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EXPANDING POSSIBILITIES: PROJECT WORK USING ICT

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Abstract: *One of the main findings from the SITES Module 2 study internationally is the increased use of project work connected to the use of information and communication technologies (ICTs) in many countries around the world. The Norwegian cases presented in this article support these findings, showing that when teachers and students use ICT in school settings, it is most often part of project work. However, there is a need to analyze to a larger degree the project work using ICT. In this article, project work using ICT is analyzed firstly by studying the changes in learning environment that the technology represents or as a catalyst for physical changes in the spaces in schools. Secondly, project work is analyzed by studying the potential for benefit (affordances) that new technologies might provide for the students learning activities.*

Keywords: *Project work, information and communication technologies, ICT, learning environments, affordances.*

INTRODUCTION

Many proclaim that the Western cultural form is in a process of transition, brought about by the new digital technologies (Castells, 1996; Levy, 1997; Mattelart, 2003). As a cultural process we are moving towards what the cultural anthropologist Margaret Mead (1970) describes as a prefigurative cultural form. This implies a shift in learning processes from what is known through historic and cultural knowledge, where adults brings the knowledge over to the next generation, towards a situation where the young have gained competence that other generations do not have, and that turns around the conception of who teaches whom and what learning is. This is not to say that the teacher will be irrelevant, but how we conceptualize the learning process and what it means to be educated changes. This, of course, has several consequences for how we conceive the role of education in a knowledge society, and in the way we organize schools, their content methodology, and learning activities.

The use of technology in school settings, as such, is not new. As shown by Larry Cuban

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in his book, *Teachers and machines: The classroom use of technology since 1920* (1986), the expectations of new technologies in education have been high since the motion picture film was invented more than 100 years ago. However, these technologies have had little impact on the nature of schooling. So what makes things different now? Partly it is related to the technology itself, in the sense that the digital technologies we use today have a different impact on our culture in general, and that our conception of learning has changed.

In this article I will highlight two issues. One is the development of learning environments in schools linked to project work. The other concerns the new possibilities the new technologies represent for how teachers and students work and how they learn in pedagogical practices. To discuss these issues I will present data from the Norwegian cases taking part in the international SITES M2 study (the Second Information Technology in Education Study Module 2; see Kankaanranta, 2005, this issue). As will be elaborated later in this article, the SITES M2 study is unique in its scope and perspective involving qualitative analysis of more than 170 cases in different countries around the world. I will relate to our analysis of the 11 Norwegian cases taking part in this study.

TECHNOLOGY, SCHOOLING AND INNOVATION

It is easy to get discouraged when we look at the research on school reforms. The research in Norway shows that many reforms come and go without many changes happening in the classroom (Telhaug, 1997). Even though this is not true in all instances concerning schools, it is obvious that schools as organizations and in the way they work have not changed much in the last 50 years. When we look at the rest of society, it is at the same time obvious that much has changed in the way we live our lives and the way we work and communicate. Schooling is lagging behind in the developments in the culture at large.

The school system that was developed more than 100 years ago rose out of the Industrial Revolution and can be described as a factory model of schooling with an assembly line instruction. In many ways this is still the model of schooling in our society and how most people think about learning. Our society, however, has changed drastically in the last 50 years towards what has been termed "the information society" (Mattelart, 2003), "the knowledge society" (Bereiter, 2002), "the network society" (Barney, 2004; Castells, 1996) or "the hypercomplex society" (Qvortrup, 2003). In this context we need to develop alternative models of schooling that can show us new ways of developing learning and education.

The expectations from the policy level on what impact new technologies will have on improving and changing schools have been strong in many countries (Pelgrum & Law, 2003). There has been a naïve belief that just getting computers into the classrooms would revolutionalize schools. So when the results in the last couple of years show that this is not the case and that the impact of technologies in school settings takes time, policy makers get restless and they need to adjust their expectations.

Michael Fullan (1993) and others have shown us the complexities involved in school development and educational change. The message is that, when planning for educational change, we have to take these complexity issues into consideration. Factors that create resistance can be grouped into factors that hinder

a) *change entering the school culture,* such as moral resistance toward the students' popular culture or skepticism toward technology and technological development;

b) *change developing in schools,* related to the confusing objectives of schooling, the fact that change is not rewarded, the lack of incentives, and the control function of the teacher in the classroom; and
c) *change spreading in schools,* because the communication channels are not working, a very hierarchical system exists in schools, and there remains unequal access to technology.

This also relates to the main issue in the Norwegian context at the moment concerning the scaling up of activities. We have seen for a long time interesting examples of individual teachers working with one class using a specific technological tool. The issues of complexity become more important when we talk about changing Norwegian schools in general, and when technology issues are thought about in all schools and involving the whole school.

One interesting theoretical conception in trying to grasp such challenges is the developments of activity theory and activity systems done by the Finnish researcher Yrjö Engeström in what he calls expansive learning. "Expansive learning is learning what is not yet there by means of the actions of questioning, modelling and experimentation. Its core is the collaborative creation of new artefacts and patterns of practice" (Engeström, Engeström & Suntio 2002, p. 216).

Expansive learning in schools implies a holistic approach towards school development. To change pedagogical practices one has to look into different systems of activity and how new artifacts like new technologies create both tensions and challenges related to change processes.

This holistic approach influences also how we discuss and conceptualize innovation. This has been central in many projects involving new technologies and school development, as well as in the SITES M2. However, it is not always clear what this implies. Where is innovation to be found? What do we really mean by this term? And, for whom and in which context is something defined as innovative?

We also discover the same when we ask teachers and students to define what they view as innovative in the changes going on. One student sent me the following e-mail:

> *Hello! I am a student at a pretty normal school. We have a lot of computers and some other equipment…. We also have study time. We are part of the [xxx] project…. Study time means that we have to sit with a bunch of assignments to work on. This is called innovative by the teachers. I call it old fashioned. It is just the same as it was in primary school, [sic] we almost never get time to work on the computer, it is just working with books and not directed towards the future. You have to do something about this! Best regards…* (Student)

Of course, schools have very different points of departure for defining what is innovative. Some have long experiences with using ICT, while others have very little experience. Some have much experience with project-based learning while others have less. This has to be taken into consideration when we discuss changes in learning environments using new technologies.

Innovation processes in schools can be characterized as a "flow of innovations," with more than as one single innovation having a specific impact. Change processes are going on all the time in schools, and some might be said to be more important than others. But the concept of flow illustrates better the constant influences on schools, teachers, and students.

This can be seen in the empirical material that I relate in this article. However, according to Castells and Himanen (2004) and their vision of the "information society," there is no one model of innovation in schools.

NATIONAL STRATEGIES ON INNOVATION AND ICT

It is very important to remember that what we do and what we study is part of an ongoing development in schools, and in the culture as such. In research we often take out fragments of social practices to study them closer. Often we do not bring in the contextual factors that explain certain tendencies or give some direction to our analysis of the data.

The year 2005 marks 10 years of strategic development on ICT in the Norwegian education system. These 10 years can be divided into three main phases. The phases indicate the overall national agenda involving all Norwegian schools. Of course there have been innovative teachers that, for some time, have done interesting things with computers. However, my main interest here is with the contextual factors brought about by the national agenda for ICT in schools and the scaling up of activities. The three phases are also expressed in specific action plans from the Ministry of Education (Ministry of Education and Research 1996; 2000; 2004).

