Reaching out: Digital artifacts supporting knowledge construction

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Work In Process.

Introduction

The focus of this paper is the school as a field of practice and how ICT, as a set of new artifacts, creates new conditions for learning and for activities in the educational sector (Bliss & Säljö, 1999). In this matter, we want to investigate two partly overlapping problem formulations. The first concern which way ICT contributes to the development of new learning environments and the second concern the consequences these learning environments might have on knowledge construction.

As a frame of reference we will use some major research initiatives in Norway studying the impact of new technology on learning activities among students. Several ongoing projects in Norway have a strong focus on qualitative methods and action research in trying to search out the possibilities technology give for creating new settings for students learning in schools. We will use data from two lower secondary schools, which both are cases in an international project we participate in called 'SITES module II'[1]. The reason for using two cases is the fact that different school cultures have a major impact on how the learning environments are implemented. Our unit of analysis will be the different project-activities of the students.

The theoretical foundation will be within a socio-cultural perspective, specially linked to reflections on learning environments (e.g. Jonassen & Land, 2000; Schauble & Glaser, 1996). Developments of tool structures or artifacts have created new dimensions to our organization of learning environments. Two important concepts we will focus on, linking to the students learning processes, are knowledge construction and externalization. The importance of students getting actively involved in their own and other students learning process is highlighted. The students are reaching out beyond traditional learning environments and individual knowledge construction.

Theoretical framework

In a Norwegian context there is a need for more qualitative data about the impact of information and communication technology on students learning processes. The technology itself has been much in focus. However, we know much less about the framework within which different technological applications can enhance learning. Several projects in Norway have now been established to study the variation in learning activities that technology might open up for. In this paper we want to focus certain aspects of these project activities.

Learning environments

Traditional learning environments often focus on mapping what students do not know on different age-levels and then provide them with information on what they do not know. To a lesser extent we have been oriented towards creating constructive learning arenas. That is arenas that are more challenging for the students in their search for knowledge, and which is not defined in a textbook. Student-centered learning environments focus on the opportunities they provide learners for effecting their environment and meaning making, rather than focusing on how information can more effectively be transmitted by teachers and understood by learners (Jonassen & Land, 2000). Such environments are designed to support individual efforts to negotiate multiple points of view, while engaging in authentic activities. Important

[1] The central point for the SITES Module II study is innovative pedagogical practice, which is embedded in three contextual levels; (1) the classroom (micro), (2) the school organization and local community (meso) and (3) the

assumptions in student-centered learning environments are that the learner defines how to proceed based on individual needs and learning is highly tuned to the situation in which it takes place. Another important aspect of learning environments is that understanding is deepened through exploration, interpretation and negotiation. Learning is also knowledge-dependent; people use current knowledge to construct new knowledge (Land & Hafinn, 2000). Technology is often used as a tool to support and enhance the learning environment. The use of computers enables learners to represent their thinking in concrete ways and to visualize the consequences of their reasoning. Thus, the tools are used to extend and argument thinking capabilities (Salomon, Perkins & Globerson, 1991). Mercer &Wegerif (1999) stress the importance of the students talking together before responding to computer prompts. In this way one will maximize the educational potential.

An open learning environment implies a reconsideration of the teacher and student role. The teacher's role is not to advocate the counter-culture, but to challenge the students search for knowledge. The new roles of the teacher are quite complicated, since they have to play on the whole range from the role as a lecturer and teacher-centered discussion to inquiry and problem-based learning. McGhee and Kozma (2001) investigated six new roles of the teacher; instructional designer, trainer, collaborator, team coordinator, advisor and monitoring and assessment specialist. Each role is associated with specific activities and is made possible by the use of technology in support of project-based learning and inquiry-based learning methods. Wells (1999) says that an important role of the teacher is to create an environment for the students where they in collaboration are engaged in productive, meaningful activities, which makes it possible for them to take over the culture's *"tool-kit of skills, knowledge and values so that they are able to participate effectively in the practices of the larger society, and develop the disposition to act creatively, responsibly and reflectively in achieving their own potential and constructing a personal identity"* (pp. 335). This can bee seen as the same as what McGhee and Kozma (2001) refers to as a team coordinator.

