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The Case of Norway

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1. The importance of computers: To have or have not?

Since the late sixties, computer skills have been seen as an important resource in the labour market. To qualify for the use of this new technology stood out as a major challenge to the educational system. In the last decade, the computer and its qualities has become more and more important in the discourse about schooling and training. To provide computer skills has become an education policy requirement. The current uses of personal computers as gateways to explore the potentials of multimedia technologies has reinforced this view, while at the same time radicalised the potential of this technology to provide a basis for a transformation of teaching.

Compared to previous machines, like typewriters, gramophones, tape recorders or television sets, the personal computer with multimedia capabilities displays some important similarities. It is commonly found in many households, even if it seldom appears as an education tool. Skills required to use it are more commonly developed at home than in schools. Also, the educational potential seems much greater in theory than what is realised in practice.

Of course, the uptake of multimedia in education belongs to a well-known set of problems related to social shaping of technology and the introduction of new artifacts in society (Williams & Edge 1996). We know that technologies often diffuse slowly, that critical decisions about social configuration have to be made, and that user constituencies may need to be persuaded to find a new technology beneficial. However, compared to mainstream technology studies (Bijker, Hughes & Pinch 1987, Latour 1987, Bijker & Law 1992), a study of multimedia in education offers a very interesting opportunity to analyse how technology is integrated into a large, mainly public, social system. It is a way of providing better insight in the way that technologies are appropriated in complex, multi-layered social institutions, in particular about the construction of new practices in relation to conventional ways of acting and arguing.

Consequently, this paper is an effort to explore some strategies of integrating multimedia personal computers in the educational system. This integration may be perceived as an effort "from above" to *regulate* the role of

multimedia in the education system. This refers to the need to construct aims, strategies, standards and practices that put this new technology to use, not only as an educational tool but just as much as a needed skill. Thus, here, regulation refers to public sector efforts to influence, facilitate, standardise and/or restrict the use of multimedia. In principle, the multimedia challenge to the education system is to initiate use, provide machines as well as software, and above all to stimulate discoveries of new multimedia-based teaching and learning practices. This could be seen as an issue of shaping and implementing policy "top-down", but also as constructing a system of social learning to cater policy needs.

However, we do not think that this is a sufficient perspective because it places too much emphasis on the constituency of policy makers in education. In line with the approach of the Social learning in multimedia-project, we will focus on broader processes of social learning, in particular related to regulation (Sørensen 1996). Thus, we are also concerned with the way practices are constructed "from below", thus exploring the possibilities of strategies "bottom-up" and systems of social learning emerging among users.

Consequently, the paper is an effort to analyse the emergence and characteristics of different strategies of social learning related to multimedia in education, in view of the need to communicate insights and experience. To do this, we will examine the system as a *learning economy*. This way of thinking highlights the way that producers and users interact and exchange experiences and ideas, an interaction that may provide a basis for learning to produce as well as to use technologies more efficient and beneficial (Andersen & Lundwall 1988). The notion of producers may be less relevant to systems of education, but this way of thinking may be just as important to an analysis of interaction and learning between the different groups of actors in education: policy-makers, administrators, teachers, etc. This may mean that we find different processes of social learning in the education system, perhaps even smaller sub-sets of learning economies, for example between teachers at a given school.

We believe that such analysis may be facilitated by the use of an approach where one study appropriation of technologies like multimedia as processes of *domestication* (Lie & Sørensen 1996). To be put to use, multimedia needs to be domesticated at different localities of the education system. Social learning happens when the outcomes of this domestication process result in new ways of using the technology as well as when the experience is communicated. Here, we are particularly interested in the communication process and its discursive structure. May we observe exchange of information between the actors of the system, and what kind of information is flowing?

We will emphasize that the relationship between actors and localities has to be examined. Even if there is a formally defined hierarchical relationship between them, we do not make assumptions of, e.g., the existence of efficient top-down strategies. The point is to break away from either determinist or rationalist assumption, from either the view of technology as an imperative that

will come through or the view of technology as something implemented according to social planning.

