned in the bottom line, or something
In this excerpt, the teacher asked a series of questions, starting with whether information presented in newspapers was ‘often reported right’ (20) and continuing with questions about the type of content in the news article, its source and whether that was mentioned (22 and 25). This seemed to make the students think again about the trustworthiness of their chosen text (21, 23, 24).

If we look at the excerpts together, we see that the talk mainly focused on the status of the knowledge in the selected text. Overall, the teachers continuing questioning, and the categories in environment prompted the students to consider whether a statement could be accounted reliable if it was made by an ‘expert’ (excerpts 1 and 2), whether and how the source of the statement in the newspaper article was given, and the context of this type of text (excerpts 2 and 3). However, students A and B expressed doubts about what could be accepted as reliable knowledge (in both excerpts 1 and 2) and this demonstrates that an abstract category like reliable knowledge does not carry any fixed meaning. A semantic definition does not help the students, because the concepts become relevant through their use in relation to certain elements in a text. As Arnseth and Ludvigsen (2006, p. 179) point out, ‘it is not easy to distinguish between them because they [the categories] do not mutually exclude one another. This is because any knowledge object can be categorized in a number of different ways’. Therefore, although the categories did not carry fixed meanings and the ways in which they were interpreted varied across groups, it is also the case that across groups the categories represented a focal point assisting the teachers continuing questioning (Arnseth, 2004). Typically, teachers stay with a topic in their questioning of students, so in and by itself this is not new; however, it can be argued that the categories assisted the teacher’s job in doing so.

In further analysing the data, we will concentrate on three topics that we will discuss in relation to other studies. First, we will look at the impact that the computer scaffolds had on the direction of the talk. The second finding we discuss is the role that the teacher assumes in these kinds of environments. Finally, we will discuss the analysis of the above-mentioned excerpts in relation to studies that have followed the use of inquiry environments over longer stretches of time and that have focused also on school culture in relation to how inquiry environments are being used and understood.

11.4. The Role of Computer Scaffolds in Collaborative Activities

The first finding from our empirical illustration concerned the role of computer scaffolds in the student–student interaction. Our analysis revealed how the software prompted the students to create arguments in relation to the knowledge building categories inscribed in the environment. When students become engaged with the categories, such as in the three examples given earlier, they represent a shared reference that prompts discussion and reflection concerning the knowledge encountered. Research has consistently demonstrated that external representations such as computer tools do act as scaffolds in peer group collaborative activities.
One finding that is reported throughout several analyses is that the computer screen works as a shared resource and that this helps students to stay on task (Wegerif & Dawes, 1997). Another commonly reported benefit is that objects on the screen are available for shared reflection for those working around the computer and that this scaffolds students in the process of asking for clarifying questions and expanding on explanations (Crook, 1994). Moreover, it is found that computer tools scaffold students to be active in trying out and pursuing new ideas (Cazden, 2001; Scardamalia & Bereiter, 1996).

However, computer prompts do not always function as scaffolds because students might ignore them to finish the task more quickly. Generally, studies find that students seldom elaborate on or share views in tasks set in school without prompting (Mercer, 2000; Rasmussen, 2005). One explanation for this put forward by Furberg and Ludvigsen (2008) relates to the time frames that students are given to solve and hand in their assignments. Their analysis demonstrates that when students are urged to hand in their task, their orientations shift from an initial orientation towards exploring and discussing the content towards completing the task efficiently. Furberg and Ludvigsen believe students stay within the more or less explicit values, demands and expectations embedded in the school (ibid.). Our example case in Section 11.3 showed that the students went about the use of the categories as with any other school task: They discussed what to do to reach agreement and to complete the task (Collins, 2001). Also, it would be naïve to expect that an isolated computer-based learning environment could alter this well-established ‘school contract’. The analysis of the DoCTA data demonstrates that peer groups generally reached agreements without much discussion (Arnseth, 2004). Looking at the data, we see that the students found it difficult to interpret what the categories entailed and how they should be used. As Arnseth and Säljö (2007, p. 436) argue in their analysis of another group using the same categories:

To be able to evaluate truth claims and factuality involves the mastery of a whole range of historically developed skills and knowledge. It is therefore perhaps not surprising that the students find it difficult to make ‘adequate’ interpretations of what the categories entail, and how they should be used.

Although the students discussed how to use the categories in relation to their text, they did not connect this activity to research and knowledge building as intended in progressive inquiry. This design idea seems to be too abstract and unrelated to the task and the expectations that the students adhere to in school. As such, the students’ interactions did not match the ideas intended by the designers (Arnseth & Säljö, 2007). This finding reoccurs across studies of how peer group interactions relate to design intentions (de Jong & Jules, 2005).