McGhee and Kozma (2001) also identified three new roles of students; self-learner, team member and knowledge manager. The self-learner is associated with students selecting their own real-world projects and identifies possible solutions. In this way they help determine the content of the curriculum. A team member is one that is actively involved in advancing the working groups project. By collaborative work the students move the project forward. The third role they observed was that of knowledge manager. The focus here is on knowledge products. Activities demanded of this role is formulating questions, searching for information, collecting and analyzing data, and design reports and presentations. The role of knowledge manager is the one most associated with the use of technology to support project-based learning. This approach moves conceptions of learning beyond rote memorization of facts and procedures to learning as a process of knowledge creation. It moves education beyond the notion of a place where knowledge is imparted to one classroom towards knowledge building communities (Brown et.al., 1998, McGhee & Kozma, 2001).

Another important distinction in this understanding of learning environment is community of practice and practice fields. Practice fields are separate from the real field, but they are contexts were learners can practice the kinds of activities they will encounter outside schools. The goal is to present students with real-life societal, business, or educational problems. Problem-based learning is an example of one approach to creating practice fields. But since the practice the students are engaged in, is still school tasks abstracted from the community, the activities are divorced from their contribution to the society. They are practice, not contributions (Barab & Duffy, 2000). The goals of participation in community, on the other

hand, are to develop a sense of self in relation to a society outside the classroom. As Lave and Wenger (1991) defines: *"A community of practice is a set of relations among persons, activity, and world, over time and in relation to other tangential and overlapping communities of practice…Thus, participation in the cultural practice in which any knowledge exists is an epistemological principle of learning"* (pp. 98). In the school context, it is important to create activities that has a historical context, a history of experience to use, and that the results of the activity contribute to the society. We do not think that one of these designs is better than the other. Rather it is two designs that fit different kinds of school activities and students at different age.

Externalization and knowledge construction

An interesting dimension in studying different learning environments with integrated use of ICT is of course how it affects student outcomes on different levels. We limit ourselves to focusing on two concepts. That is the process of externalization and knowledge construction.

The concept of externalization (and internalization) has been used in different ways in different contexts, from Piaget to Berger and Luckman. It is also a concept that has been criticized by its limitations within a cognitive framework (Rogoff 1991). However, in our study we believe externalization still has certain implications that are important when studying different learning environments.

First it relates to the tools we use to systematize and present knowledge elements. That can be everything from written texts, note sheets for music, video presentations, and so forth. In our context it is the implications of new technology that is of primary interest. Secondly, externalization deals with the process of making knowledge accessible for others with whom one communicates, either through oral language, visual communication or other ways. Thirdly, it implies the sharing of meaning among actors in concrete learning activities. That is how meaning making is negotiated and how different information sources are used to construct knowledge.

In recent years it has become quite common to formulate models of transition from one state of affairs to another relating to our understanding of meaning making and knowledge construction. Jonassen and Land (2000:viii) have for example marked a transition from 'instruction' to a 'student-centered learning environment' consisting of many different dimensions. It is not our intention to go into all of these dimensions here, but through our analysis our intention is to illustrate how the use of new technology can enhance such a development towards more focus on the students learning activities.

Knowledge construction has become a key term in describing a more active student role in developing and creating their own knowledge processes (see for example McCormick and Paechter 1999). It is a term that is central in describing the process of learning within problem-based learning and project orientation. It is based on pedagogical ideas from Dewey and certain constructivistic perspectives. Knowledge construction imply and active and reflective information-seeking process among the students where the teacher is not the primary or sole provider of information. Within the projects we are studying it also imply a social process where the students have to relate to each other in order to complete their tasks. What lacks in many studies, however, is how the use of information and communication technology influences the process of knowledge construction within different subject areas on a concrete level. For several of the projects we are involved in an intention has been to

provide better insight on how students work on knowledge management and construction in different kinds of projects and learning environments.

Methods

This paper is based on two out of eleven cases Norway have contributed with in the international project SITES Module II. Such examples can be important to give descriptions of opportunities in the use of ICT. We are aware of the complexity in the use of ICT and learning, but for this purpose it has been important to focus on how ICT create new dimensions to our organization of learning environments and knowledge construction.