The first phase, from 1995 until 1999, was mainly concerned with the implementation of technologies into Norwegian schools. There was little focus on the pedagogical issues involved. In the next phase, from 2000 until 2003, the focus was more on whole school development with ICT and changing learning environments. The phase we have just started, from 2004 until 2008, puts more emphasis on actual student learning and what learners do with technology. In addition, "digital literacy" is now included in the national curriculum as an overall competency area. The data I will present here is focusing on the transition from the second to the third phase.

One immediate challenge in this has been the balance between top-down and bottom-up strategies. It's one thing to have commitment from the Ministry of Education in developing ICT in Norwegian schools, but another to get schools to use ICT more actively. The latter has been more difficult, and there have been periods of too much pressure from "the top" initiating projects without too much happening at "the bottom." In the last 3 to 4 years, this has changed in the sense that more schools start activities themselves.

But to give a contextual understanding of the situation of ICT in Norwegian schools at the moment, I will start by presenting some data from several surveys the Network for IT Research and Competence in Education (ITU) has done during the last 2 years.

According to the national ITU Monitor (Erstad, Kløvstad, Kristiansen & Søby 2005), conducted by the Network for IT Research and Competence in Education (ITU) at the University of Oslo every second year, on average there are two students per computer at upper secondary level and six students per computer at both lower secondary and primary level. Broadband access to schools has also been steadily improving, even though 65% of teachers think access to the Internet is too slow.

The majority of schools still have specific computer rooms at the schools, where most of the computers are placed. There are also computers available in what is called a *mediatek*, such as the library or specific labs for training of skills other than the computer room. In the last 2 years, there has been a gradual shift towards moving more computers into the

classrooms, making the access better. There is also a tendency for more schools to combine stationary, portable and handheld computers at school (Erstad, 2004).

One problem in Norway has been that teachers do not use available computers much in their own teaching. The tendency has been that teachers use computers and the Internet mainly for preparing their teaching and not actually in the classroom. When we asked the students how much they use computers in school activities during an average week, 54% say that it is about 1 hour or less, and 17% say never at all (Erstad, 2004).

Another issue is that students and teachers relate to technology in different ways. When we asked students and teachers what they use computers for both at school and outside, the results show that teachers have a more limited usage of ICTs than do their students. The students often (daily or 2-5 times a week) use ICT for a variety of purposes, like writing, surfing on the Internet, sending e-mails, chatting, downloading music, playing games, and making Web pages.

However, for the teachers, almost 90% use ICT for writing, sending e-mail, seeking information on the Internet, or surfing for entertainment purposes. They almost never use ICT to download music, chatting or playing games. Teachers use ICT mainly as an extension of technologies they already know, like the typewriter, calculator, pen and paper, and book. Young people use the new technologies to seek out new possibilities of use. Teachers often have negative opinions of such ICT usage, but they speak less out of personal experience and more out of a general expectation. At the same time we see that many teachers have a positive attitude towards computers and the impact it might have on students learning (Erstad, 2004).

So we might conclude that teachers have positive attitudes towards new technologies, and more so now than before. Still, they have less direct experience with the various applications and possibilities that ICT offers than the students have, and therefore do not include this in their own teaching.

RE-FRAMING LEARNING ENVIRONMENTS

Traditional learning environments are centered around the teacher and the book for transmission of information, from one speaker (the teacher) to a group of listeners (the students). To a lesser extent, we know how to create constructive learning arenas that are more challenging for the students in their search for knowledge (De Corte, Verschaffel, Entwistle & van Merriënboer, 2003; Schauble & Glaser, 1996). Several models of transition from a reproduction model of learning to a production model have been presented. Jonassen and Land (2000) have indicated, for example, a transition from "instruction" to a "student-centered learning environment" consisting of many different dimensions. *Student-centered learning environments* are designed to support individual efforts to negotiate multiple points of view, while engaging in authentic activities (McFarlane, 1997). Important assumptions in these environments are that the learner defines how to proceed based on individual needs and that learning is highly tuned to the situation in which it takes place. Another important aspect is that understanding is deepened through exploration, interpretation, and negotiation. Learning is also knowledge-dependent in the sense that people use current knowledge to construct new knowledge (Land & Hannafin, 2000).

To conceptualize how we think about learning environments, I refer to the concepts of "frame" and "framing" from the sociologist Erwin Goffman in his book *Frame analysis*

(1974). Goffman makes a distinction between primary frameworks and what he calls "key/keyings." The first relates to contextual factors as we experience them, for example, when we open an umbrella because it starts raining. Key/keyings relate to contexts where we bring in other contextual factors to support interpretation of the situation, for example, opening an umbrella on a theater stage when imagining it is raining. I will not go into the many elaborations that Goffman does of these concepts, but for the discussions in this article these concepts support a focus on context and learning environments both in a concrete social setting and our interpretations of such settings. The implementation of new technologies raises questions of how these technologies might imply what I call a re-framing on both levels. To re-frame in this sense indicates a change in the concrete setting for learning activities in schools, as well as how we conceptualize and reflect on the possibilities these changes in learning environments might have on the students' learning.

This focus on context and learning environments also relates to the concepts of "practice field" and "communities of practice" (Barab & Duffy, 2000; Wenger 1998). The first concept implies a situated practice that is separate from the real field, like the school, but at the same time relates to the real and is influenced by it. Studying the practice field in schools is influenced by many factors, like the curriculum, the role of leadership, and school culture. Communities of practice relate more to the participation part of the learning environment.

> [Community does not] imply necessarily co-presence, a well-defined identifiable group, or socially visible boundaries. It does imply participation in an activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their communities. (Lave & Wenger, 1991. p. 98)

One challenge in many efforts of developing communities of practice in schools has been much focus on the contextual setting but less on how "development of self through participation in a community" (Barab & Duffy, 2000) is taking place. How students develop in their learning process is something that has to be taken into consideration when we develop a new framework for learning environments with embedded uses of technologies (Bliss, Säljö & Light, 1999; Crook, 1999).

AFFORDANCES USING TECHNOLOGY

According to modern learning theories, learning is a mediated process (Wertsch, 1998, 2002). As James Wertsch writes,

> From this perspective, to be human is to use the cultural tools, or mediational means, that are provided by a particular sociocultural setting. The concrete use of these cultural tools involves an "irreducible tension" between active agents,

> on the one hand, and items such as computers, maps, and narratives, on the other. (2002, p. 11)

To consider learning a mediated process implies two simultaneous perspectives. The first has to do with learning taking place through cultural tools and resources. Subject knowledge, but also values and traditions, are examples of cultural tools that gain their importance in the light of historical, institutional, and societal conditions. In modern society, language, texts, forms of communication, and knowledge are cultural resources for learning. The second perspective has to do with children and young people transforming such cultural resources as they put them into use. The activity and learning of children and young people have their point of departure in forms of communication and knowledge and in the norms and values others have established for them; however these are adapted and transformed through the activities and interactions of the children and young people (Faulkner, Littleton & Woodhead, 1998).