In relation to our example, the environment contained a range of resources including different types of text. In particular, as the first and second excerpts show, the students had to orientate, interpret and make connections between the resources encountered, and the task was not straightforward and transparent for them. If we
broaden our scope further to relate this challenge of interpretation and integration to
even richer computer-based environments, such as simulations, similar findings are
reported. Current research on learning with computer environments shows that
learners of all ages experience certain difficulties when learning about conceptually
rich domains such as science, mathematics and social studies (Linn, Davis, & Bell,
who has studied the use of a 3D simulation of the insulin gene in an ordinary science
education classroom finds that the students spent most of their time figuring out how
to handle the tool and less time on the relation between the activities performed and
the subject domain. The result was that the students did not manage to consider the
subject concepts in relation to the simulation and could not see that the concepts they
were working on actually were part of a larger conceptual system. This implies that
future designs need to take into account how to scaffold the relation between the
students’ activities performed in computer-mediated learning environments and their
construction of conceptual understanding (Krange, 2007).

When we consider these findings in relation to the claim that more authentic
learning environments will make learning easier, we see that the claim is far too
simplistic. Compared to the more traditional combination of teacher instruction and
textbook assignments, more complex representations such as those included in
inquiry environments increase the richness in the learning situation and thus create a
situation that is distinctly different. In textbooks, explanations of central concepts
and facts are usually well structured and tightly connected to the tasks. Empirical
analysis of students’ interactions with inquiry environments suggests that textbook
procedures might not work, that they are too simple to be seen in relation to the
complexity that characterises many computer environments (Furberg & Ludvigsen,
2008). Accordingly, teachers need to develop new competencies in scaffolding
students’ learning in these environments. Therefore, the second issue that we address
through our empirical illustration concerns the role of the teacher.

11.5. The Role of the Teacher

The teacher’s intervention in the extracts given earlier, and the talk that followed,
stimulated discussion of the problem of the level of trustworthiness attributed to the
text in use, but it was only as a result of the teacher’s consistent questioning that
students continued to discuss and elaborate on the topic. Although teachers usually
ask questions in the classroom, we also know that part of the problem with many
teachers’ questioning practice — across both countries and school cultures — is that
they do not manage to keep the conversation focused on a specific topic for a long
stretch of time (Alexander, 2000). Our empirical example showed that the categories
that were present on the computer screen assisted the teacher in keeping the
questioning sustained and consistent. This finding is very much in line with other
studies that also focus on the interdependency between the teacher’s instruction and
the quality of the pupils’ interactions around the computer (Mercer, 2000; Littleton,
These studies have found that students are often unfamiliar with the ways in which they are expected to interact in classrooms. Inspired by this recurring finding, an intervention program in which emphasis is placed on making the implicit norms, or ground rules, of education and classroom interaction explicit has been developed for the primary school level. This program, which contains teacher-led ‘Talk lessons’ combined with computer-based activities, has provided promising results in both English and Mexican schools (Mercer, 2000; Mercer & Littleton, 2007; Rojas-Drummond, 2000). Indeed, several studies have found that learning how to interact, talk together and argue are challenging for students, but that practising such skills improves students’ understanding of concepts in different domains (Andriessen, Baker, & Suthers, 2003). Students must be trained to be able to interact — agree and disagree — in productive ways. Social conventions and institutional norms are important for the social regulation of talk. This implies that conventions and norms must be made explicit so that students can confront one another without taking a social risk. Without confronting one another’s knowledge framing of a problem, a deeper understanding of concepts behind the issue may not be developed.

The cognitive work that is enhanced by the computer tool must meet the social organisation of learning activities to be productive. Often, researchers report that students engage in exciting hands-on technology-rich environments, but in isolation from any written or oral discourse on the possible implications — or interpretations of the significance — of the activities and their relation to scientific methods (Sutherland, Robertson, & Jones, 2008). Moreover, studies have shown that students are often left without guidance on how to find, select, interpret and further develop information they encounter in technology-rich learning environments (Rasmussen, 2005). Teachers are key resources when it comes to connecting the students’ work with computer-based activities and more traditional ‘paper and pencil’ school tasks (Koedinger & Corbett, 2006). One can therefore argue that the teacher role becomes more complex when it includes moving between being an instructor and a connector of different activities. Our interpretation is that the computer tool and the social organisation of the activities that relate to it, including the teacher’s role, should be understood as specific types of interdependency that are necessary for students’ conceptual development.

To sum up, the teacher has to ask questions and enhance processes that empower students to think about specific problems and to help them create different types of arguments, which include both elaborating on ideas and drawing conclusion based on data. Our example shows that although the students did not initially pick up a prompt from the computer-based learning environment, they could not overlook it after the teacher had intervened and reinforced the point. Across various groups that were observed, the categories represented a focal point, assisting the teachers’ continuing questioning as they walked around the classes guiding the group work (Arnseth, 2004).