We visited the schools at two different times during the academic year 2000/2001. We interviewed 4-8 students at each school, the teachers engaged in the specific project we focused on, some other teachers at the school, the principal and some of the parents. We also conducted observations of classroom activities, which we videotaped. The interviews had a duration of 45-60 minutes and were transcribed by a graduate student. The interviews were systematized according to themes important for the SITES project. These themes were then organized to illustrate learning environments and knowledge construction. Finally we link the themes to our theoretical framework.

Empirical analyses

We will first provide some background for the pedagogical practice in the two selected cases. Based on our data and our theoretical framework, we will describe and analyze what the pedagogical practices at the two schools indicate about learning environment with the use of ICT and knowledge construction.

Case 1: The use of visual communication strategies and project-oriented pedagogy

This lower secondary school is situated in an area with families of lower socio-economic income and characterized by a lot of social problems. Since the middle of the 1970s, the focus on project-oriented pedagogy has been very strong. Nationally the school is well known for having a long tradition of working with alternative approaches to teaching and learning. Both the principal and teachers at the school explain the impact of computers as a breakthrough for making their pedagogical visions more effective and give it a new direction towards knowledge construction. As such, importance has been given to create learning environments and arenas for negotiations, which implies an extended definition of knowledge, not just reading and writing. They organize their learning environment within different areas with different activities, such as drama, art and craft and use of local knowledge.

One important aspect of the schools vision on teaching and learning is to create a learning environment where students can become better at what they are already good at. This implies an approach for creating better self-esteem for learning among the students. Time is spent on finding a subject-area where the developmental potential of each student is high. The challenge for the school is then to stimulate this competence in each student, creating better performance and trust in their potential for learning. Further on this attitude towards learning might spread to other subject areas. The school does also emphasize strongly the need for students to produce knowledge and present for other students. This way the students have to think more about how to illustrate their arguments and how to best present it for others to create understanding. The students get experience on how to master and get a better conscious attitude towards their own learning process. The students are also responsible for teaching

other students at certain times, because the school believe that through teaching others is the best way of learning yourself.

The students are organized in teams of 40, with a team of 5 teachers. In the projects the students always work in groups of 3 or 4. Teachers and students decide together the main focus of the project themes.

In the paper we will refer to one specific project where the students make an animation movie on the theme 'the changing features of water'. Even though the basis for the project is natural science, it has an interdisciplinary approach since they use elements from other subjects, like e.g. English. Each project consists of 4 steps. The first concerns experience, where the students are introduced to different ways of experiencing the theme for the project. Then they can search for information at the Internet or talk to experts in the local community etc. The next step is called the 'tool box', where they sit down and decide which tools they need to complete the tasks in the project. In this particular project it was important to get special training in visual tools like iMovie and the use of digital video cameras. In addition to this, they got training in word processing (Apple Works). The third step is the production phase where the students collect information about particles for then to make a storyboard to document their project in one way or another. The last step is presentation for all students, with feedback and discussion. New technology is an important aspect of the three last steps.
The important, however, is what this can tell us about the contribution the use of ICT have in the learning environment and which consequences it has for the students.

The use of computers often is a problem-based `meeting point` where students and teachers are gathering forces to solve different problems, both technically and academically. These situations often show signs of intensive exchange between questions and answers and negotiations of solutions. The teacher often does not know the answer of the questions, and he is therefore often at the same level as the students in the attempt to solve the problems. The teacher is not always the expert in choice of technical and creative solutions. As one of the project teachers says:

> I experience that my role changes from being a person that knows it all to become more of a resource person. A person that is more like a pusher, one that sets the framework, a conflict solver, an adjuster. I feel that this role becomes more important. Another situation that you see more of now is that I sit down more together with the students, and that you communicate on the same level and solve the problem through discussions with the students. It is a larger degree of equality when you sit in front of the screen and have to decide on what has suddenly come up. Also that you as a teacher can say that 'this I don't know, this I have to investigate closer', that is very important (Project teacher).