I will here follow the Swedish researcher Roger Säljö when he writes about "learning as the use of tools." He states,

> Learning is always learning to do something with cultural tools (be they intellectual and/or theoretical). This has the important implication that when understanding learning we have to consider that the unit that we are studying is people in action using tools of some kind. The learning is not only inside the person, but in his or her ability to use a particular set of tools in productive ways and for particular purposes. (Säljö, 1999, p. 147)

The important aspect is to see actors and artifacts in combination and not as separate entities. Human development is characterized by interconnections between our knowledge building and the tools the culture provides to us. This does not mean technological determinism, that our opportunities are limited to the technological development of our society. We are ourselves the ones who develop new technological tools, which then give us new possibilities in different social practices. We then have to study how these new tools open for us new possibilities and how they represent cultural transformations. According to Säljö (1999):

> Rather than arguing for or against the merits of using information technology in contexts of learning at a general level, it would seem appropriate to inquire more precisely into what features of such resources are likely to have an impact on learning in the diverse range of settings in which people appropriate knowledge and skills. The issue might not just be one of facilitating teaching and learning as we conceive of these today. It might also be that what we

> conceive of as learning will be somewhat different when our communicative practices change. (p. 145)

The concept of affordances, originally drawn from Gibson's (1979) theory of ecological psychology, has been important in studying the consequences of new technologies in school-based learning environments. It implies a focus on the possibilities that new technologies offer for the students' learning activities and the teacher practices. Gibson (1979) writes,

> An important fact about the affordances of the environment is that they are in one sense objective, real, and physical, unlike values and meanings, which are often supposed to be subjective, phenomenal, and mental. But, actually, an affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer. (p. 129)

According to Ryder and Wilson (1996), the notion of affordances embodies the potential that an object draws from the environment, and the possibilities that the user can generate from using that object. Therefore, studying the affordances of new technologies in schools will have to relate both to the environment in schools and the students and teachers as actors in such environments. The challenge is to specify the actual consequences of such an interaction between environment and the subject concerning knowledge building (Hakkarainen, Palonen, Paavola, & Lehtinen, 2004).

THE CHALLENGE OF PROJECT WORK

One of the main findings of the international SITES project is that project-based learning is defined as one of the main innovations taking place in the participating countries (Kozma, 2003). There is a need to challenge this finding, at least within a Norwegian context.

In the national curriculum of 1997 (Ministry of Education and Research, 1997), project work and project-based learning became a basic methodological approach in all Norwegian schools. Group work and students' active participation have been on the educational agenda since the 1930s. However, it is only since the mid-1980s that project work as a method in schools started to become common. We have some schools that have been totally project-based year round since the mid-1970s. As an educational practice, project work is often described in relation to students' activity, group work, and making specific products (Berthelsen, Illeris, & Clod Poulsen, 1987; Rasmussen, 2005). Its focus is on the students

themselves formulating problem statements, finding approaches to work on the problem, collaborating, and presenting. There has been a continuous debate about the roles of the teacher and students, on content, and on the best evaluation procedures to use. The idea is that the students will be more motivated to learn and will create more flexibility in the learning process. "Working on real problems" is defined as more essential for learning than subject-matter content itself.

We also see from our national surveys that both teachers and students report that when ICT is used in schools, it is mainly as part of a project they are working on for a couple of weeks (Kløvstad & Kristiansen, 2004).

In recent years different research projects have raised critical remarks towards the use of project work in many schools, especially from a discourse analytical perspective (Postholm, Pettersson, Gudmundsdottir, & Flem, 2004). The Norwegian research groups working on this issue show that what is going on in project work in schools is unclear, that the teachers often give unclear instructions to the students, that the students' work does not have a clear direction, and that despite the many activities going on no specific indication of knowledge building among the students can be measured (Klette, 2003).

The SITES M2 study focuses mainly on factors that influence the framework for integrating and using computers in schools, and not on the learning outcome as such. In light of what has been mentioned above, there is a need to analyze the possibilities that new technologies might have on the framework for learning and the stimulation of learning activities in schools and, at the same time, to make critical judgments of project work using ICT, since this is one of the main findings in the SITES M2 study.

INNOVATIONS IN THE MAKING – CASE ANALYSIS

The methodological approach used below is mainly based on a qualitative data analysis, primarily from the case material as part of the SITES M2 study. Norway participated with 11 cases in this study. The unit of analysis has been project activities using ICT. I will present elements from some of these cases to discuss the research questions mentioned below.

In this article I will concentrate on case studies in Norwegian schools, with a focus on specific project work activities. Case study research is a challenging methodological approach (Stake, 1995; Yin, 1989). The strength of such a method is the in-depth qualitative data one gets. It gives you a rich description of activities and opinions of ongoing processes. For the SITES M2 research, this methodology was employed and consisted of various methods of data collection (document analysis, questionnaire, interviews, and classroom observations). I will only refer to the interview and observation data in this article.

The SITES M2 research is a unique international study in its qualitative approach. On a national level it first of all gives us a richness in description about ICT in pedagogical practices. It also represents a systematic way of analyzing a broad range of different cases.

I will structure the presentation according to two main research questions: (a) What characterizes changes in the learning environments through the use of ICTs? and (b) What are the affordances offered by ICTs as part of project work in schools? These will be elaborated in the points below.

Learning Environments in Transition

The 11 Norwegian cases in the SITES M2 material represent a wide variety of what has been called "innovative pedagogical practices using technology" (Kozma, 2003). In matters of context, the cases range from small schools trying to compensate through the use of technology for the obstacle of being in remote local communities, to large upper secondary schools where all the students and teachers have their own laptops.

The cases represent a huge variation and diversity in the way schools define a learning environment using technologies. It is not simply a matter of the technology being implemented in a neutral, instrumental way. The contextual factors play an important role in how changes in the learning environment are taking place.

One characteristic among the schools is that they want to change the way they organize and manage their learning activities. In their strategic plans they have all stated a general need for change demanded by the transitions in society and the culture towards a knowledge society.

A common trait in the way they formulate the changes in the learning environments is the emphasis put on ICT as a catalyst for change. In the interviews it is clear that the principals and teachers conceptualize this in different ways. Some report that the issue or debate of new technologies itself sets off several change processes in the school, or that, by gaining experience with ICT, they discover and form ideas about how learning might change.

The reasons for using new technologies in these schools are mainly related to the concept of flexibility. They want to make the learning environment more flexible to create more variation in the way the learning activities are developed. Several stopped talking about the classroom and instead started linking space much more to the various kinds of activities that are going on in different spaces.

Two pictures from schools, as Figure 1 shows, might illustrate the transition from a traditional learning environment using ICTs towards a flexible learning environment where the technology blends much more into the learning environment.

Figure 1. Re-framing learning environments.

These illustrations are of two different learning environments using ICT. The one to the left is a traditional classroom, where computers as placed in a traditional way. The one to the right is from a classroom using project-based learning and ICT.

Related to the above is also the important transition from a teacher and book-centered learning environment towards a student-centered learning environment (Land & Hannafin 2000; Schauble & Glaser 1996). Many use this as a slogan, but do not really change their practices, or the teachers state that they work much more student-centered, but when we talk to the students they state that it is more or less the same thing that has traditionally taken place within the classroom. A student-centered perspective is more a matter of activating the students more than before.

I will present a few short descriptions of different school settings where ICT has been embedded in various ways. This in order to exemplify some of the points made above, and also to show how ICTs expand the learning environment in different ways.

School A: Realizing a Student-active School

This primary school has seven classes and 137 pupils (aged 6–13). The municipality has invested money to promote a more integrated use of technology in all three schools in the municipality. This implies 2 to 3 stationary computers in each classroom and better equipped computer rooms. The overall innovative pedagogical practices at the school are linked to what they call "a student-active school." They have stopped using traditional time schedules, the pupils make their own activity plans, they have started what they call "comfort time" at the beginning and end of each school day, they have stopped using subject textbooks in several subjects and are using the Internet as a learning resource instead, and they have created more flexibility in the way they use available rooms at the school to promote the students' learning activities. They have taken part in a European project (Comenius) called "European book," where students in different countries all have contributed to writing a book. Another activity has been called the "Internet as a learning resource in English." The objective was to let the students work more actively with different resources to learn English. The teachers had problems motivating the pupils to learn English and saw this project as a possibility to change that. They also wanted to strengthen the students' ability to communicate in English.