At the same time, it is quite obvious that students do not learn new concepts or conceptual systems in a short period. This relates to yet another prototypical feature, namely the fact that studies of classroom learning usually include only 1 or 2 days of
investigation. One might well ask, what can be learned in a day or two? Most learning does not happen suddenly; rather, the construction of knowledge and understanding evolves over time: ‘we do not one moment fail to understand something and then the next moment grasp it entirely’ (Barnes, 1992, p. 123). An interaction observed within a particular session usually arises from circumstances that have previously been established. Specific conditions — such as the teachers’ organisation of classroom activities and of how they and the pupils initiate and follow up actions (immediately or over a period) — are of obvious importance. This bring us back to the finding that to enhance learning by means of computer environments, technological and social scaffolds must be combined to give rise to and enhance conceptual growth (Krange, 2007; Mercer & Littleton, 2007).

11.6. Time and School Culture

According to this more specific focus concerning how students and teachers use and understand inquiry environments over a period, we will discuss two studies in which the researchers analysed activities conducted in the CSILE over a longer stretch of time. In the first study, Hewitt (2001) followed and compared two projects where CSILE was used in biology at the primary level (grade 6). The results from the first project were disappointing in relation to the intended design goals. There was little collaboration and the students rarely shared their theories and assertions with others. The plans that the students wrote contained listings of topics but not how they were going to find out about them. As a result, questions played a minor role in structuring the students’ activities; they rarely referred back to their questions and too many questions were left unanswered. What the students did was to examine broad areas rather than specific problems, which produced a gradual accumulation of information about various topics without much discrimination (Hewitt, 2001). These findings resonate with several problems reported earlier, such as, the lack of relation between activities performed with the 3D simulation and the creation of conceptual understanding in Krange’s (2007) study and the reproductive fact-oriented accumulation of information in the students’ products demonstrated by Furberg and Ludvigsen (2008). Hewitt explains his findings — from the first project — as resulting from the students’ lack of understanding of the nature and purpose of progressive inquiry (Hewitt, 2001).

In contrast to the first project, the second came much closer to the goals of progressive inquiry because by this time the teacher had developed a set of strategies for scaffolding discussion through the use of categories. Hewitt concludes that the change in activity patterns was mainly due to the fact that the teacher changed the focus from task completion to developing understanding. This is a very interesting finding seen in relation to our own example, indicating that when a computer-mediated learning environment becomes more attuned with teaching practices, it is used more productively and effectively. The second study of how inquiry environments are used over time compared Canadian and Finnish classrooms and
their encounters with the CSILE (Hakkarainen, Lipponen, & Järvelä, 2002). This study confirms Hewitt's (2001) conclusions. The most interesting aspect of these findings was that in the Canadian students — who had been exposed to different types of computer-mediated learning environments over longer periods gradually became more productive in their way of interacting in the CSILE. This change was again linked to the development of teaching practices. In the Finnish classrooms, where the students and the teachers had less experience with such environments, the students used fact-oriented patterns. This means that they solved the problems with the help of factual information gained from the Internet and from textbooks, but they were not prompted by the categories inscribed in the CSILE to discuss and engage with the content they encountered.

This section has focused on studies of inquiry environments designed to cultivate the students’ capacity to use information from different sources, to develop and test ideas, to search for evidence, create summaries and to write up conclusions. As such, the core design idea is to develop cognitive scaffolds to assist the students’ processes of knowledge integration. However, as the empirical studies demonstrate, there is no direct relationship between design ideas and the kinds of activities that students will engage in. Rather, these findings demonstrate that there are particular challenges in the design of new computer-mediated learning environments concerning how institutional practices and individual agency influence the activities that develop when students and teachers engage with — or ignore — features inscribed in such tools.

11.6.1. Computer Tools for Participatory Production

While the shared normative design idea of both inquiry environments and environments for participatory productions is to scaffold students to engage with and reflect upon some kind of conceptual object made public through talk or writing, what distinguishes these environments are, for the most part, the opportunities for participatory production and the organisation of the content. As already mentioned, content in environments for participatory production is typically built from the bottom–up, but this does not mean that its representation is flat. Rather, the features inscribed highlight and downplay the content. Participatory production and bottom–up organisation of the content is one of the typical features of Web 2.0 technologies or social medias as they are also called (O'Reilly, 2005). Web 2.0 is a term that is often used to describe the Internet after 2001. In terms of both technology and content, the Internet has gone through large changes, the biggest of which is perhaps tied to how users apply the Internet. Examples of Web 2.0 tools are blogs, wikis, podcasts, chat (irc, MSN, Skype), Twitter and YouTube. All these tools and environments can be characterised as involving user participation, openness and network effects (O'Reilly, 2005). Another central term in this new landscape is therefore ‘mash-up’, which is introduced to illustrate how different types of web-based resources can be drawn together and in so doing contribute to make a more interactive and personalised presentation of a topic.
Our analysis and review so far has proved that computer-mediated environments and the features added to scaffold learning are not automatically productive; rather, they need to be related to the institutional practices and teachers’ framing of the learning activities. To dig deeper and now focus on environments designed for participatory production, we need to consider a specific part of what we term ‘institutional practices’ — something that signifies what is characteristic about the institutional ways of doing learning. How tasks are typically formulated, carried out and evaluated represents such a case. To carry out a task, participants have to create an understanding of what to do and how to do it (Bergquist, 1990). Following the students’ participation trajectory will therefore reveal students’ interpretation of a school task, and this will give us an indication of what they think is expected of them in school. Tasks are also one of the teachers’ most important structuring devices to give direction to learners’ agency. The focus on the relationship between the educational tasks and the specific features of computer technology is vital for understanding how learners and teachers orient themselves towards a shared learning goal (Hampel, 2006; Pierroux, 2009).