The role of the teachers in new learning environments can be complicated, since the teachers still maintain many of their traditional roles, but also have to negotiate multiple new roles that utilize technology-supported classroom practices. The teacher describes the complexity of being a teacher in such new learning environments and he also stresses that he see his role as more important now than earlier. The roles the teacher describes, is what McGhee and Kozma calls the instructional designer, team coordinator and enabling advisor. The teacher describes that he no longer is the expert. One should therefore arrange for interaction that involves both teacher and peers as contributors to an individuals learning. The students then gain more control over the progress and the content in the projects they are working on (Schofield, 1995).

By studying the students explorative talk when sitting in front of the computer also show that they are very active participants in negotiating different solutions among themselves. If they get stuck with a certain problem they gather forces, all steering into the screen looking for ways to solve the problem. This way they often manage to agree on a solution. This also illustrates another important aspect of the way these students used the computer in their project activities. Collaboration was an essential element in working with such a knowledge production focus. By working together the students support each other, even though conflicts may arise. Many argue however, that disagreements with other children serve to highlight alternatives to the child's own point of view. This can foster a student's progress in understanding (Light and Littleton 1999).

The use of ICT creates new and unexpected situations all the time, which is something the students and teachers have to deal with. From the students' point of view, the biggest change is that the teachers don't handle them so much information anymore. In relation to the work with the animation movie, the students say:

> Boy1: Editing is the most fun thing to work on. Because we do things ourselves, there are no teachers who stand and point and tell you what you should do. You get to choose yourself and sort of what you think is best.
> Girl: There is sort of no specific assignments, 'now you have to do that', we decide what we should do and how we should do it.'
> Boy2: The teacher makes us not to give up.
> Girl: If we need help, then they are available. But if we want to we can do everything ourselves, if we manage to.
> Boy1: That we do it the right way.
> Girl: If we need help, they are there for us.
> Boy1: The teachers do not give us a lot of information, like they used to do in primary school. They give us an assignment, and then we should find the information we need to complete the assignment ourselves.

The use if iMovie can be defined as an effective artifact that give flexibility and at the same time quality and a professional product. The visual focus has changed how the students relate to their own learning process and it has created a new framework for engaging the students in different subject oriented activities. It generates creativity and it is an opportunity for experimenting with different solutions and putting together different components of knowledge.

It makes it easier for them to relate to a challenge partly because they can use a broader repertoire of their own competence, and partly that it focuses their attention more. They have become more independent as a consequence of a learning resource with many opportunities. This stimulates the students' motivation as well as their focus to the academic content. As one of the teachers says; *"The advantage with visual presentation is that the students have to study the material well, if not, they will not be able to create a movie"*. The students themselves say they remember more of what they learn, because they have to know the material well to be able to present it to others. The importance of presentation is shown when a student says; *"And if you stand there and you haven't done it good or you don't remember, then..."*. The learning is under another social pressure than it was earlier. Many have stressed the importance of students creating products they have to present to others (e.g. Brown et.al. 1998, Rogoff 1998, Wells1999). It is through academic discussions like this the students show that they truly understand a field of knowledge.

If one focus on the students process instead of the product one form the basis of a learning environment. The focus is no longer on facts but the students' ability to engage in complex learning activities, where both the academic and social aspects are central components. The focus on the learning process is also supported through an alternative assessment strategy. All students must demonstrate their products through the completion of an electronic portfolio[2]. The students get written assessments on their portfolios instead of grades based on numbers.

The use of ICT has created new educational possibilities for the school. Using ICT gives the students a possibility to operate more on their own. iMovie has becomes an important tool for producing knowledge and create better consciousness about how to put information together in a meaningful way. The students themselves explain it as:

> Boy1: It is more practical, so this way we learn more by doing things more than just to sit and write stuff.
> Girl: I think it is much better. I think I learn more by doing it on the computer than just sit and read about it. When you just sit and read or write then it becomes boring, and then you don't get it in. However, when you have to do something to get it right then you better grasp it.
> Boy2: You forget things easier when you just sit and read.
> Boy1: You just read, take a look in the book; write the assignments, without any of it going through the brain.