Of course, as we shall explore in some detail, multimedia technology has been brought into national education policy discourses. However, we have to be sensitive to the possibility that this technology is introduced in an independent manner in other localities as well. Multimedia technologies have not been developed according to some overarching plan, but are in fact brought into Norway as tools that in many respects are ready-made. Thus, there is no need to give policy makers a priori privilege as the main shapers of multimedia in education.

Domestication implies, metaphorically, the taming of a new artifact or a new set of knowledge (Lie & Sørensen 1996). Originating from the study of the way households make sense of technologies (Silverstone & Hirsch 1992), it has been developed as a tool of analysing the production of routines as well as the meaning related to technologies in everyday life (Lie & Sørensen 1996, Sørensen, Aune & Hatling 1999). This means to analyse three dimensions: the practical, the symbolic, and the cognitive. These dimensions have different implications in different localities. In the classroom or by teachers and students, we should be concerned with the ways a given technology is put to use, the related attribution of meaning, and the learning needed to achieve this.

In the context of policy making, practice is not just related to ideas about how the technology may be used. In addition, an infrastructure has to be brought forward, policy makers have to develop a division of labour between different sets of institutions, people, and competences, and they have to provide guiding visions of the achievements one could expect of the new technology (Dierkes, Hoffman & Marz 1996). These are potentially important dimensions of the regulatory activities required, and thus possible of objects of learning by regulation (Sørensen 1996).

From this mindset, our analysis of the use of multimedia in education will be furthered by studying the following problems:

- What are the main features of the policy view of multimedia and the political tools that are applied in order to implement this technology in the Norwegian primary and secondary education system?
- What are the main features of national, regional and municipal planning regarding multimedia in primary and secondary education and of the related social experiments to explore and promote multimedia technologies?
- In particular, we are concerned with multimedia in individual schools. How do school managers and teachers engage in multimedia? How are local strategies of applying the technology constructed? To what extent and in what manner may multimedia be appropriated by individual teachers, and how do they relate to the potential of the technology in relation to teaching?

Thus, the analysis of multimedia will take us through a cross-section of the system of education. The underlying idea is that multimedia in education is used in ways that are shaped through the interaction of people and institutions at all levels in this system. We should not assume that this shaping takes place only in the Ministry or only in the classroom. In principle, all localities may prove to be important.

In our paper, we have used the Norwegian system of education as a case. Of course, we cannot claim that Norway is typical in any way. However, that is not the point. Our main concern is to identify interesting strategies and constellation, to use them as the basis of conceptual development, rather than outlining the typical or most common strategies in this or that circumstance. Also, we want to show how domestication of multimedia needs to be studied through a multi-local ethnography in order to map out the complex interaction of actors and institutions in the shaping of this technology. In order to do this, we have chosen to analyse different strategies that may be observed regarding multimedia in the Norwegian system of basic education.

The paper is based on analysis of relevant policy documents and interviews. 12 teachers from 9 different schools have been interviewed. This includes primary and secondary schools, covering the age group from 6 to 18.² Also, we have talked with two informants from the National Centre for Educational Resources.³ A few administrators and representatives of teachers' unions have been interviewed as well.⁴ Reference is made in the text to indicate the nature of the source that provides the basis of observations and arguments. Even if different sources of information have been combined, our study is of course limited by the rather small number of institutions and individuals that has been approached. Thus, we do not claim to have produced a complete study of multimedia in education even in Norway, although if we believe our observations offer some general insights into the Norwegian situation

The reader should also note that we do not study multimedia in the form of specific, advanced experiments where interactive combinations of pictures, sounds, and texts are performed. Rather, we look at multimedia as an aspect of computers that has been added to the traditional potentials of this technology. This means that our analysis is based on an understanding of multimedia technology as something related to, and difficult to separate from, computers (Brosveet & Sørensen 1999).