School B: Surviving in Remote Areas

This case consists of two very small primary schools in the north of Norway. They are situated on two small islands. Many schools like these are distributed along the coast of Norway, with few pupils and teachers at each school. The schools are constantly threatened with being closed because they are too small. They themselves see a possibility of combining different technologies and in this way compensate for the obstacles of being small in remote areas. The headmaster and teacher at one of the schools have been innovative in their use of the technology to meet the special needs of this school and the pupils. By integrating ICT in the school they compensate for the lack of teachers, learning materials, and contact with the outside world. The activity was developed as a collaboration between this school and the school on a neighboring island. They used a video conferencing system with sound and image connections between the two schools so that one teacher could teach students on both islands at the same time, and they used the Internet as a source for information and communicating.

School C: Students as Knowledge Constructors

This lower secondary school is one of the schools in Norway that has the longest experience with project orientation and student participation. The school has for several years been involved in projects using ICT. The school is situated in Trondheim city, in one of the areas with poor socioeconomic status. The school has about 300 students, with 22% of the students having a mother tongue other than Norwegian. The objective for the school was to create engaging learning environments for their students and to have projects that portray social and cultural issues relevant to the students' everyday lives. The school opened environments for the students when they were working on their various projects. The learning environment contained various resources to stimulate different competencies among the students, especially in visual communication. This relates to the visual competence of the students and how they use this competence in relation to ICT and visual manipulation. The iMacs they used function like a multimedia machine, giving the students different, easy to use, and flexible tools for their learning activities.

School D: Integrating School and Industry—Students as Consultants

This upper secondary school is situated in the northwestern part of Norway in a small city. The school is part of a national project focusing on innovation and the use of ICT. The school has only recently started to change their pedagogical practices towards problem-based learning and the use of ICT. To break off from a traditional pedagogical learning environment, they have started activities using the storyline method (Storyline Scotland, n.d.) as a pedagogical perspective. This approach implies a more holistic view on learning, and integrating different subject fields. The students created a story about a certain subject, collected relevant information, and then identified roles and developed a story. The students created different kinds of products as part of the project. An important part of the process was the students' ability to relate this to reality and to evaluate their own perceptions of the subject. The teachers developed key questions that drove the story and student activities. The students then elaborated on these questions. The local maritime businesses in the community were involved in the schools and saw this involvement as a key for the future, in order to keep young people within the community. For periods during the project, the students were present in these businesses. ICT was used as a central tool in this process, both for collecting information and for communicating.

These case descriptions illustrate that there are changes within the learning environments in all of these schools as a consequence of using ICT. However, at the same time, these schools are very different in the way they specify their learning environments and how the new technologies are defined within this environment. Two important factors play a role in how the learning environment is developed and the new possibilities the technology gives. One is the importance of the local community, and how the school relates to its surroundings. Most immediately we see it for the two small schools, and for the school that collaborates with the local industry. The technology used expands the learning environment from the traditional classroom setting towards work within different settings that are geographically

spread out, and also towards "real life" settings at a local company, where students stay and learn for periods of time.

The other factor important to developing new possibilities is the school culture. From several of our research projects we see that the schools that succeed in changing their practices using ICT manage to focus on certain key components of the technology that are relevant for teachers and students. Both school A and C above can be defined as successful in this way. The first one had for some time wanted to get the students more actively involved in their own learning, and new technologies gave them the push for doing this; they were then able to change the physical look of the school to create more flexibility. In school C, they focused primarily on the visual tools of the technology they had available, and not as much on the other possibilities for resources that the computers or the Internet could give them. In this way they gained experience in using the technology successfully in specific areas and tasks, which convinced teachers and students of the added value of the technology and also had the consequence that they started to include other elements of the technology. There are of course several constraints that affect how this works in different school settings, such as the available infrastructure, technical support, teacher competence, and so forth. I will not go into this here since this is outside the scope of this article.

Mediated Actions

The next issue is of course what teachers and students do within these new learning environments, and how they interpret what is going on. This implies a focus on the activities, what has been termed "productive interactions" (Littleton & Light, 1999) and the affordances that new technologies offer students and teachers.

To illustrate how students and teachers use and reflect on their use of ICTs in pedagogical practices, I will give a very short description from three projects from different schools and on various levels. All citations from students, teachers and principals are based on transcriptions from interviews.

Project A: Creating Their Own Interactive Web Resources

This primary school, situated on a small island, has created its own Web site as an alternative learning resource for different subjects. The intention of the school's Web site is to give students, teachers, and parents a common portal to the Internet. On the Web site they can arrange teaching instructions and the Web site has links related to subjects and topics. They also use the Web site to get closer to the local community. When we were observing the class, they were working on a project about Buddhism in the religion and ethics subject. The students used a variety of learning resources, the Internet, the Web site they have developed themselves that they called the "interactive learning resource," and books from the library. The students worked in groups of two or three. The goal of the project was to learn about Buddhism and to foster tolerance of different religions. The students used word processing, presentation, pictures, a scanner, the Web site, and the Internet. When the teacher did her planning she did not just focus on the topics in the textbook but rather used the goals in the curriculum to find relevant links to publish on the Web site. It is not the textbook that directs the learning process but the goals of the national curriculum. The teacher often started lessons

with a discussion, talking about problems the students might have in the project. The teacher prepared the students for the different topics they were going to work on.

The teacher sees her role as one who is available to the students, when needed. The teacher likes this form of teaching because she sees that the students get involved in the project. She says, "*The students have sincere questions, things they really wonder about. Because they have questions, they want an answer too; we get a good dialogue. It is not a question that we have made them answer.*"

The teacher spends plenty of time talking with the students, especially when they are working on the computers. She helps them find relevant material from the Web portal and different Web sites, and shows them how they can change the text to make it their own and not just copy directly from the Internet. This sequence of a dialogue between the teacher and a student shows how she helped the students.

> *Teacher: You should have double space or bigger fonts. It might be easier to read.*
> *Student: Like this?*
> *Teacher: This sentence could be changed. Do you have any suggestions?*
> *Student: What about this?*
> *Teacher: Did you read the text before you started to write this summary?*
> *Student: Yes, I did. But it is difficult to write it in my own words.*
> *Student: What shall I write? Rites of passage in Buddhism?*
> *Teacher: Or what about….write it down first. If you use quotation marks in your search, all the words in the sentence are involved in the search. If you don't use it, you get too many hits.*
> *Student: That was smart! But there is still a lot of information to choose from.*
> *Teacher: Is there a special rite of passage you are interested in, for example weddings? Maybe you can search for "Buddhist weddings"?*

The questions in the project have various levels of difficulty. While some questions only need factual answers, which can be found in the book or on the Web site that the teachers have developed, others require more work with different supplementary means. Examples of different activities they can work on are making a poster about the Dalai Lama, with some facts and pictures; finding out if there are Buddhists in Norway; and using different Web sites to gather information, and writing a few sentences about Buddha; or drawing the outline of one's feet and then researching what the foot imprint means for Buddhists.

