

OECD/CERI ICT PROGRAMME

A Case Study of ICT and School Improvement at

Røyse Elementary School, Hole

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1. Overview

Røyse Elementary School is located in Hole, a small rural community. The educational innovation is based on a project-based learning approach supported by a highly flexible, wireless ICT-network.

The headmaster of Røyse Elementary School had a central roll in the development of the ICT strategy for the community and the key person in implementing the educational reform at the school level.

The reform at Røyse Elementary can best be described as a Project Based Learning approach - a teaching and learning model that focuses on the central concepts and principles of a subject, involving students in problem-solving and other meaningful tasks, allowing students to work autonomously to construct their own learning, and culminating in realistic, student-generated products.

The stories of the teachers at Røyse Elementary School indicate that innovative technologies to support

collaborative knowledge building, coupled with training and support, serve as a catalyst to changing teacher practices.

If the new tool is to be efficiently utilised, traditional instruction and lecturing has to be eliminated. This principle, together with Reform 97, which demands more project-based learning and less lecturing, initiated a fundamental change in teaching. (Principle)

However, a very important issue for the initiation and continuation of the program, is the fact that the innovation is anchored in new perspectives on learning and instruction, and not in the technology per se. The headmaster referred to The National Curriculum, which partly focuses on themes, projects, or problem-solving activities that may draw on an interdisciplinary base of knowledge construction, as a basis for changing the school policy. In this respect, The National Curriculum plans (L97) were used as an important supporting document for reorganising the school program.

The new approach at Røyse Elementary requires changes in teachers' instructional practice, their relationship to the curriculum, and the role they play in the classroom. The whole learning community has considerable insight when it comes to defining the curriculum and appropriate instructional activities that can push the community's pursuit of knowledge further. However, the reform is mainly visible at the structural level: the flexible timetable and the flexible organisation.



Fig. The classroom is converted into a studio.

The profound changes in instruction and curriculum transform the social interactions among the members of the learning community. Teachers, who, in the past, had worked only within a specific class and assigned subject areas, interact more with their colleagues and expand their curriculum content.

The 2:1 student/computer ratio and a wireless network give the students and teachers almost unlimited access to ICT power. The research team expected that operation and maintenance of the ICT network would be described as a difficult uphill battle. However, this was not the case. The reason why operating the ICT platform turned out so well seems to be the "bubble of support" that surrounded the initiative and the fiscal and technical assistance that came with that involvement.

Most important in this case study is that the project based learning approach merged with powerful ICT network resources. This provides an arena for reflection on computer-mediated activities and learning. This part of the project is still at an early stage.

The Norwegian school structure and system

The school sizes in Norway vary from schools with 50 students or less in the rural areas to 600-700 students in urban areas. The explanation for these differences is the geography. Norway has a beautiful nature, but it divides the country with deep fjords and high mountains. Thus we have a decentralised population and this is reflected in school sizes. In rural areas the school will often represent a social meeting place for the community. The education is free of charge the first ten years. The expenses are covered by taxes.

In 1997, the starting signal was given for a national reform called Reform-97. The Reform-97 introduced ten years of compulsory school, from the age of 6-16 years. This meant a new milestone in Norwegian school history. After ten years of compulsory education, youths in our country have the right to achieve three further years of education. Thus we can say that youths in Norway remains in school for at least 13 years.

The 10-year compulsory school is based on, and consolidates, the principle of "one school for all". The compulsory school must, based on the same curriculum, provide equal and suitably adapted education for everyone in a co-ordinated system of schooling. Everyone has the same right to education, regardless of economic background, race, sex and language. This required that the schools spend time and resources in order to educate all sorts of students, including those with special needs. Reform 97 also clarified what methods the Ministry wanted to see more of. Certain parts of the teaching are organised thematically. The themes can also provide a basis for project work. The projects can be carried out in the school or in the local community. As long as local reforms initiated by a school or a local school authority do not interfere with the basic ideas described in the national reform, the schools can create their own profile.

2. The past

Røyse Elementary has 7 grades and 137 pupils (age 6 – 13). The 16th of October 1995, a large-scaled ICT strategy plan for the municipality of Hole was ratified by the local political assembly. There is a number of important macro-level factors contributing to the reform. The innovation was based on an ICT enforcement for the municipality. The restructuring was originally carried out by a few people who managed to integrate the national educational reform into the ICT strategies of the local community. The background documents reveal analysis, which formed a solid basis for a wide reaching and ambitious decision. Numerous arguments in favour of an ICT enforcement were presented.

The reform processes put into practice give evidence of a co-operative attitude and approach on behalf of different sections of the local administration. Four main ideas seem to dominate the reform work:

- The idea of modernising the municipality administration
- The idea of internationalisation
- The idea of a pedagogical reform
- The idea of implementing ICT in schools

When such ideas are brought together, it creates a foundation both for pedagogical as well as for general local development. It implies that the school is an integrated part of local strategy of development. The pedagogical reform and the ICT implementation are best understood when considered as a whole.

The starting point for the development was the ICT strategy of the municipality of Hole. The school was seen as one of five target areas towards the year 2000. In 1996, a rather comprehensive ICT strategy laid for the schools triggered a large-scale enforcement of the ICT standard. Primarily, the strategy dealt with a period of three years. Simultaneously, quite unlike standard procedure in Norwegian schools, a sum corresponding to 8% of the total budget was set aside for maintenance of the equipment and infrastructure.