This sequence shows that the students have gained a room for negotiation and they take an active part in their own knowledge production. The students discussion also shows how important it is with assignments that is practical and appears meaningful for the students. Dons (1998) found that it is easier to get students started with academic work when one use aesthetic angle of incidence. The use of photo and video in the students work process contribute qualitatively to knowledge creation and presentation. This bring us over to the last aspect of importance in this project; the question about differentiation. Both well and poor performing students benefit from working with the computer this way, but maybe specially the poor performing. Both parents and teachers expressed this. A strong statement came from one of the mothers to a couple of twins in this group:

> My girls are academically weak because they have dyslexia both of them. And during the years in primary school they have all the time struggled with not being able to prove themselves in any subject oriented way. I think it was incredibly positive for them to come here ... to be able to work on computers and film and editing and such things. They have done a bit of that at home before, so they had knowledge that the other students could get from them, and through that they got a higher status in the group. So for them it has been like ... I don't know... almost like a new life. It is very important that they gain ownership to their work. I think that is one of the keys to create engagement. For adults it is like this, and I do not think this is different for children (Parent).

An important assumption for these learning consequences was a combination of giving the students believes in their own potential for learning, and the flexible opportunities, which is in the use of ICT. The project teacher also confirms this when he talks about the same students;

> We have some students who are very weak, they cannot read the watch and have real problems reading and writing. We got a note from their primary school that they were mentally several years behind the others. Then yesterday they worked on e-mail. In fact they were the first to

[2] Some schools in Norway have further developed portfolios to a methodology that have consequences for the students- and teachers' roles, understanding of knowledge etc. towards more involvement from the students in

> complete the task. Also that we discover that they are good at visual communication. Suddenly these students come into a learning environment where they have experience related to a new tool that becomes available for them without only focusing on reading and writing. But also for the students that are clever and take things fast, this seems to give them more. Also for them it is a growth environment to produce good results.

Heterogeneous grouping that is employed in this project has been very positive for students at all levels. According to McGhee & Kozma, 2001 and Underwood & Underwood, 1999) we found that this can make provision to ensure that low performing students play a significant part in the group's work, especially when using ICT for visual communication. The learning environments have, for all the students, been challenging and stimulating, which seems to give good results for the students performance and learning progress.

Case 2: Students interacting with two women crossing the Antarctic

The second case took place in a lower secondary school as well, and as the fist case differentiation in approach suited all students, from the poor performing to the best, is seen as very important. This is the reason that they have started what they call 'Go ahead'-groups, which is the group of students we will focus on. This is an offer for, according to the principal, students *"…that have more to go on"*. Students who perform well is offered to go out of their regular classes to participate in specific projects that they have an interest in, but they are expected to follow the progress of their regular classes in addition to participating in the project.

We will focus on a project called the "Antarctica project". The overall focus of the project has been 'to make a dream come through'. It all started in October 1999 when the explorers Liv Arnesen (Norwegian) and Ann Bancroft (American) presented their ideas for an education program connected to their Antarctica 2000-2001 expedition. 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. In addition the school had a special arrangement with one of the explorers, Liv Arnesen, that they would have 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.

The project is defined according to overall curriculum goals about an interdisciplinary approach and project orientation. However, it is different from how most other schools define the same goals in the sense that this is an activity to give certain students a bigger challenge and organized as a project in addition to regular classes. The main change is still the content of this specific project and how they used technology for communication purposes, to gather information and as presentation tools. On the question of vision on ICT in the school the principal says that:

> It relates to be 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 get 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 (principal).

The first step in the project was that the students wrote a short essay about their 'secret' dream. They discussed these dreams among themselves, and to what extent it was possible to make them come through. The next step was to exchange dreams with other students in other countries. Some teachers had gone on the net and found some schools in the USA, Poland,

Finland and Palestine. The teacher explains the impact of this as: "*The students got input on how to understand youth culture, to understand life conditions, that they are different"*. As a result from this activity, the students saw that one have different dreams in different countries. While some of the students in Norway dreamed about become better on snowboard, a Palestinian girl dreamed about a stable and secure school.

The next step was that a couple of teachers started a project to follow the two women crossing the Antarctic. A group of eight students joined for this specific project. The aim of this project was to create a web page that would contain different kinds of reports and information gathered by the students about the expedition and Antarctica.