These formulations by the teacher emphasize an active student who has to work in different ways to solve the tasks. It seems like the students have a critical mind towards the use of the Internet and it is no longer as attractive as it was in the beginning. One of the students points out, "*...when you get better at using the Internet, it is no longer as interesting as it was before."* It seems like most of the students like to work with the Web site, and one of the students says it makes the teaching more interesting. It is "*...boring to just use the library to gather information. Using the Web site is so much easier and more fun*." Some of the students also think it is a good opportunity to learn more from a project. As one of the students says, "*You learn twice as much when you are working on a project and at the same time use ICT. When you use the Internet in a project, you find more material."*

On the Web site developed by the school, the students can find the goals in the national curriculum, links to relevant Web sites, tasks, other student's work, assessment, and yearly and periodical work programs. Some of the students' products are published there as well. Each class has its own area on the school's server. As the students solve the tasks, they create hyperlinks between the questions and answers.

An example of other Web sites at the school is the one put together by 10th grade students on World War II, with texts and photos. Another teacher is working on a Web site for English: The content will cover the culture, grammar, and literature areas. Teachers are planning to develop the Web site in religion and ethics area further, and expand the use of the Internet in general. They would like to replace the regular textbooks to a greater extent. For this matter they want to develop "theme webs." The principal sees this as a good opportunity to give the students other ways to think about knowledge and to create new forms of knowledge. The teachers involved in developing theme webs will organize them as a timeline, with portals for different time eras. It will be an interdisciplinary Web site with at least history, language subjects, and practical arts subjects. The principal thinks this new way of constructing the different subjects will be more interesting for the students, since they have the opportunity to use different means of instruction and have access to much more information. Because of the interdisciplinary approach, she also thinks it will be easier for them to see the connection between different subjects.

The affordances provided by new technologies in this case are related to the changes in the way learning resources are defined. By using digital technologies and the Internet, teachers and students produce these resources themselves. This gives both teachers and students a more productive role in their activities at school. At this school this has also meant that they opened up towards the local community to a larger degree than before.

Project B: Interacting with Two Women Crossing the Antarctica on Skis

Differentiation of approaches suited to all students from poor to top performers has been very important for this lower secondary school. This is the reason why they started what they call "Go ahead" groups, with project activities for students, as the principal states, "*who have more to go on.*" The reason for starting these groups was a feeling that many of the bright students were not challenged enough. This school does not have a lot of computers: They have six computers with Internet access installed in the library. In addition, they have a few computers in the classrooms. On the question of the school's vision, the principal said,

> *It relates to being able to use many senses, and to do things and to see that it works, to learn about another country by reading about it in a book compared to getting it presented through Internet images and sound and experiences, you might say, and communication with students in other countries direct through e-mail and chatting, and all that which now is possible.*

It all started in October 1999 when two explorers, Liv Arnesen, a Norwegian, and Ann Bancroft, an American, presented their ideas for an education program relating to their Antarctica 2000-2001 expedition (Your Expedition, n.d.). This was presented as a global activity where schools in different countries could participate. A special database was developed where anyone could follow the expedition. The activity involved factual

information about Antarctica, up-to-date information about the progress of the expedition, some images, and an opportunity to e-mail questions to the explorers during the expedition. In addition, the school had a special arrangement with one of the explorers, Liv Arnesen, with whom they had had direct interaction before, during and after the expedition. This was both to get factual and research-based information, and information of a more personal nature about the experiences of the two women in Antarctica. Liv Arnesen lives not far from the school so she was invited for a visit and to talk with teachers and students about the expedition. In January and February 2000, the school had several Antarctica-related projects integrating history, science, study of former explorations/expeditions, health, nutrition, pollution and the ozone, whaling, and weather/meteorology. They also had a specific art and music project to present some of their findings.

A couple of teachers started a project to follow the two women crossing the Antarctic on skis while pulling sledges. A group of eight students joined this specific project, with the aim to create a Web site that would contain different kinds of reports and information gathered by the students about the expedition and Antarctica. The intention was also to collaborate with a school in the U.S. on this project. However, after a while it turned out that this school did not follow up and the Norwegian school had to work on the project alone.

The intention was that the students would have a regular contact with the explorers, both through e-mail and by satellite telephone. The students had only two telephone interviews with the women during the expedition. Because of this, the students had to rely more on information from other sources. One important source was one of the main newspapers in Norway, which had a special agreement with the expedition organizers to get up-to-date information. The teachers negotiated with the newspaper to let the students use this information and the connection with the explorers. The newspaper also posted a link to the students' Web site from its Web site.

One important aim was to get the students to evaluate different sources of information and to handle information themselves for presentation.

> *What I have stressed a lot during this process is that they have to be clear and objective with regard to the use of sources, so that what they write is formally correct and can be backed up. I have included certain journalistic principles and methods as certain knowledge-based factors in the project. (Teacher)*

To be able to critically evaluate sources was something the students themselves had become aware of, and which was reinforced because real journalists interviewed them. The students became aware that they have to know the subject they are working on well when being interviewed, because it was embarrassing to not be able to answer when they were asked about something. Another aspect was that the students saw how the journalists used the information from these interviews and how they may have changed the information they got. A third element was that the students were very eager to present the information on their Web site in as good as possible form when they knew that everybody could read what they had written.

One of the teachers expressed his motivations for initiating the project in this way:

> *I wanted to expand the use of ICT to enable the school to interact with the world. And I think it is exciting for me personally to work with something that is*

like a small snowball, which begins to roll and get bigger and bigger without fully knowing where it might end. And then I also see that this focus might be exciting for the students. They meet people; they make contact with students in other countries. And in this project there was an opportunity to communicate via satellite with Antarctica, to follow an expedition as it unfolded, giving the students front row seats in the arena.

Our observations showed that the students worked mostly by themselves during an early phase of the project. The girls said that they wrote the information most of the time, and then the boys worked on putting it on the Net. They used the Internet often to search for relevant information. Later in the project they worked together more, defining what to use of relevant information and how to present it.

Girl: In the beginning there were a lot of small disputes among us about what we were going to put on the Net. To solve it we talked about different solutions.
Boy: It was a lot of fun to go to Dagbladet and be together with the real journalists.

This last comment refers to the collaboration between the students and the national paper that covered the expedition. The students visited the journalists working on this and the journalists also interviewed them. They observed how the on-line newspaper was put together.

Concerning student outcomes, it can be said that the students gained different kinds of knowledge during a project such as this. Regarding factual knowledge, several of the students said that they learned a lot about Antarctica. An important part of the learning process had been the method by which they gathered information, in the sense that they had been very active in finding relevant information and evaluating what to use. All the students learned much about using computers for different purposes.

Student 1: I think it is very exciting to hear how they [the explorers] can get messages, and also about the technical part, how we can get messages from them, where they are.
Student 2: You learn that, because a lot the information on the Internet is in English, and then you have to translate it into Norwegian.
Student 3: Yes and then, where we get information about how far they have walked, it is given in miles, and then we have to convert it into [Norwegian] miles.
Student 2: We are also going to make a press release that we are going to give to ...