The plan for the ICT work can be summarised in the following outline:

ICT goals	ICT strategy	ICT actions

Within this area of enforcement, we have the following goals:	To reach our goals, the following strategy has been chosen:	Specific actions necessary to achieve the goals in this area:
<p>No child should be a loser due to ICT development in society.</p> <p>Students should have the opportunity to be first in line when it comes to utilisation of ICT in learning.</p> <p>Teachers should have the opportunity to stay one step ahead of the majority of students within ICT areas that are relevant and important for learning.</p>	<p>Students will be offered the same sort of equipment at school as elsewhere in society, and be introduced to tools used in public and private business.</p> <p>The school will take advantage of the possibilities ICT offers in the effort to give students optimal learning opportunities, regardless of any disabilities, physical and psychological handicaps.</p> <p>Be able to collect information national borders.</p>	<p>Sufficient equipment, software and instruction for students and teachers.</p> <p>There is to be issued a plan for ICT teaching adjusted to the economy of the municipality and related to plan for ICT in Norwegian education.</p>

The principal has written the complete ICT strategy for the municipality of Hole, and he has also contributed to the development of the strategy for the schools. From August 1998, ICT technical staff were employed for each school as full time employees. These were to run the networks, as well as support teachers and students. The school has 24-hour access to the Internet, and is also connected to the local administration via Breeze radio link. The school's access to the Internet is channelled through a common web server, proxy-server, and a mail sever. CD-ROM-servers are installed in each school.

Røyse Elementary School has one computer room, and all classrooms are supplied with a small number of computers. The teachers are mainly supplied with laptops and a few desktops. In addition, the school is equipped with video projectors and a digital camera. An agreement with the local authorities secures the opportunity to hand over outdated computers to the municipality administration.

All computers have MS Office and Microsoft tools such as Front Page, Publisher and Project installed. Teachers', assistants' and students' competence is dealt with in a plan covering the autumn of 1998. The extensive local support has made it possible for each school to form its individual strategy. Courses have been related to practical situations.

3. The present

In the wake of the reform at Røyse Elementary School, many innovative changes that have been carried out, are now becoming visible.

- First, curriculum becomes for the teacher less a plan for achieving predetermined outcomes and more of an environment designed to enable knowledge-construction in a specified arena of discourse.
- Second, curriculum has less a focus on subject matter or content and more an emphasis on an environment designed around themes, projects, or problem solving.
- Third, we have seen an attempt to expand the learning communities.
- Finally, teachers and students roles have been changed.

Each of these shifts is examined in the following sections:

From a Plan to a Learning Environment

Prior to the reform at Røyse, the curriculum was based on a subject-oriented schedule with a fixed timetable for different subjects and a system of grades. A traditional view of curriculum depicts it as a plan for achieving predetermined learning outcomes. In a given course, students participate in learning activities that are guided by learning goals mandated for that course, usually in a specific sequence. By accomplishing the learning tasks for a few learning objectives every day, they build up sufficient knowledge and skills to satisfy the learning goals set by the curriculum.

In contrast, the new approach shifts the notion of curriculum from a *plan* for achieving predetermined learning outcomes to that of a learning *environment* designed to enable knowledge-construction in a general area of interest.

The traditional time schedule is replaced by working programmes providing guidelines and instructions for the student work. Students are free to choose when to deal with the different tasks, and they are free to decide about methods and whether they want to work individually or in pairs or groups. Some lessons are plotted into the programme by teachers, and some subjects are run in a traditional way (e.g. Physical education and Music). The extent of student freedom depends on age and maturity.

Learning outcomes are still a teacher concern, as revealed by teachers' statements about the kind of state-mandated curriculum coverage they were able to achieve. The difference, however, is that coverage of the curriculum occurs in a non-linear fashion. Teachers design a learning environment which contains all the elements of their curriculum, but which also gives students as much responsibility as possible in order for them to engage in their knowledge-building activities. In this way, they encounter the more traditional curriculum learning objectives on a need-to-know basis. As a teacher puts it, "students do what they *need* to do rather than what they *have* to do."

ICT and the learning environment

The changing perspectives on curriculum have a profound effect on the way ICT is being introduced. Computer-based activities are not set up as a separate subject or course. It is more an appropriate tool for planning a project by including information on the project web pages or presenting a project. ICT is used regularly. Approximately 50 % of the students use ICT on a daily basis. Learning ICT-skills by using the tools to present their project can best be described as "learning on demand".

The learning process takes place in context and on demand. Integration of work and the learning of ICT skills is grounded in authentic activities. The main supporting system can best be described as a process of peer-tutoring.

Curriculum Designed around Themes, Projects or Problem-Solving

Traditionally, the curriculum at Røyse Elementary School was subject- or content-based, particularly at upper elementary level. The sciences, social studies, mathematics, and language arts were all conceived in the curriculum as separate entities with their own unique type of knowledge and content.