As with the inquiry environment in this section, we will also use one specific case as an example and relate other studies to it. We have selected a project that has designed Web 2.0 computer tools and which reports results based on interactional analysis from the use of these tools in everyday school work. The project used wikis and is termed TWEAK — Tweaking Wikis for Education and Advancement of Knowledge (Rasmussen, Lund, & Smørdal, 2007). The basic premise of a wiki is that anybody can contribute, revise and delete and that any change is immediately available in a browser window for anyone to see (Leuf & Cunningham, 2001). Yet another reason to include this case is that it sets out to improve the relationship between educational tasks, tools for participatory production and support for teachers, which is precisely the challenge identified in recent studies. The design in TWEAK was inspired by inquiry environments, such as CSILE and FLE2, and with the aim of scaffolding students’ engagement to advance jointly constructed knowledge objects (Scardamalia & Bereiter, 1996). However, the design efforts in CSILE and FLE2 have not specifically addressed the relation between the task design and the technological design. In fact, the design of inquiry environments seems to overlook the fact that a vital part of collaborative work is to mutually interpret and negotiate the meaning of a given task (Lund & Rasmussen, 2008). By contrast, this was the focus in the present project where tweaking refers to aligning task design with the development of technological features to meet needs jointly identified by researchers and teachers. The wiki were constantly refined and new features were tested, while at the same time, the teachers discussed in their teams how to formulate tasks and activities that sought to capture the participatory element that marked the tool they were going to use. Hence, the TWEAK project represents the cutting-edge design of new computer-based learning environments while at the same time representing a continuation.

The data consist of observations and video recordings made by researchers, audio recordings of team meetings made by the teachers, log files and interviews. In Section 11.7, we will present data from two schools. We will start by analysing the data and
then present findings concerning computers and copying — a controversial issue in
the educational use of computers and with wider relevance than Web 2.0
technologies. After that, we will focus on the types of tasks that teachers tried out
and how the technological features inscribed inspired their thinking.

11.7. Computers, Copying and School Accounting Practices

A central characteristic of computers is their capacity to store information so that it
can easily be attained, reused, transformed and transported. The copy function is
crucial in this connection. The copy function saves the source code, allowing the user
to paste the copied content easily in a single operation. This function has — in other
words — changed how information is reproduced. In our analysis of data from the
TWEAK project, copying materialised in a particularly interesting way. We begin by
describing a general pattern that is found in several studies that have followed
students’ activities over time (Rasmussen, 2005; Wheeler, Yeomans, & Wheeler,
2008). The trajectory described in these studies aligns with the way in which students
who took part in the TWEAK project often approached school tasks.

The trajectory can be described in the following way. First (if it was a
collaborative task), the students would divide the task into sub-tasks. Then, they
would look into Wikipedia to access and assess already existing material on the
subject. This seemed to provide an overview of the task topic. More or less in
parallel, learners also used Google. These searches differed from the Wikipedia
approach in the sense that they were more exploratory and relied more on serendipity
and randomly constructed searches. Whether from Wikipedia or Google ‘hits’,
learners gradually started copying material they found which was either immediately
relevant to their task or had potential for later use and pasted it into separate Word
pages or to the wiki. These places seemed to function as temporary storage for
information in flux (Lund & Rasmussen, 2008). However, this way of using the tools
was not without conflict and tension as the following data indicate. The interaction is
taken from a situation where a teacher explained how the students could use the wiki
as a tool for participatory production.

Excerpt 4

15. Teacher: This [the wiki] is a place where you can all go and see what you have
done and share information
16. Student: Or they can steal!

The blunt response from the student suggests that she is unhappy at working in
this way. She seems to reject the usefulness of the teacher’s description of the wiki as
a place where you can ‘see … and share information’ (15). The features for
participatory production — the shared spaces (or ‘place’ as the teacher calls it) where
participants can share and revise one another’s texts — clash with the school’s
culture for individual production. Students are introduced into an institutional
In a similar fashion to academics, students tend to protect their ideas as their own work, and although happy to post their contributions to a wiki space for other group members to read, they are resistant to having their contributions altered or deleted by other group members. This seems to be less of a problem in user-created content sites such as Wikipedia, where contributors are relatively anonymous. In classroom contexts, where students are familiar with each other, ownership appears to be an issue.