In this conversation the students mentioned several outcomes that illustrate an integrated view of knowledge acquisition. They practiced English and used mathematics and science in a realistic way. In addition they gained a different feeling for the process of writing and expressing themselves by putting different kinds of information on the Internet, by writing press releases, and so forth. The students also mentioned, concerning learning, that,

Interviewer: What did you like best with this project?
Student 1: To be in the press.
Student 2: To learn something new.
Interviewer: What new things have you learned?
Student 2: I have learned how to design pages on the Net.
Student 1: I have learned that you should not present things that you might regret afterwards.
Interviewer: In the press you mean?
Student 1: Yes, it might come out all wrong.
Student 2: We have also learned a lot about Antarctica and the projects of Liv and Ann, from their Web site. And we have learned a bit about what they do and why they do it. What their future goal is and such. There is an educational content connected with it. And it is all about others who can make their dreams come true even though it sounds hopeless. It is possible.
Student 1: We have learned a lot. We have had visits by Liv, and she told us about her former expedition. We have made penguins in the snow in the schoolyard. And we had a day where we wrote a short essay in English about our dreams, and then we exchanged that with students in other countries. I now have an e-mail friend in the USA, and then you learn a lot about what their schools are like and such.

The students produced their own information. For the students, this project also created some new perspectives on the school as an institution. Commenting on the use of technology in such a project, these students said in the interview,

Boy: It becomes more fun to be at school. When you split it up a bit more, instead of having six hours in one stretch, then it becomes easier to get through the day.
Girl: For some it might be a big shock when they get into the work market, because you do not sit and make mathematical assignments as such. When we work on projects you get a better grasp of what is happening in real companies and such.
Boy: We should get more experience on how it is in real working life.

This way of working, where you change the regular classroom hours, also gives different students better opportunities, according to the teacher.

Students who have problems with traditional teaching can function much better when they can work on their own, by having a more continuous way of working. I think the most challenging thing for the school from now on will be to reform the whole structure of the school day where you have 45 minutes and then you have to change to something completely different in five minutes. I think it is much better for the students to work for two hours with small breaks when needed. That they work in intervals better suited to their capacity. A more flexible school day has to come. And I believe that ICT will contribute in accomplishing this.

The main technology used in this project was the creation of a Web site. Additional activities consisted of collecting information from different sources and presenting it on the Web site, for the local press and the school. The Web site was created as part of the national school Internet, and thereby became available to all schools in Norway. The site had about 3,000 visitors per week. For their work on the Web site, the students used Photoshop and FrontPage 2000. Mainly one PC was used for updating the Web site. They used the Internet to get access to information and e-mail to stay in contact with the explorers and other students in and outside of Norway. They used Word and learned a bit about HTML editing and coding. A couple of the students know quite a bit about programming, even more than the teacher. For example, they downloaded a video presentation program and also digital programs in order to edit the interviews with Liv Arnesen, and then posted a link to them on their Web site. Different kinds of technology have been used in different phases of the project. It started out with ordinary information retrieval on the Internet about Antarctica. The next step was to create Web pages about the expedition. On their Web site the students made a digital map where they plotted, week to week, the route that the explorers took. One teacher mentioned that he also used SMS messages on the mobile phones to get in touch with the students after school hours. He sent out SMS messages to the students when the satellite connection with the explorers was confirmed and then all the students came to the school to participate. In addition, as a consequence of the project, the students have now also started to use video conferencing equipment. One example is that a teacher and one student were invited to a conference in a town in northern Norway. During their presentation they had a synchronous videoconference with students at their school.

A project as the one described here illustrates how ongoing projects in schools can be linked to fascinating activities in the outside world, and also how the work of students can have an impact on the outside world, as in this case with local journalists. The students worked on authentic problems. The students produced content to a larger degree, published it for others to read, and collaborated by using the computer.

Project C: Internet Newspaper about South Africa

This upper secondary school has about 620 students between the ages of 16 and 18. It has about 80 full- and part-time teachers. All students and teachers have their own laptop computers, and there is a wireless network connecting the whole school. It is interesting to see what impact this technology project has had on the school's development in general. The principal is quite explicit about this, "*My impression is that we have worked with the active student model for almost 15 years, at least 12 in Akershus [the county], and I have never experienced changes as fast as those that occurred this spring."*

One English language teacher decided to organize a project about an English-speaking country. At the same time, the school was invited to participate in a competition on creating school papers, which was organized by a national agency. The teacher was quick to show her interest in this, stating,

> *I thought that this might be a very authentic situation, if they could compose a digital school paper on a specific theme, namely the English-speaking world. Traditionally we have chosen Canada, South Africa, and India. Now we had to*

> *choose one. It was really me who chose South Africa and suggested that for the students. The reason is that so much has happened there now.*

It was defined as a 3-week project. The project was organized by a group of seven student-editors, each with two to three students who acted as journalists. The curriculum content changed in the sense that the teaching of English became more related to authentic issues in the world for the students. According to the students, this created more enthusiasm for working on a subject. The students learned English in a more active way by creating the content themselves. Throughout the whole project, the students had to speak English. Having a process-oriented way of writing also created a more active way of learning English. It was important for the teacher to focus on formulating problems for the students rather than just stating facts. She said that, "*The editorial group and I agreed beforehand that it would be much better if they wrote an article about Nelson Mandela that they had a problem formulation they would find an answer to, and that it should not be a listing of facts."*

The teacher also used the computer as support for administering the project. She entered all the problem formulations and hyperlinks and used a video projector during her introductory lectures where the problem formulations were presented. Before the project started, she had found some links she believed would be good for the students. Through the whole project the students sent comments, questions, and drafts for articles to the teacher and received answers back. The teacher also put different documents on the school's intranet so that the students could download whatever information was there. The teacher studied the intranet logs the students wrote at the end of every day. She also made suggestions for the outline of the Web newspaper.

The students were organized like a newspaper staff in order to make it more like real life. The editorial group consisted of an editor in chief, layout chief, webmaster, two editorial assistants, and two web assistants. From our observations and the teacher's interview, it was clear that two girls were the main initiators and organizers of the editorial group and the group as a whole. They told people what to do and made sure they delivered on time.

After some introductory lectures by the teacher, the editorial group sat down with the teacher and brainstormed how to focus their work, based on the suggestions for problem formulations from the teacher. When they had decided on the process, the teacher put the final formulations on the intranet. The other students could then choose which themes they wanted to work on. The editors then negotiated who should write which articles. One of the girls in the editorial group explained some of the process in the initial phase.

> *There were some who wanted to write about the same thing. Then we had to ask them to collaborate in order to write different things, because we do not want two articles on the same thing. And since our focus is on South Africa then and now, one could write about then and one about now.*

After the assignments were given, students gathered relevant information for their articles. Most of them used the Internet to search for both written text and images. Many also used the links the teacher had provided, as well as the library. Some of the students also started to prepare the layout of the Web paper.

The editorial group, therefore, functioned as a teacher and organizer of the other students, which is a new experience for all of them. Working like this also triggered more collaborative work. One student stated in a interview that,

> *The way this project is organized is very good. Because then you are not really alone at any time. You have someone around you all the time; if there is something you wonder about, there is someone who can help you, but sometimes it is good to sit and work by yourself too.*

The second element was the importance of using laptops and the wireless Net. It made everything very flexible for the students. They could move around the school and sit somewhere where others did not interrupt them. Many of the students sat part of the time in the classroom and at other times in the library. From wherever they chose to sit they could surf the Net. In the middle of their project work they also had a vacation period. Having their own laptop implied that they could work on their articles during the vacation. Said one student, "*It is good we have portable PCs because then we can take it with us to the cabin."*

During the project the students could also send e-mails to each other discussing different things. By relating to the editorial group, the students kept their focus more on the assignment as compared to when the teacher lectured, maybe because the editors were students themselves and knew more about the different ways of using the equipment.

In the project work they used FrontPage to develop the Web paper. This was very motivating to the students working on the newspaper. One aspect was that they could search for more up-to-date information.