The new approaches tend to cut through these curricular partitions and instead focus on themes, projects, or problem-solving activities that may draw on an interdisciplinary base of knowledge construction. Though none of these approaches require interdisciplinary study, they do open up an opportunity to do so. The typical classroom situation where all students learn the same content with the teacher lecturing to an entire class or where all students are working independently on the same schedule, will not work in this new classroom structure.

Project Based Learning varies a great deal from lower levels to upper levels. Activities also vary according to

teachers' definition of Project Based Learning. By looking more closely into the study program, we see that there are some examples of projects that allow the students to investigate an overall challenging question. Some of the studies may be labelled as an activity-based instruction.

Themes, Projects, or Problem-Solving and use of ICT

Teachers emphasise that ICT fits in with this methodology. Some attract attention to the restructuring and claim that it demands a flexible way of organising and accessing the ICT equipment. Learning is optimal when students are motivated and therefore the access has to be on demand. It is a goal that ICT is integrated and used as a tool in the students' learning:

At Røyse Elementary we feel that we have succeeded in making ICT available and in reorganising the learning environment. We see a relation between student responsibility and ICT integration. Students are free to choose between ICT and other available tools. ICT is to be used only if it is found to be the most suitable alternative. (Head teacher)

One may conclude from the study that learning about computers has been replaced with a wish to learn with computers. At Røyse, the computers are frequently used as tools to help teachers and students produce work, in other words, to use them as production tools. The main reason for focusing on these general-purpose tools is outlined in the documents describing the ICT plan:

Students will be offered the same sort of equipment at school as elsewhere in society, and be introduced to tools used in public and private business. (ICT - strategy document)

Most of these tools are from the office packages from Microsoft. Word processors, graphics and presentation tools like PowerPoint and FrontPages, are included in this category. A substantial part of the children's work using ICT involves using a word processor throughout a week. The ICT co-ordinator stressed that children are encouraged to use a word processor, rather than pen and paper, for drafting their ideas.



There is however, very little data that can help us determine what kind of effect some of these tools have on students' knowledge construction, reflective thinking or scaffold thinking. Some comments on these issues give us reason to believe that some tools do not significantly restructure and amplify the thinking of the student or the capabilities afforded by that thinking. Word processing does not restructure the task of writing. It does not provide an alternative formalism for representing ideas. Clearly, the ease of editing text makes the students less careful during initial composition, but we do not know if this makes them more creative writers. The teachers stated that the students are more motivated and proud of their work than earlier.

On the other hand, the teachers also stated that it is difficult to maintain handwriting skills when most of the text production is heavily supported by ICT tools.

Draw and paint packages represent a rapidly growing class of tools that allow the student to present ideas visually without the artistic skills required to produce original illustrations. These tools can help students interpret and automate some of the manual processes for creating images. Most of these tools are *special-purpose draw and paint* programs used to help learners understand and express ideas in geography, metrology, chemistry and physics. In the case of Røyse Elementary School, clipart libraries containing the *general purpose draw and paint* programs, are available to the students.



Drawing made by pen and pencil Drawing made by a paint program Drawing made by clipart

In spite of the diversity of content, almost every business presentation with PowerPoint in the nineties used the same drawings from the clipart library. This is also true for some of the material inspected at Røyse. What we lose and what we gain is not always easy to say when we focus on affordances of a tool (i.e. what it enables the student to do). The clipart library may not emphasise personal and aesthetic expressions. It is difficult to evaluate the effectiveness of visualization tools outside the context of the project in which they are being used.

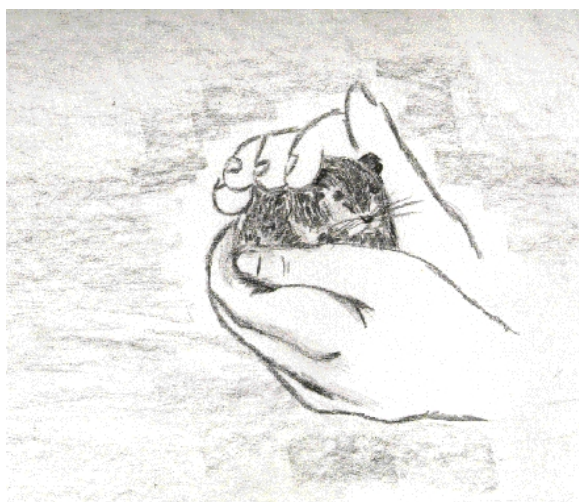


Fig. My pet.

Apart from focusing on the production tools mentioned above (Word, PowerPoint), the students use the Internet when they work on themes, projects, and problem-solving. Although the 2:1 student/computer ratio makes it possible to use the computer all the time, the teachers encourage the students to use different types of media. Internet is not always the first choice. The teacher also uses other instructional strategies that allow students to work on different learning activities simultaneously during the project period.

With many of the projects at Røyse, the teachers and the ICT-coordinator provide links or relevant information on a web page to guide the student's work. In this respect, the student is exposed to the worldwide hypertext system that presents text and multimedia resources with embedded links that support non-linear reading. The reason the teachers embed these links is that there are so many interesting topics to explore and it is so easy to do this that students often become off-task, following links that take them away, rather than towards, their learning goal.