2. Computer angst as a policy vehicle?

The structure and logic of national systems of education vary. In the case of Norway, primary and secondary education is funded and managed publicly. There are only a few private schools, and the majority of them receive substantial governmental support. Thus, the management of primary and secondary

education is a public responsibility. Standards are set by central government to ensure that the system of education is homogeneous. However, in practice, the system is characterised by a complicated system of division of responsibility and control between central, regional, and local government, and with considerable discretion of decisionmaking residing in the individual school and even the individual teacher (see, e.g., Lauvdal 1994, 1996).

This means of course that it is difficult to change the system in a short time, for example, by introducing multimedia technology into local curricula in a homogeneous manner. Central government may set certain standards as objectives, and they may even call for quite distinct didactic changes. However, the decision to buy computers resides with local authorities and the individual school. Concrete educational planning is mainly a prerogative of the individual school and teacher.

The situation presents very definite challenges of social learning. In theory, we should be facing a «learning economy». Since we are studying a hierarchically organised public sector with long traditions of learning by regulation, we would in fact expect to observe such linkages. On the other hand, there is no reason to expect that the learning economy of the education sector is well-functioning. As already indicated, the system in question is set up with considerable autonomy of the actors involved. We have a Ministry of Education, Research and Church Affairs (KUF) responsible to the Norwegian Parliament, that commands a set of regional offices of education, one in each of Norway's 18 counties. Each county has an education administration of its own, answering to the Fylkesting, and there is a similar arrangement in each of Norway's 435 municipalities. The number of schools, teachers, and classes is of course much too large to allow for close control by any administrative body. Thus, it is by no means obvious how this learning economy functions.

Even if the system of education is administratively segmented, there is definitely a national discourse on computers and multimedia related to the sector. This discourse is clearly shaped by the belief that information and communication technologies (ICT) is vitally important, to society and industry as well as to the individual citizen. The sector of education is supposed to help qualify young people for the labour market of the future as well as making them knowledgeable and skilful members of society.

However, politicians as well as citizens fear that the schooling system will fail to do so. One of the main diagnoses offered at the moment is related to computers and multimedia. Presently, it is a public concern that Norway may be lagging behind other countries in preparing its youth for the coming of the information society. This anxiety of falling behind, that the country may not provide sufficient skills for the "information society" could be called *computer angst* because the argument very seldom is grounded in any form of analysis. Often, it is just a response to some simple and not very meaningful numerical indicators, in particular the number of pupils per PC. The indicator does not place

Norway in a particularly favourable position, compared to other countries (Sundvoll & Teigum 1997).

Thus, the Norwegian discourse on ICT in education has been focussed on the physical availability of computers, rather than on multimedia content or teaching practice. This indicates a way of thinking that is influenced by technological determinism, a belief that access to ICT in itself will provide the educational value. Thus, neither policy nor plans are strikingly visionary. The general aims are quite vague, while the specific goals are mundane and down-to-earth. Pupils are supposed to learn to use word processing, spreadsheets, and information data bases, supposedly the most basic computer skills required in today's workplaces. This means that ICT is perceived as an object of instrumental skills, rather than a reform tool of education.

Lately, the ability to use the Internet has been added to the list of important skills,⁵ and there is an emerging awareness that ICT may become a tool to improve teaching. Still, the analysis of potential gains remains vague and the strategies to integrate multimedia in teaching are described in general terms.⁶ One might be tempted to conclude that the use of computers and multimedia is perceived as so obviously necessary that - in the policy discourse - no clarification of benefits is really needed.