A shift from the individual towards participatory production may present different epistemological positions, and hence, we should not expect a smooth transition. Both copying and sharing radically confront the tradition of a school’s way of implementing teaching and learning. A feasible explanation for the protective behaviour observed in several studies may lie in the fact that students often struggle to find, select, interpret and further develop the information they encounter (Rasmussen, 2005). Students often proceed through the material in a bottom–up fashion, ‘acquiring information in absence of an overarching application’ (Land & Greene, 2000, p. 61). The limitation of this strategy is that the students’ understanding ends up being fragmentary. Simply put, students often gather a range of information that leaves them in a state where it becomes difficult to create an understanding of the phenomenon that they are studying. This reminds us of the tension between the commonly held view that copying is considered the same as cheating and the fact that copying is part of a pupil learning the skill of information handling. Students are generally instructed to find information but lack guidance in how to select, interpret and use the information they gather (Sutherland et al., 2008). The metaphor ‘transport and transform’ has been suggested as a way of describing how learners typically cope with this situation (Alexanderson & Lindberg, 2004). The metaphor emphasises learners’ tendency to transport ‘facts’ into their own product and the teacher’s tendency to ask whether the texts were written ‘in their own words’, which again leads learners to become focused on transforming words rather than engaging with their content and meaning (Alexanderson & Lindberg, 2004). In view of this, it becomes important to ask what it means to write ‘in your own words’.
We would argue that school learning is a matter of ‘getting inside’ a specific way of looking at the world to use it for thinking and acting (Barnes, 1992, p. 128), and this includes using other people’s words. This part of school learning is unfortunately seldom made explicit in teachers’ instructions (Dysthe, 1996).

However, we also know that peers play a central role in school learning. An example of how peers scaffold selection, interpretation and use of content found and copied from the Internet is described in a study of group project work. Rasmussen (2005) found that the tendency in peer groups to split the task and copy texts from the Internet brought about a need for some kind of artefact to visualise the integration of the disjointed texts that had been copied. To tackle this obstacle, all the groups observed in her study created some kind of external representations to support this integration, while some groups created diagrams on the computer or by means of pen and paper; others used an organisation tool in the software. These overviews were created as the pupils explained the structure of their presentation to one another and to their teacher. The central point is that in organising and structuring their presentations, the students had to engage actively with the content of the texts they had copied. Simply because they, as a rule, did not agree straightaway about what should be prioritised and highlighted, and what their storyline should tell, they had to engage with the content to get their views heard.

### 11.8. Computer Scaffolds and New Tasks

We will now focus more closely on the relation between designs of tasks and technological functionalities. As for teacher activities in wiki, there are currently few studies of this (but see Lund & Smørdal, 2006). In Section 11.6, we pointed out that studies have emphasised the role of the teacher in helping learners to analyse content to extract its essential meaning and to be able to use it productively. At the same time, studies have often found that teachers see a limited role for themselves in a computer-based learning environment. In the TWEAK project, one of the teachers expressed this in the following way:

Teacher A: Wiki – now, I have been part of several stages of the wiki life and the first one was very …, then I lost the learners because they were given an assignment … a wiki works in the way that from the moment you have published your material everybody owns it, everyone can change it, and … eh, it was difficult to trace, for me as a teacher, who had contributed with what, and I felt that I lost the learners, I did not know where to go in order to guide them (…) because in general there is no extensive space for a teacher in ICT [applications] in class, it is difficult to know what is the function of the teacher because everything is automatically moving, it becomes a separate world, it becomes so expansive. (…) When we have used wikis in projects they [learners] tend to disappear into their separate worlds
and it becomes difficult for me to guide them and maintain my job as a knowledge provider. (...) I don’t know what is the end product, what I am supposed to assess at the end, what I should assess, what a grade is applied to. (...) My challenge as a teacher is that I need to develop competence, how to learn how to assess learners’ work in a wiki and, in addition, develop better tasks so that they cannot solve the task individually and that they cannot solve it by merely copy-and-paste operations.

We included this quotation because it signifies a concern that many teachers share: namely that teachers are expected to be accountable for learners’ progress by monitoring and guiding them, but this most important institutional contract is made difficult to fulfil when the students are working in computer environments. As the statement suggests, teachers struggle with giving shape to the wiki activity and at the same time having to commit to persistent monitoring and assessment of the individual learners in their class. When working on computers, learners ‘disappear into different worlds’ where they cannot be traced individually and where their products are difficult to assess. In other words, overlooking and connecting both the physically co-located classroom and the online, distributed activities represent a new major challenge for teachers when they use computer tools and environments.

We have seen that the computer tool does not fit comfortably with some of the traditions of schooling. Nor does it merge easily with the institutional demands of being a knowledge provider. In the above-mentioned quotation, the teacher described this challenge as ‘losing’ learners to online activity. The texts produced in the wiki were different from those that students usually handed in and the teacher therefore asked, ‘what is the end product, what am I supposed to assess at the end?’.

The teacher’s immediate solution is to develop competence and, interestingly, she suggests task development for learner interdependency as a possible way out (Lund, Rasmussen, & Smørdal, 2009).