The screenshot shows a Microsoft Internet Explorer window displaying a web page titled "FORFATTER". The browser's address bar shows the URL "http://www.royse.gs.bu.no/forfatter.htm". The page content includes:

- Forfattere** (Authors): A list of names including Torbjørn Egner, Klaus Hagenrup, Anne-Cath. Vestly, Alf Prøysen, Roald Dahl, Astrid Lindgren, Thorhild Thorstad Hauger, Søren Lund Kirkegård II, Eirik, Mette og Phillip Newth II III, and Tor Åge Bringsvær.
- Figurer** (Characters): A list of names including Ole Brumm, Albert Åberg, Kurt, and Harry Potter.
- Linker** (Links): A list of links including "Barnebokforfattere i Norden", "Gyldendal, forlag", "Grøndahl, forlag", and "Boknett".
- Bibliotekressurser** (Library resources): A list of links including "Tønsberg", "Bergen", "Lesenett - Østfold", "Biblioteksentralen", and "Nettskolen".

The main text on the page reads: "I uke 38 og 39 skal 5. og 6.klasse gjennomføre prosjekt **FORFATTER**. Hva det betyr skal du som elev være med å bestemme. På denne siden finner du mange nyttige ting du kan bruke. **Men husk: Det er ikke bare på Internett man finner svar. Det er minst like viktig å bruke bøker, og din egen fantasi!!! Fantasien er kanskje viktigst!**"

The page is divided into two sections:

- 1. Idemyldring** (Brainstorming): "Vi starter prosjektet med å ha en idemyldring der vi vil få fram alt dere tenker på når dere hører ordet **FORFATTER**."
- 2. Lage grupper** (Forming groups): "Når vi har hatt idemyldring skal vi sortere alle forslagene, og lage grupper som dere skal melde dere på. (Kanskje en gruppe vil skrive en bok, en annen intervju en forfatter. Hvis noen vil finne ut alt om en forfatter kan de gjøre det)."

The browser's taskbar at the bottom shows several open applications, including "Røyserap 0.4 - Micro...", "UKrevised - Microsoft...", "Outline for reports on...", "Min datamaskin", and "Lv på 'TorHome' (H.)". The system clock shows 19:30.



Fig. Project introduction on the web.

Fig. Internet is not always the first choice.

Many projects conducted at Røyse are presented on the Internet (<http://www.royse.gs.bu.no/prosj.htm>). Teachers or ICT coordinators mediate most of the project reports, edit the text and present it on web pages. A few examples demonstrate that students have full responsibility for collecting data and making a hypermedia