> *Student 1: We are almost dependent on the Internet. You do not find that much about South Africa in the encyclopedia.*
> *Student 2: I think we are dependent on the PC, that is the technology, when you do projects like this.*
> *Student 1: You have to filter away whatever is not relevant.*
> *Student 2: I found all I needed.*
> *Student 1: You learn to look for what is relevant.*

Through the whole project there was an ongoing discussion among the students about what is and what is not relevant, and how they should treat the information they find. Some students also sent e-mails to different institutions for some information; for example, one student sent an e-mail to the South African embassy and received a lot of information in return. Another student sent an e-mail request for information to a well-known journalist and correspondent for the South African region.

Concerning the subject itself, the teacher was not sure that the students got better results in English by working on a project like this. At the same time, however, she was convinced that they learned better through being more active. This became obvious because all the students had to speak English all the time during the project. Moreover, the process-oriented way of writing English made the language more alive to the students.

By making the Web paper, the students also become aware that newspapers are different from books.

> *What is special is the use of hyperlinks and stuff. You have a main page that consists of two parts, then and now. So you can click now, and then you enter another page, and then you probably get a list of many different subjects. With hyperlinks, you just dig your way inwards instead of just sitting and turning over the pages. You get a much better overview. (Student)*

The teacher also mentioned that working with technology like this made everything look more professional, and that this was more rewarding for the students. Her conclusion was that, "*Many of the students say that this has been very motivating. Usually they think that English is boring, but now it has been fun."*

The affordances provided by new technologies in this case are related to communication possibilities and the information access that the technologies provide. The students are also producing much more text than before.

From these three case presentations we see that there are many similarities across the cases, but also huge differences. And, in a way, the differences are more interesting than the similarities in the sense that they show how contextual factors—the school community and the local community—play a role in the way new technologies are used in pedagogical practices.

What all three case presentations show is that there are expanding possibilities in the way teachers and students work and how they relate to content in specific projects. The biggest impact of the technology is in how the learning space is made larger in the sense that the students can reach out of the classroom and work on and with issues in the outside world, and it creates more flexibility in relation to subject content. The resources to be included in the learning activities are more varied and stimulate different learning styles among the students.

INNOVATIONS WITH LIMITATIONS

Even though these case presentations are small glimpses of ongoing activities, they show some important developments in school-based learning. To what extent they can be defined as innovative is a more open question. Innovation is a relative concept depending on the position and perspective from which it is defined. The most interesting aspect of these developments is not if they are innovative or not, but rather evaluating the different developments in schools where new technologies have become an important part. The differences are often bigger than the similarities between schools.

In this article my analysis has concentrated on two important aspects of the Norwegian cases taking part in the SITES M2 study. The first aspect concerns changes in the learning environment in these schools and the role of ICTs. I have used the term re-framing as an indication both of changes in the physical space and how activities, tools, and symbolic systems used can create changes in the conception of space in schools. In Figure 1, we saw an illustration of changes in technology-rich learning environments—from a traditional computer room-based model towards a more open space in which computers are integrated in the classroom activities of the students. The school-based examples mentioned all show how working with computers changes the learning environment towards more flexibility.

One school created a more student-active environment, where the computers supported this development and also made it possible for the school to collaborate with schools in other European countries. Another school took advantage of the multimodal resources that ICT gives to support students as knowledge constructors in different ways. A third school case showed how the technology could support collaboration between two small schools in remote areas of Norway, and the last case showed how ICT supported collaboration between the school and local industry, where the students did their project work in both arenas.

Taken together these short case descriptions express genuine changes in learning environments in schools that represent new possibilities for the learning activities towards more flexibility. The cases are defined as communities of practice where students and teachers work together in different ways. The technology used created new ways of participation in communities of learners breaking off from the traditional classroom. Using ICT in this way is a new development for all these schools, and the developments often suffer from technological problems and lack of technical support. The larger schools, in terms of the number of students, often experience some resistance among the teacher staff. What effect this resistance has on the use of ICT in these schools depends mainly on the school leader and how he/she creates a climate for discussing school development using ICT. In Table 1, different factors that influence the development of learning environments are presented.

The second aspect of our analysis highlighted here concerns how ICT is used in some concrete learning activities as part of project work. The mediated actions that are going on in these learning environments are influenced by the tools used. The important question has been what the affordances of these new technologies might be. In the presentation, three cases were analyzed. These three represent some important issues also seen in the other cases.

In one of the cases, both teachers and students created interactive Web resources, in another the students followed and documented an expedition across Antarctica, and in the third, the students made a Web-based newspaper on South Africa. Some similarities across the cases are that they all used ICT as part of project work, they were all student centered, and they all wanted to use the technology to support the students in their explorations and learning activities. They were also all creating digital resources themselves, taking advantage of the possibilities given by the technology. They all used the Internet to search for information and explored the communication possibilities that the technology represented. However, they did this in very different ways.

In the case where they made their Web resources on the religion and ethics subject, they started without any expertise in developing such resources. Because of financial difficulties at the school, they decided to build such expertise among both the teaching staff and the students to create their own learning resources that could be shared and further developed by other schools. The students reported that using this resource created more motivation, that the Web portal contained different kinds of material, and that they had periodic tables for the different subjects; the aims of the curriculum were more easily available by which to structure and plan their learning activities accordingly. By both developing and using such a resource, the students and teachers related directly with their own local community more than before, as a resource informing their learning activities at school.

The next project explored the communication possibilities of the technologies. They communicated with two women crossing the Antarctica on skis—before, during and after the expedition. In addition they searched for information from different sources and developed their own Web resource documenting the project. Both students and the teacher reported that

Table 1. Trajectories of innovation related to mechanisms of learning.

	No use of ICT	**Traditional classroom use of ICT**	**Flexible use of ICT in schools**	**ICT use representing new learning arenas**
Curriculum	Prescribed goals, content and methods	Prescribed goals, content and methods	Overall goals with open content and methods	Locally adapted
Leadership	Not involved in ICT implementation; no strategies on ICT	Some involvement in ICT implementation; limited strategies on ICT	Integrated strategies; realistic visions of school development with ICT	Breakthrough visions of development creating a new agenda for education
Learning environment	Traditional classroom, four walls with rows of students	Traditional classroom and computer room with limited use of ICT	Different rooms with integrated access to ICT; virtual arenas	New ways of organizing learning, breaking with school as the single organizing principle, and using virtual platforms for collaboration
Methods	One-way transmission of information and collaboration	One-way transmission of information and collaboration with limited use of ICT	Project orientation and collaboration. Use of ICT in and outside of school, also virtual. Differentiated approach adjusted to students needs	Dependent on activities and goals, not predefined
Content	Subject-oriented books	ICT use supporting traditional skills; reading, writing, numeracy	Combination of books and different digital resources, as well as self-produced	A wide variety of resources: games, simulations, hypertext and multimodal resources
Teacher roles	Active provider and transmitter of information	Active provider and transmitter of information supplemented by teacher-organized use of ICT	Different roles related to activities	Teacher as organizer of environments, knowledge challenger and learner
Student roles	Passive reproducer	Passive reproducer	Active producers of knowledge, individually and collaboratively	Learners with good learning strategies
Knowledge building	Reproduction	Reproduction	Production and inquiry-based	Based on students ideas, knowledge production and inquiry

this was a new way of working in the school setting, that the learning activities became more authentic by relating it to something going on in the world outside of the school, and that the students experienced more challenges in evaluating different sources and reflecting on them and their content. By integrating different subject domains in this project work and by using a broad scope of different technologies the knowledge acquisition and the learning experiences of the students became more integrated.