The teacher and the students have worked close in this project. Some of the students knew more than others about the technology, and functioned as mentors for the other students when they had problems. The teacher has used e-mail and SMS messages to get in touch with the students on their spare time. They had a couple of direct conversations with the explorers, and that was out of school time. The teacher sent SMS messages to the students when the connection was decided and then all the students came to the school to participate.

Another important information source about the project was one of the main newspapers in Norway, which had a special agreement with the expedition organizers to get up-to-date information. The newspaper also put up a link to the students´ web page on their web pages. In addition to that, the students have used Internet to get access to more general information about Antarctica and they have downloaded some video-presentation program and also digital programs to edit the interviews with the explorers and put it as a link to their web page. This editing process was an important learning activity for the students.

The students work very independent and they define the frames and much of the content in the project. The teacher and the students are together negotiating the goals for the project. In this way the students feel responsibility. The students have the role as a self-learner (McGhee & Kozma, 2001). They determine the content of the curriculum and are responsible for organizing and managing the activities. But one important aim stressed by the teacher is 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, both related to the use of sources, that what they write is formally correct and that they can justify it. That is certain principles within journalistic methods and source-critic that I have included in the project as certain knowledge based factors (Innovation teacher).

Even though the students are working very independent, the teacher is aware that he has to take into account all of the resources available to meet the students needs and implement well designed activities to meet those needs (McGhee &Kozma, 2001). To be able to critically evaluate sources is something the students themselves have become aware of also because journalists have interviewed them. The students become aware that they have to know the theme they are working on well when being interviewed and they see how the journalists use the information from these interviews and how they might change the information they got. In this way the students get a meta-cognitive perspective on the meaning of their own project. The same can be said about the consequence of publishing their own knowledge on the net so everybody, potentially, can see what they have written. Then it gets very important for the students that the quality of the text is good enough.

Concerning student outcomes they can be said to have gained different kinds of knowledge in a project such as this. Of factual knowledge several of the students refer that they have learned a lot about Antarctica. Important in learning about these things has also been the method by which they have approached the information, in the sense that they have been very active in finding relevant information and evaluate what to use. All the students have learned a lot about using computers for different purposes. In one conversation the students reflect on their own learning when saying that:

> Girl: I think it is very exiting 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.
> Boy1: You learn that, because on the Internet a lot is in English, and then you have to translate it into Norwegian.
> Boy2: Yes and then, where we get information about how far they have walked, it is formulated in miles, and then we have to calculate from (English) miles to (Norwegian) miles.
> Boy1: We are also going to make a press release that we are going to give to ...

In this conversation the students mention several outcomes that illustrate an integrated view on knowledge acquisition. They get to practice English, to use mathematics and natural science in a realistic way, for example they have to find out how many Norwegian miles one English mile is. And as the principal mentions; *"In the Antarctica project the students have to work with problem formulations about health, nutrition, pollution/ozone, whaling and weather/metrology..."*. In addition they get 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.

For the students the project created some new perspectives on the school as an knowledge institution. By commenting on the use of technology in such a project some students mention that:

> 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 on what is happening in real companies and such.
> Boy: We should get more experience on how it is in real working life.

Commenting on the Antarctica-project the Innovation teacher mentions another meta-cognitive outcome*: "I think they have seen a bit more of reality. I think they have seen that if you are going to accomplish something you have to fight for it"*. This is not something the students just learn through the use of new technology. They have projects at the school where they use art, music and other resources. But in relation to this project the technology has given some opportunities and arenas for negotiation that creates exciting consequences for the students learning.

Conclusion

In is paper we have tried to show how technology contributes to the design of new learning environments and knowledge construction in classroom-activities. In the second story we could see how contact with two explorers in Antarctica created a new dimension for the students to relate their knowledge to. Since "real life" is a part of the learning situation new arenas for negotiations is being partly created. The knowledge creation is more relevant for the students. Tearing down the physical and mental barriers of the classroom brings the real

world directly into the learning environment. At the same time you reach out into the real world by the communication possibilities of new technology. This project moves towards the concept of community. There is a historical context for the activity, a history of experience to be used, and the students become a part of something larger as they contribute information from the expedition to the community and have contact with a national newspaper. However, the problems are not necessarily addressing a real-word need and the community is formed only for the duration of the project and will not continue to reproduce.