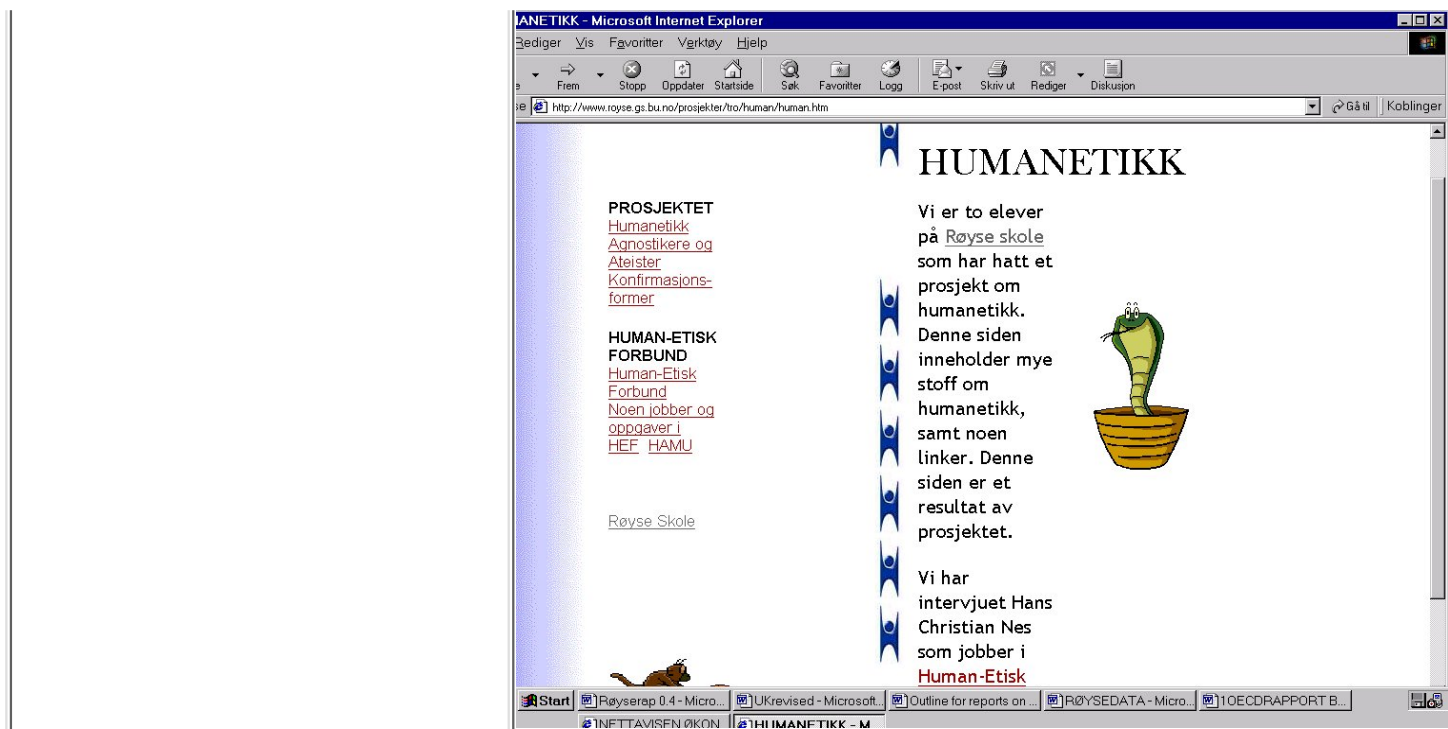


Fig. A group of students working on a project on diseases.

Fig. Students working on the subject of different denominations. What does the discipline of humanistic ethics represent ?

The screen design can be judged on the basis of how the objects move around the screen, the unbalanced or balanced composition, whether or not the effects are distracting, the use and overuse of colour, objects or effects. By applying some of these criteria for evaluation of student hypermedia production, we have to say that learners as hypermedia authors are at an early stage at Røyse. It is necessary to have more information on how the students are coached during work.

The expanding learning community.

The curriculum in this case remains under constant revision, based on the current experience. There are several ongoing attempts to expand the learning community. A prime example here is a computer-supported collaborative learning project in English. The learning circles project facilitates collaboration among small groups of participants. Collaboration, of course, requires closer communication and is easier with a known audience than an imaginary one. Communication between students is supported by using synchronous conferencing, mainly the Internet Relay Chat (IRC). It provides for basic interaction through typed messages between groups of users. The asynchronous communication is supported by using electronic mail. In this first attempt at ICT-based collaboration, there was a British school at the other end of the communication channel. This is also the school that the students visited. The feedback from the students was naturally overshadowed by the overwhelming experience of staying in a British home. It is in hindsight therefore difficult to determine the real effect of ICT in this initiating phase.

The learning implications of the synchronous computer conference are very difficult to judge. There is not enough information to evaluate the quality of student messages. When the students communicate synchronously about an issue or a problem, we may only be able to evaluate the log file. We can use this to determine if student s messages are random, unrelated to task or issue, or if the student s messages are closely related to discuss, elaborate, modify, or comment on issue or task of conference. The only statement we have on this issue is that the synchronous computer conference is often used for social gatherings.

In the next phase, the collaboration group was expanded and the Internet took the leading part as mediator between the partners, the students and the teachers. The database developed on the Internet is a place for learning English for students in Hradec Kralove (The Czech Republic), Florence (Italy), Erfurt (Germany) and Røyse (Norway).

A contact seminar for teachers at the collaborative school was arranged at Røyse. The purpose of the conference was to start new projects between European schools. The theme of the conference was 'It takes a village to raise a child'. There were delegates from Austria, Belgium, Finland, Hungary, Slovenia, Scotland, Portugal, Sweden, Greece and Norway present. All the delegates visited Røyse Elementary School to experience a Norwegian school and to see how the co-operation between parents, the school and the local environment worked.

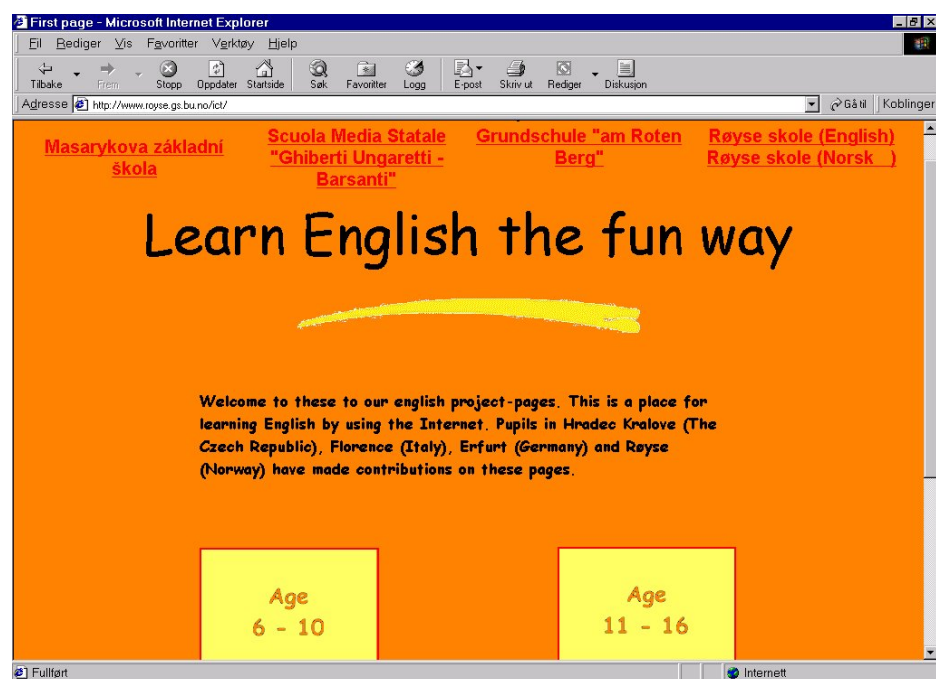


Fig. The collaborative portal for learning English

The collaborative schools are in a process of building a database to be used in teaching and learning English as a foreign language.