The introduction of the wiki changed the implicit contract between the students’ responsibility to perform individually and the teacher’s responsibility to evaluate this work. Moreover, the way in which the issue of copying surfaced shows that the wiki confronted students with new uncertainties when they were exposed to sharing early drafts of their work. Carr, Morrison, Cox, and Deacon (2007, p. 280) also found that the introduction of a wiki brought about a range of responses as students attempted to negotiate an unfamiliar and potentially risky terrain. Based on their analysis, they argue that

Educators also need to negotiate this new collaborative terrain amid their own uncertainties about managing student processes and challenges to accustomed assessment processes. Consequently some educators may be reluctant to use collaborative designs in their teaching while others may provide ambivalent support for group processes. Both educators and students need to tolerate discomfort to
negotiate within the risk zone created by such an online collaborative intervention if they are to find ways forward.

The Teacher A quoted earlier pointed to the struggle with participating in and following up online and offline activities that simultaneously call for new competence. We will now turn to some of the ways in which the teachers in the TWEAK project meet these challenges in their day-to-day work. In the next interview statement, another teacher describes first how the teachers at his school traditionally work and then relates his experience with using features in the wiki to try out new types of tasks.

Teacher B: In my school we have always started with classroom instruction and then handed out task assignments to the pupils and these have usually been conducted by using Word. Quite traditionally – I would think.

Here, the teacher describes a typical individual task tradition with computer-based learning. One of the fears when the investment in computers started was precisely that computers would lead to individualised learning activities, without appropriate connection between peers and teachers. However, in practice, how computers have been used seems by and large to connect with traditional school communication. Therefore, while some schools have stayed with individual task tradition, others have used computers to enhance collaboration between students and their connectivity with the outside world. In our example, one of the schools used computers mostly for individual work. As the teacher told the interviewer (in the second paragraph, see below), this way of using computers was problematic. Meanwhile, he starts by explaining how he, inspired by a novel functionality in the wiki, formulated new tasks to enhance collaboration between students.

Teacher B: I have often divided my class in three and given three different tasks and then I have told them to answer one task assigned to them and then to comment on the answers that others have given on their tasks. So, in that way the work is not only to answer a question handed out by me, but also to evaluate how other pupils have replied and to add critical input or complementary information to that what others have written. And that is ehmm ... actually a very new way of working compared to what I have done previously.

When someone has written a reply or when someone has written a contribution, then the commenting has often been: but this was not the most central, the central issue was this or that. Then they relate to – they problematise each other’s contributions in a way that I find to be of great value and in a way that they seldom do in relation to for example a textbook because they just accept that as an authority. But when it comes to commenting on each other, then there is more of an
opening for them to correct something or that it is possible to be
critical to what is written. In that way, their own commenting seems to
be more thought provoking than say for example a textbook or even
what I say – because; far too often they just take that as a given.

First, the teacher explains his intention. He wanted the students not only to
answer questions but also to evaluate one another’s replies. Then, he reflects on
experiences. Note that although this task and its functionality do not represent a
dramatic shift, it still represents a ‘very new way of working’. Concretely, this implies
that the students started to problematise and discuss the most central issue on which
they needed to focus. The teacher says that it is usually very difficult to get students
engaged in problematising content. Textbooks and even his own lectures are taken as
a given. However, commenting on what a peer has written seemed to open up the
possibility of reflecting on and problematising what is said.

Our analysis of the content in the wiki shows that the students gladly commented
on and shared texts but never edited one another’s texts other than to correct minor
language errors (Lund & Rasmussen, 2008). Other studies also show that comments
are used by students and that they perceive this as an acceptable way of engaging
with one another’s work while still respecting ownership (Kerawella, Minocha, &
Conole, 2009; Grant, 2006; Carr et al., 2007). Hence, increased peer collaboration
was perceived as a solution to the challenges that an individual task tradition brings
when conducted with the means of new computer tools. The commenting function
seemed to empower students to engage in reflection upon the content of the work.

11.9. Technological Features and School Tradition

Do tools that are designed to improve school learning manage to alter and change
school activities? The findings in this section focus on the challenges that new
computer tools bring in relation to school learning. In the case where a wiki was
introduced — a tool that participants are meant to share and jointly produce and
revise content — the issue of copying surfaced in interesting ways. Whereas students
copied content from the Internet frequently, they were very protective towards their
individual contributions in the wiki. We found that sharing content was difficult and
controversial for students. What made sharing difficult and controversial seemed to
relate to the individual school task tradition. Hemmi, Bayne, and Land (2009, p. 19)
found a similar constraint in their study of wiki and blog use in university courses.
They state that