Our first story involves students working collaboratively and developing expertise in one problem area, defined by the students themselves. When they have made an animation movie on the theme, they share what they have learned with a bigger audience. An atmosphere of individual responsibility and communal sharing has been created. They also develop a community of discourse, in which *"meaning is negotiated and renegotiated as members of the community develop and share expertise. The group comes to construct new understandings, developing a common mind and a common voice"* (Brown et.al. 1994:200). The activities are realistic, but they are still school tasks abstracted from the community. They therefore reflect the concept of practice fields. Again, we do not think that one of the designs is better than the other. Rather it is two designs that fit different kinds of school activities.

One can say that the use of ICT opens for more variation and differentiation. It makes it easier for the teachers to let the students investigate different sources of information and use it for their own knowledge production. One of the main conclusions from the two stories is that it is not a simple technological application that is the most important in order to stimulate the students learning process, but an integrity in the learning environment with the different resources and methods. In the examples presented the use of technology is an integrated part of the pedagogical processes, and therefore work as a support for a student centered vision on learning and teaching.

We have also tried to show the consequences new arenas for negotiations can have for the students learning process and knowledge construction. As many other studies have shown (for example Ludivgsen, Arnseth & Østerud, 1998, Flo, 2001) the students motivation towards the subject content and the school as a learning arena increases considerably. The use of ICT makes it possible for the students to operate more independent. The essential features of these stories are what one can call a deeper academic insight. The combination of a different pedagogical method combined with the use of ICT gives the students a deeper input to the subject matter. The students themselves express that it is easier to remember the content, that different principles get more understandable and it is easier to see the connection between different knowledge domains.

Some of the schools and teachers in Norway report that their students academic level have dropped as a result of an increasing use of ICT. But the technology is then usually used as an advanced machine for typing, calculation or searching. The computer-use dialogue structure is relatively ´close´ and directive. The stories in this paper show that knowledge has another meaning for these students, because it is within the totality that ICT function to enhance the students learning progress. Activities, tasks, understanding and knowledge does not exist in isolation, they are a part of a broader system. Knowledge is therefore gained in co-construction with other learners. One of the most effective ways of using computers for teaching and learning is through activities that integrate the instructional and supportive involvement of a teacher with software expressively designed to elicit discussion and

opportunities for pupils to work together without constant teacher supervision (Mercer & Wegerif, 1999).

Knowledge construction is a central concept in this context. In the first story this was made explicit since the students had a role were they themselves defined the sources for information, and as a result constructed the knowledge. The importance of students presenting their projects was emphasized in both the stories. The students have to know the task they are working on well to be able to present it for others. The use of ICT, as we saw in the last story, also implies that the students get experience with publishing information on the web. In this way, they get involved in sources of information that are made available.

Another thing is how the use of different software are helping the students to organize information in files, folders etc. The technology gives the students an opportunity to share files, project assignments, questions etc. to other students, teachers and people outside the school. In this way knowledge is included in new and expanded learning communities.

One can understand the consequences of such technology-oriented environment on three levels. First it is consequences on the personal level. The students we have talked to express that they have positive experiences of working in open learning environments and working with the resources the technology gives. School and learning have another meaning for them, even though it varies how well the students handle such a position. Secondly, when the students use different cultural artifacts, they can take in use their cultural competence in other areas than earlier. The students thus get an extended comprehension of knowledge. Thirdly, it is consequences on the academic level, which is the students' acquisition of academic content. In both of the stories we have seen how the academic content is defined as interdisciplinary, where knowledge is problem-based.

The challenge now is to create more open learning environments, what Jonassen and Land (2000) call "open-ended learning environments, which makes it possible to implement student-centered learning. The challenge is first and foremost to develop flexible and open learning environments of good quality based on the recent years development of learning theory, and not allow the technology to set the standards. The students are then reaching out beyond traditional learning and individual knowledge construction.

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