Based on the statement from our informants, there are reasons to believe that when students write for a larger, networked audience of peers, they are more motivated to perform than when they write only for their teacher's red pen.

Changes in Teachers' and Students' Roles

Almost 100 % of the students and teachers participated either formally or informally in project-based learning. When teachers change their instructional practice and their relationship to the curriculum, they also tend to change their role in several ways. First, we have seen a departure from the direct teaching approach in that teachers use less lecture and demonstration and act more as a learning guide or coach for students who pursue their own knowledge goals. Second, we have seen that teachers become involved in designing a curriculum that is more sensitive to student interests. Third, we have seen that teachers become less followers of curriculum as they take on the role of directors of curriculum.

One of the important changes reported by teachers was the change in the structure of classroom discourse. First of all, we have seen how several teachers characterise their teaching practice prior to the new approach as traditional, featuring the teacher's control of classroom discourse. For instance, classroom practice was characterised as highly structured. The "teacher-directed" component has been gradually reduced. Several

teachers particularly declared that giving students more choice, extending trust to students, and handing students more control over their own learning were key factors in transforming teacher classroom practice.

The approach to curriculum reported by the teachers, exemplified collaboration between all members of the community in the creation of curriculum. Teachers interacted closely with colleagues in brainstorming for curriculum ideas that would work well for their local community. Students were given responsibility in designing and elaborating some aspects of their own curriculum.

Perhaps the most obvious change noted by our informants was the change from teacher-directed classroom practices to student-directed learning. The change was expressed as gradual rather than absolute change. In fact, several teachers noted that there should be a place for direct-teach methods such as lecture, recitation, and independent seatwork as well, because these are ways to expose students to basic information. Some of the teachers reported having made changes in their teacher-directed/student-directed ratio. While other teachers did not speak of perceived changes in their instructional practice, specifically in terms of "student-directed," they were clearly making a transition towards adopting increasingly student-centered approaches based on their statements about class organisation, curriculum development and instructional procedures.

The following statements are paraphrased from teachers and students at Røyse Elementary School by asking about project-based learning approaches (Perspective on innovation/improvement):

Benefits Described by Teachers

- Students are not dragged away when working on the project.
- Students seem to like it whenever they are given real responsibility and control.
- Realistic self-assessment is very meaningful to students, especially when their performance is evaluated in terms of results or the reactions of the public.
- Students who have withdrawn or are sullen begin to participate, slowly at first, then with great enthusiasm.
- Students' interest and self-confidence is carried over to other activities.
- The element of risk-taking pays off in heightened student feelings of self-esteem.
- Students become more connected to the community and more aware that they can make a difference.

Problems Described by Teachers

- A demand for more extensive student freedom, which forces us to endure more noise, activity and disturbance.
- A lack of group and class feeling created out of common activities and experience.
- Missing the role of the storytelling teacher.
- Within a Project Based Learning unit it can be difficult to collect evidence that students have attained the stated objectives (or have learned something of value related to the curriculum).
- I'm afraid that students spend most of their time carrying out activities (e.g. drawing, labelling, constructing) that are frivolous or that do not represent new learning.



Benefits Described by Students

- We may choose what to work on.
- We learn that we can make a difference.
- There is an audience for the product, and we know we have to meet the deadline and present it to the audience.
- Everyone felt needed and played a part. Nobody is left out.
- We didn't need to use our texts, and we were actively doing things and learning something.

Problems Described by Students

- Sometimes it is too much.
- I want to have more English lessons.

4. Main Hypotheses

4.1 Hypothesis 1

Technology is a strong catalyst for educational reform, especially when the World Wide Web is involved. The rival hypothesis is that where true reform is found, technology served only as an additional resource and not as a catalyst, that the driving force behind the reform was also the driving force for the application of technology to specific educational problems.

Evidence in support of hypothesis 1:

- It is obvious that implementing ICT was used as a major incitement to change the character of instruction and teaching. Available documents show clearly that use of new technology makes traditional lecturing in classes impossible. Together with the Reform 97, which gives schools a higher percentage of project-based teaching, this formed the motivation to change teaching fundamentally.
- Extending the learning community beyond the geographical borders of the school is hardly realistic without access to some sort of information network.

Evidence in support of the rival hypothesis:

- The innovation is anchored in a project-based learning approach.
- Surprisingly many of the projects are run without any ICT support.
- The use of ICT is mainly a tool for production and presentation.

This means that in the case of Røyse, it was partly a planned change, and the implementation of ICT supported the change. Surely, there exist additional resources besides the ICT that served the innovation, but the whole infrastructure of ICT is and will be the main indicator of this school's approach.

4.2 Hypothesis 2

The diffusion of the reform (and therefore of ICT) followed the traditional diffusion pattern for reforms and innovations, as outlined by Rogers (1995). The rival hypothesis is that technology functions differently from traditional innovations and reforms and that different diffusion patterns therefore occur.

The diffusion theory assumes that innovations only spread gradually through an organisation.