The last case illustrated how students could work as active learners in a multimodal way. By creating a Web-based newspaper, they worked on process-oriented writing, downloading and using images, and were supplied with oral information from interviews, film material, or as explanations by students. The teacher selected South Africa as the theme, and this was experienced as authentic for the students and the teacher. The students took the role of newspaper journalists in organizing their own work. The computers made it possible for them to support each other's writing process, to search for information from various sources, and to communicate with different informants. All the time the students had to talk and write in English. By using ICT in this way, the motivation among the students increased. One important aspect mentioned in all three cases was the flexibility that ICT offered the learning activities during such project work, for both students and teachers. Related to Howard Gardner's (1983) concept of "multiple intelligences," these cases also documented how ICTs stimulate students' learning competences in different ways.

It is interesting to see that several of our schools do not define project work or project-based learning itself as very innovative, but that the technological part changes how the projects are defined and how the students work in these environments, both virtual and face-to-face. The teachers indicate that by using ICTs they now can realize some of the ideas they had for project-based learning, but had not been able to do before. For example, students can work together and communicate with the teacher even though they are not together in the same physical space.

Some critical remarks can be raised about the sustainability of these cases. It is not clear to what extent these activities using ICT are embedded within the whole school. We can also ask whether these are projects that will last over time or if they are single events. In the case material from Norway this varies. For the smaller schools, the technology obviously is part of the whole school culture more than for the larger schools. For the schools that work more with project-based learning, the activities using ICTs are more continuous than in schools were project work is something they do two or three times during a school year. For the latter, such activities using ICT tends to be singular events and not something the teachers build on.

As mentioned earlier in this article, there is a need to analyze more in-depth project work as a methodological approach in schools than has been done so far (Hakkarainen et al., 2004; Postholm et al., 2004; Rasmussen, 2005). Compared to other research on project work in Norway, our research on the SITES M2 cases show that the teachers play a more active and structured role in initiating project work and following up with the students during the process. The projects are enriched because students can include different sources and different ways of expression in a multimodal way. Additionally, the products and project reports the students make are of better quality and defined as more authentic because they relate to the community outside the school. The students are very motivated by this process, and both teachers and students highlight the flexibility that the technology provides.

However, the case material in the SITES M2 study and many other studies on ICT and school development has focused mainly on the activity level and less on the actual learning going on. The data tell us a lot about what teachers and students do in technology-rich learning environments. This relates to issues of methodological approaches, project-based learning, and progressive inquiry, as well as stimulating frameworks for using new technologies in schools (Hakkarainen et al., 2004). In a sense, the examples presented here are expressions of the schools' capacity building for development.

The open question is what impact this might have on the students' knowledge building. There is some evidence that using ICTs has a positive effect on students' learning (Harrison et al., 2003; Scardamalia & Bereiter, 1996a, 1996b), but much research still has to be done to make this connection clear. From the cases I have presented above, it is quite unclear what the actual knowledge building among the students really is. This is the reason why we in Norway now have started some large scale national projects focusing on building knowledge in pedagogical practices by using ICT.

We also see that the activities using technologies are more collaborative than individual. This is of course linked to the fact that the technologies are mostly used in connection with project-based learning. The students work together, both in located settings in the school and in and towards distributed settings outside the school. The technological applications they use support this.

At the same time we see that using the technology in practical pedagogical settings gives a better possibility for differentiation, that the students can follow their interests and that the teachers can adjust the challenges for different groups of students, according to their competence levels. The technologies give more variation in the resources that are made available to support the students' learning.

Another aspect is the way teachers and students talk about the content and the resources they are working with. Again, the activity of the students is important, and many teachers talk about the students as becoming knowledge producers more than knowledge consumers.

Referring back to my research questions, we can sum up that technology-rich learning environments, as shown in the cases in this article, provides more flexibility, both within the school and by linking the project activities to the world outside of the school. Concerning the impact of project work using technologies on the students' learning experiences, the case material shows different results. All the cases document a much more active and involved learning experience among the students. They work with learning resources that are more complex and interactive, and they communicate more extensively.

Based on the complete analysis of Norwegian cases, we can develop what I call *trajectories of innovation* in learning environments using ICT. These represent a development from "no use of ICT" towards "ICT use representing new learning arenas." (See Table 1.)

Most of the cases in our Norwegian study fall within the category of flexible use of ICT in schools. They have moved from traditional classroom use of ICT but they are not yet representing new learning arenas breaking off from the school settings we traditionally relate to. However, the case material from the SITES M2 study in Norway shows some important developments in all the mechanisms of learning mentioned above. In all, except for curriculum development, which is nationally defined in Norway, the schools themselves changed in important ways concerning the role of the leadership, how they define and develop learning environments, the methods used, the access to content, how they develop content themselves, in teacher and student roles and, how using ICTs support knowledge building.

CONCLUSION

As indicated in the title of this article, using new digital technologies expands the possibilities for learning activities in schools. For our Norwegian cases, this is also directly linked to project work. ICTs integrated into project work create new and interesting ways of

approaching the challenges of learning in the knowledge society by opening up the school to the outside world, through working with more problem-based situations, and by letting the students become more active producers of knowledge in a flexible learning environment that supports their learning activities in different ways. But these cases are just the first steps, and we need to systematize experiences from such case studies, to develop models for others to build on, as well as the scaling up of such activities to involve more teachers, students and schools in looking into how ICT might best support learning among children and youth. At the moment in Norway we are undergoing a national curriculum reform in which digital literacy is defined as important as reading, writing and numeracy; this means that all students, in all subjects and on all levels of schooling, should use and learn how to relate to the new digital technologies. In this sense, projects like SITES M2 can inform us on how to best use and implement ICT in educational settings.

The use of technology in pedagogical practice is complex. Through research on ICT and learning, one often can get a simplistic presentation of activities involving teachers and students using computers in different ways. My point is that in order to understand innovative pedagogical practices, one has to take into consideration different contextual factors. It is the sum of the elements, not one specific artifact, that creates the innovation. As stated by David Olson (2003) in his book *Psychological theory and educational reform*, we need to integrate perspectives and research on institutional development with perspectives and research on learning activities in schools, which is no easy—but a highly necessary—task. In this article I have presented data on school culture, on changes in learning environments, and on specific learning activities involving ICT. To understand innovation, you must view the combination of these different aspects. The challenge is how we build on research such as the SITES M2 study to provide a framework for school development with ICT as integrated element.

The SITES M2 study is important and gives some striking examples of how the technologies give students and teachers expanding possibilities for learning activities in the classroom. Equally important is that we see that it is not only the "good" schools—good in the sense that they have cultures that always move forward in learning development—that get better. Several schools mentioned here, with a less positive starting point, have used the new technologies as a catalyst for change and have made huge leaps in school culture and pedagogical practices. In this way we might say that innovation is a *flow process* for several of these schools, meaning that many impulses follow the implementation of new technologies; yet it is not the technology itself that brings this flow forward, but how it relates to other factors in school development. It is not a single factor but the system of factors that creates a positive flow of innovation involving new technologies. At the same time, it is important to take the digital divide into consideration. Who will be the winners or losers in this new educational setting? The inequality of access to information and communication technologies will remain something that should be investigated fully in the research on innovative pedagogical practices using technology in the next few years.

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