the academy’s tendency to constrain and contain the possibly more radical effects of these new spaces. Despite this, the findings present a
range of students and tutor perspectives which show that these new technologies have significant potential as new collaborative, volatile
and challenging environments for formal learning.
However, the TWEAK case demonstrates that in particular the commenting functionality prompted teachers and students to change their ways of participating. The students took part increasingly in what used to be the sole responsibility of the teacher, and the teachers tried out new types of tasks that stayed within the school tradition while at the same time were introducing new ways of participating and sharing individual work. What is particularly interesting about the uptakes is that they are not too far away from the way in which teachers and students usually work. Overall, our analysis revealed that the features that were immediately picked up and set into use were the ones close enough to the traditional way of working in school, so that they did not confront and clash with this tradition. We saw a productive gradual transformation — drawing on the tradition but transforming and aligning the task to the tool so that the pupils’ often passive reproductive pattern of information without engagement and effort was transformed. Moreover, this did not represent a one-time trial, but rather quickly became integrated into the task repertoire of the teacher team. Hence, our analysis shows that tasks are cultural and social constructions and there are cultural conventions of approaching and solving them. Whereas commenting was perceived as acceptable, revising was not. Introducing a wiki with new features for participatory production may provide actors with opportunities for change, but they may also be experienced as obstacles. Ravenscroft (2009, p. 4) concludes the special issue on social software, Web 2.0 and learning: ‘it is not the social or Web 2.0 technology per se that is most important, but the technology-mediated social practices that are supported, and whether these are in harmony, or not, with our pedagogical expectations and ambitions’. This underpins that we must look for small incremental changes, which over time will create new conditions for students’ learning. Social practices become transformed — but not rapidly (Rasmussen & Ludvigsen, 2009). And changes are not always unidirectional or progressive.

11.10. A Closing and an Opening: Trends and Emerging Issues

In this chapter, we have raised questions based on an overall interest in understanding how computer tools and environments contribute to structuring learning activities. We have used the sociocultural perspective to interpret the studies reviewed. Interdependency, mediation and scaffolding have been used to bring together historical insights into social practice, learning in schools and analysis based on moment-to-moment interactions between teachers, students and tools. In the following discussion, we draw on this perspective to highlight the most central issues raised in this review.

We started by looking broadly at issues raised in studies of computers in education. The picture that emerged based on our interpretation of the different studies is diverse but at the same time increasingly robust. Despite varying outcomes in studies that measure gains of technology use in subjects, we find strong indications and evidence that specific features in the technology can trigger processes that lead to
enhanced learning outcomes. However, these design features must be seen in connection with the social interaction and the social organisation of learning activities. The implication is that the agency of the participants is both dependent on the historical practices that characterise the school institution and constituted in the moment-to-moment interaction. Looking across these studies, we can conclude that computer tools represent both new possibilities and new obstacles in terms of teaching and learning. Our review demonstrate how thinking and reasoning is tool-dependent in nature and that the way in which computer-mediated environments are used shapes different types of reasoning, which means that rich representations of knowledge will create new types of interdependencies.

In Section 11.6, we considered both how students choose to engage and orient themselves and the implications contained in the tools they use — including what and how they prompt. We demonstrated through the analysis that the tools create directions for procedural and conceptual orientations among the students. We have seen that inscribed scaffolds in computer environments alter talk — the student’s orientation was affected and the teacher used these features as a point of reference when questioning and guiding the students’ work — to sustain and keep a focus on the topic. Here, scaffolding should be seen as the main concept. This finding resonates with a range of studies that has demonstrated that prompts that scaffold the use of language are a central for achieving productive learning processes and outcomes with computer tools and environments (Mercer, 2000; Andriessen et al., 2003). In addition, new norms for argumentation are needed. New computer environments or simply providing access to information does not guarantee that pupils will use these resources in a manner that is valuable for learning. Although the scaffolds inscribed matter, the way in which they are appropriated does not necessarily relate to their designers’ intentions. Rather, the uptake seems more closely tied to the institutional tradition — we see this in the students’ and teachers’ accounts of their own work.

In inquiry environments that model science in an idealised and more top–down way, the activities and content enhance the potential of an advanced and specialised discourse. The review presented in this chapter has shown that students manage to appropriate this when they are working in these environments, but that the tools are used less when students resort to strategies to complete task work on time and then do not continue with strategies for exploring and understanding. We see that participation differs according to what becomes relevant to accomplish in the situation (exploring or handing in tasks). It is naïve to think that students would be able to perform at the same advanced level without the resources to draw on.

Environments for participation production are based on the idea that knowledge is created as a collective effort. The design tries to enhance the principles that are involved in such collective processes and products. The idea is that social practices can be changed if we redesign specific features in a tool and environment, change the tasks and the task structure and build in new scaffolds. We would not call this approach modelling because it takes the social practices as a central premise, but the interventions take a normative view on how knowledge building can take place. The TWEAK project brings to our attention the clash between the schools as a
trustworthy and reliable knowledge provider that engages students in curriculum subjects and the possibilities new computer technology affords — easy reproduction. Many schools today use commercial computer tools that detect plagiarism. Hence, the situation becomes one of, on the one hand, providing students with new tools that enable easy reproduction — not changing the task or instruction according to this new situation — and on the other hand punishing students for reproduction. Our aim has been to bring this rather strange dilemma to the table for discussion and to show by interactional analysis how students grapple with this problem. The openness of the wiki allows teachers and peers to give and receive useful feedback and guidance at early and intermediate stages of their learning process. This openness reveals that common challenges in facilitating collaborative process are not unique to online interventions. These challenges may include a lack of trust by students and a reluctance to share writing with peers (Carr et al., 2007). The wiki space has in other words a tendency to problematise controversial notions of authorship and ownership (Clark, Logan, Luckin, Mee, & Oliver, 2009).