Evidence in support of hypothesis 1:

- The use of ICT applications as a vehicle for meaningful learning, knowledge construction and reflective thinking, seems to follow the traditional diffusion pattern.

Evidence in support of the rival hypothesis:

- Because there was close to a 100 % agreement among the staff to participate, they could all together be labelled innovators or early adopters of this reform. This is far beyond the predicted rate of participation according to the Rodgers model. We attribute this high rate of participation to the fact that the major changes of project-based learning approach could not be implemented gradually.
- Staff training was organised to prepare teachers to use the network: when the PC network was installed, the ICT coordinator provided training for all staff. An informal weekly drop-in session provides ongoing opportunities for staff to raise questions and improve their ICT skills.

4.3 Hypothesis 3

Successful implementation of ICT depends mostly upon the technological infrastructure and student ICT competence rather than upon staff competence in the integration of ICT into instruction. The rival hypothesis is that teachers mediate such applications when they are successful, and that their academic value relates positively to teacher competence.

Evidence in support of hypothesis 1:

- Successful implementation of ICT application used as production and presentation tools depends mostly upon the technological infrastructure and student ICT competence.

Learning to use applications like Word or PowerPoint can best be described as a process of peer tutoring based on learning on demand .

Evidence in support of rival hypothesis:

- That teachers mediate ICT applications as a vehicle for meaningful learning, knowledge construction and reflective thinking will relate positively to teacher competence on designing an ICT-supported learning environment.

Coaching of students intentional information search, collaborating with the students in the knowledge construction process of a hypermedia production, helping students use ICT based visualization tools to understand and express ideas that they otherwise might not be able to, helping students comprehend, store and retrieve information in a database, coaching the construction of a semantic network, performing a conversation analysis of a chat-room, understanding success or failure of ICT-supported cooperative learning all this is accounted for by entirely different and far more complex factors and can not be labelled as technical ICT-skills in use and application.

4.4 Hypothesis 4

Gaps in performance between high and low poverty students will be enlarged rather than diminished where all students have equal access to ICT. The rival hypothesis is that equal access to ICT will lead to high poverty students closing the gap with low poverty students.

Gaps in school performance due to economic poverty has to our knowledge not been revealed in Norway, or at least not in the area where Røyse is situated. No one is unable to buy, learn or use ICT due to economic reasons. However, dynamic economic trends within trade and industry is about to create more of a class society with enlarged differences between the poor and the rich, but so far we are at an early stage in that process. ICT does give low-ability students the opportunity to experience success.

4.5 Hypothesis 5

Successful implementation of ICT will lead to the same or higher academic standards in spite of the low quality of many ICT materials. Academic standards are a function of teacher and school expectations and not of the standards of textbooks, ICT materials, and the like. The alternative hypothesis is that ICT use will lead to a lowering of academic standards as students spend more time on marginally beneficial searches and in browsing poor quality Web and courseware content.

Evidence in support of hypothesis 1:

- The use of ICT as a tool for presentation and production will lead to the same academic standards.
- The school saw evidence that students with special educational needs benefited by using some of the ICT production and presentations tools.
- Time spent on tasks such as hypermedia production or computer art do not lead to a *lowering of academic standards*, but the students learn something else. In some cases the extra curricular activity is unintentional.

It might be that ICT tools, if they are powerful, serve *different* rather than the *same* ends. In this case it is possible to put forward a new hypothesis:

The greater the difference between a learning environment and an ICT-supported learning environment - the greater the diversity of outcomes that can be attained.

5. Projection to the Future

We have presented a school with an open-minded attitude, willing to experiment and learn, and not afraid of failure. The reform at this school appears sustainable because of the project-based learning approach shared by the school's teachers. This is particularly related to the organisational models which one hopes to improve. The next step would then be to change the teachers' agreement on working hours: According to the headmasters:

The working day is not going to be limited by the individual teacher's scheduled time in the classroom. A flexitime agreement for both teachers and students, including working hours, spare time and holidays, has to be set up.

However, there is some adjustment in the curriculum designed around themes, projects, or problem-solving.

The process of transforming into new methods of teaching has revealed that students are in need of basic skills. These are skills like reading, writing, calculation and English.

We are working out specifications of demands within these skills. It will probably be made as a progression plan for the youngest students and as a list of levels for students in 5th to 7th grade. These specifications will also include social goals. (Principal)

The role ICT plays in supporting the project-based organisation sustains this reform in the flexible nature of the ICT network. The teachers' laptops and wireless network lend a high degree of flexibility to the arrangement that teachers found contributed to the students collaborating in groups and to different students being able to work on different tasks.

However, the role ICT can play in supporting learning, needs to be elaborated, e.g. coaching of students intentional information search, collaboration with the students in the knowledge construction process of a hypermedia production, helping students use ICT based visualization, coaching students to comprehend, store and retrieve information in a database, coaching students in ICT-supported collaborative learning environment.

For instance, when evaluating how students use the web, it was not possible to observe how they articulated their need for information and their intentional search on the web to fulfil that need - for example when a student says, I am looking for information to help me answer a question, build my own knowledgebase or evaluate someone else's ideas .