Also, this case does not give any absolute answers or solve any problems to show how teachers and researchers can think differently. We saw that the design and research team has designed tools that have not yet been appropriated by teachers in practice. Rather, the tools that have been appropriated are close to the schools’ traditional way of working, while allowing the students to explore and engage, critically and collaboratively, with content. We argue that there is a need to take a fuller account of these new practices — even those that are less than ideal like ‘copy and paste’ — in our re-conceptualisation of learning that is suitable for the digital age. ‘More needs to be understood about the transferability of Web 2.0 skills sets and ways in which these can be used to support formal learning’ (Clark et al., 2009, p. 56). The cases signal the need for conceptualisations of learning that follow a more social and participatory epistemology.

Notions such as the ‘networked society’ or the ‘knowledge society’ draw attention to the role that technology and knowledge have in transforming societies and their institutions. The development of the Internet, Web 2.0 and digital infrastructures has been radical and rapid from a technological and societal perspective. However, from a communication and learning perspective, the impact of these developments must be seen in relation to different types of human practices, where different aspects of human life are entangled and where changes have a different pace. New educational practices — with or without computer technology — do not change or develop overnight. Any practice within a particular context arises from circumstances that have previously been established. Development of new practices depends on both the appropriation of new tools (such as networked computers) and the expansion of existing repertoires, or perhaps even shifts away from existing repertoires. One of the challenges for schools and the educational system is to develop an institutional learning culture in which students use concepts and conceptual systems as part of their discourse. The institutional conditions for this challenge change, but to learn new concepts is a core aim of schooling. The relationship between learning and tool use must therefore be considered and reframed continuously.
If we look more closely at both types of environments, the idea that guides the design is that students should learn to be critical, creative and explore different paths in the knowledge domains to which they are exposed, and to achieve this, we see that the collaborative aspect of learning is increasingly stressed as a central competence. These design ideas are not random or baseless; they characterise the aims of most computer tools designed to improve learning in school. We argue that these aims are again related and a consequence of changes in society at large and particularly the result of technological changes. In studies where inquiry and participation are seen as the key to more advanced understanding and problem solving, students ask new types of question, but they also need to include something more or less given. We claim that it is both necessary and productive that students develop their capacity to build on the old in creating the new. This is also demonstrated in a high number of studies across domains.

The empirical study of the teachers’ and students’ participation with the wiki environment shows how incremental changes become realised in some of the teaching and learning activities. Whether this type of change can enhance sustainable and systemic change is another question (Rasmussen & Ludvigsen, 2009). Hence, incremental and gradual changes are not trivial and they do not mean that things stay the same. It is particularly worth noting the finding that incremental changes are most typical in schools rather than radical alterations of practices. The historical mandate of schools has been to build up collective and social memory. Learning is about how individuals, institutions and societies retain, transfer and make available knowledge to the next generation. And schooling is a place with a history of social practices and ways of doing this in the most effective ways. For society at large, schools are supposed to create responsible citizens who will take part in the different sectors of society. The new types of learning environments raise fundamental questions about the societal function and role of schools as social institutions. When we review studies of technology use, the old and well-known problem of passive reproduction surfaces in many studies in which schoolwork is more about completing tasks rather than understanding and exploration. Hence, one important conclusion is that new tools do not get rid of old problems. In other words, you have to deal with a problem to get rid of it. It is not that the schools’ mandate should change because of developments in technology, but rather how this mandate is carried out. We need to think again about ways of introducing students to knowledge and about how we train students to employ this knowledge.

The strength with the sociocultural perspective is that we can understand how students take part in social practices with computer tools and how their interaction is played out as part of the interdependency between both the cultural and the historical aspects that characterise learning in schools and the interactions that take place here and now. It is in such interdependencies that students’ knowledge building and meaning may take place. Given that students’ learning is tool-dependent in nature, we will need to follow the trends in technologies in the future to understand how schools as societal institutions make use of a high variety of computer tools, and under what interactional condition the new tools become productive. We need to understand how the socialisation of students gradually changes and which more
rapid changes we must pay attention to when we want to design environments for more productive learning activities.

Uncited References

Bakhtin (1986); Forte & Bruckman (2006); Kleine Staarman, Krol, & Van der Meijden (2003); Rasmussen, Krange, & Ludvigsen (2003).

Acknowledgements

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