A plan for meeting some of these challenges has just been set up:

We are planning communication and information courses for teachers and students. Unfortunately, these have so far not been effectuated. Ideally they should have been arranged in relation to a project or a theme work where choosing and evaluating sources of information are critical skills. (Planning document 2001)

A problem in transferring this reform to other schools relates to necessary funding for ICT support in project-based learning. However, *The Learning Organisation* can serve as both a metaphor and a model for a human community that has evolved to institute organisational practices. The ability to learn as an organisation has been described as the only sustainable advantage. In this respect, the problem of transferability is a problem of organisational changes.

Appendix A- Røyse

The Norwegian research team:
 Assistant Professor Lars Vavik
 Senior Research Johannes Johannessen
 Senior Research Marianne R. Notland

This team visited three schools in different areas in Norway. The time spent at Røyse School was three days for the research + one meeting in front of the visit to organise the research.

At all three schools we used the Workbook Appendix C-H for the different interviews.

Most of the interviews took place within 50-70 minutes.

At Røyse school we interviewed these number of participants:

Teacher: 5

Student: 6

Parent: 2

Tech.int: 1

Adm.int: 1

Knowledgeable people outside school: 0

For observations inside and outside classroom we used Appendix J and K . In addition to these instruments we translated the appendix I in order to avoid resistance and misunderstanding.

We also produced a final form to collect all data from the Prac. Survey (Appendix I) and from this final form we have some graphs in the report. The average lengths(in Time) of the different interviews are:

Teacher: 50-60 minutes

Student: 40-50 minutes

Parent: 40-50 minutes

Tech.int: 60 minutes

Adm.int: 60-70 minutes

Knowledgeable people outside school: 0 minutes

Other supporting evidence collected at Røyse School (Appendix C):

Examples of : - Student, teachers and adm. work

- School newsletter

The homepage address is: WWW.royse.gs.bu.no/

In order to use a seeking function we wrote all the information in Word and gave each part of the interviews a code. Thereby we got the opportunity to compare the different aspects more easily when we worked with the five hypotheses.

Appendix I

OECD/CERI ICT PROGRAMME

ICT Practices Survey for Teachers

I. How comfortable are you with using a computer to do each of the following?

	very comfortable	comfortable	somewhat comfortable	not at all comfortable
1. Write a paper	12	2	0	0
2. Search for info on (WWW).	4	5	2	7
3. Create and maintain web pages	3	2	2	7
4. Use a data base.	3	5	3	3
5. Develop a data base.	1	3	3	7
6. Send and received e-mail.	7	5	1	1
7. Write a program	3	3	5	3
8. Draw picture or program.	2	2	5	5
9. Present information (ex. PowerPoint)	4	2	3	5

II. How important is each of the following computer-related skills for your teaching?

	very important	important	so-so	not important
10. Write a paper with word processor	11	1	3	0
11. Search for info on (WWW)	5	4	5	0
12. Create web pages	0	1	11	2
13. Use a data base	0	6	5	3
14. Develop a data base.	0	0	5	8
15. Send and received e-mail..	6	5	3	0
16. Write a program	4	2	3	5
17. Draw picture or program.	1	5	6	2
18. Present information (eks. PowerPoint).	0	5	3	6

III. During past school year, how often did your students on average do the following for the work you assigned?

	many times in the week	many times in the mnd.	sometimes	never
19. Search for info on (WWW)	6	3	3	1
20. Create web pages	0	2	7	5
21. Send and received e-mail	3	5	4	2
22. Write a paper with word processor	7	3	2	2
23. Use a computer to play games.	4	4	7	0
24. Use a spreadsheet.	0	0	5	9
25. Use a graphics program.	0	1	6	8
26. Join in chat-room	0	1	2	12
27. Use an instructional program	0	1	7	6
28. Use of simulator program	0	0	2	12

29. Other computer uses

30. How would you rate your ability to use a computer?

Good: 6, Fear: 6, Poor: 2

IV. Answer nr.31-38 based on experiences from the last school year.

31. Was student computer use ever evaluated for grading? No: 10

32. If you assigned WWW searching, how much freedom did you allow students in locating sites to visit? (

No restrictions: 1, some restrictions: 6, designed sites only: 1

33. Did you modify a Web site with any of your classes that you taught?

Yes: 1, No: 6

34. What portion of the computer use in your classes was directly related to the course content?

all: 0, most: 5, some: 5, very little: 2

35. What portion of the computer use that you assigned was done by students individually?

all: 0, most: 5, some: 5, very little: 2

36. How often did you use a computer at home for preparing teaching?

several times a week,	6
several times a month,	1
a few times,	5
never,	1
no computer	

37. Did you participate as a student or instructor in a virtual course through the Internet/WWW?

Yes: 5, No: 8

38. Did you involve your students in collaborative learning over the Internet/WWW?

Yes: 6, No: 7

39. Are you currently using technology to collaborate with other teachers (chat-room, or the like)

Yes: 7, No: 6

40. How many e-mail messages do you send each week on average?

more than 12:	3
6-11:	2
1-5:	8
None:	1

V. How many of the following have you ever done!

	often	sometimes	never
41. Made changes to a computer hardware	3	3	8
42. Updated an application program (Word processor, graphics)	2	2	10
43. Recovered a damaged file	2	8	4
44. Created a web site.	4	1	9
45. Developed a database.	1	3	10