The concern for availability of computers, measured numerically, has been sharpened by surveys that give evidence to substantial differences between regions, and even between schools in the same municipality (Sundvoll & Teigum 1997). A particular emphasis has been placed on the fact that many pupils, but not all, have access to a PC at home, and that boys on the average have better access than girls. Thus, once more, there is a strong call that the Norwegian school should take on its traditional mantle as «the great equaliser», the institution that is supposed to rectify inequalities created by differences in society. This concern for equal access to computers has meant that Norwegian policy for ICT in education to a large extent is shaped to provide for equal opportunities of skills in computers and multimedia.⁷

This does not mean that the ICT in education-plans made by the Ministry neglects other issues than equal opportunities. However, the plans suggest that the challenge of producing visions about how ICT may be used to improve teaching are left to the professionals - mainly the teachers themselves. The role of the Ministry is more of the overseer than of the inventor or innovator. On the other hand, it is not fair to argue that ICT policy for primary and secondary education is mainly driven by computer angst. Clearly, the fear that Norwegian education may fail to provide the needed ICT training has been prominent in the debates. To the extent that politicians have become engaged in pushing for greater use of ICT and multimedia in schools, the fear of lagging behind other countries and of producing new social inequalities have provided them with their main motives. On the other hand, most politicians are basically trustful that the system of education will be able to take care of the challenges. As far as we have

been able to observe, there has been no great interest among politicians to try to intervene in any other way reminding educators about the challenges. Thus, we need to study the features of this system more carefully in order to understand the way multimedia is being domesticated.

3. The learning economy of central government: Learning by plan and paper

A focus on processes of social learning related to multimedia in education may be sustained through an effort to clarify what we previously called learning economies. This implies a concern for the communication of ideas and experience between different institutions and groups of actors in the system. In this section, we will look more closely at the social learning practice of the Ministry of Education and the way it communicates to schools and teachers as well as the way it gets informed about current developments in practice. What are the strategies of implementing plans for ICT in education, and how are the plans evaluated?

The concern for computers in education is by no means a recent one. The Ministry of Education produced its first white paper on the topic in 1984, and this initiated the first programme to support experiments with computers in schools.⁸ 1998 marked the start of the fifth consecutive ICT programme.⁹ Thus, the Ministry has considerable experience in the area.

Interestingly, in the light of manifest technological changes, there has been considerable stability in the visions promoted by these five generations of plans. The computer has been envisaged mainly as an object to be mastered by pupils and students. Only recently, we may observe greater concern regarding the potential of ICT as a tool to improve the quality of teaching and learning. Above all, there has been no real concern that computers might replace teachers. Computers - with or without multimedia capabilities - are constructed as tools that may open up new educational possibilities, new strategies for teaching, but the potential has been assessed conservatively. The ICT challenge, as indicated above, is seen mainly as an issue of availability of computers and the provision of simple office-type skills, with a limited potential for improving the quality of teaching. Computers are not seen as a technology that might help transform primary or secondary education in any radical way.

Thus, the five generations of ICT plans represent a steady, but small-scale effort to make some basic computer skills a part of the core curriculum. For example, the central authorities never provided extra resources for investments in PCs. These investments have been funded through the ordinary budgets. This strategy of making investments in ICT a local responsibility is clearly expressed in a talk that the present Minister of Education, Jon Lilletun, gave early in 1998:

«Regarding the issue of possible governmental programmes to stimulate investments in equipment, particularly in primary schools,

it will be known from the documents that 'the matter is under consideration', as the saying goes. I neither can nor want to promise extra governmental funding for primary schools to buy computers. However, regardless of the outcome of the budgetary priorities, there is no advantage in waiting. My advice to schools and municipalities is therefore: Go ahead! Regardless of the size and timing of an eventual effort on the part of the Government to provide extra incentives, it will be modest compared to the needs we perceive. The new IT-plan under consideration will also have as a premise that the owner of the school (local or regional governments, authors' comment) is responsible for providing computer equipment".¹⁰

This strategy indicates clearly the indirect nature of the ICT strategy. The role of the Ministry is not to implement multimedia in education, but rather to provide a discursive framework for local efforts. For example, instead of providing extra funding, the Ministry has been concerned to establish training programmes so that teachers may learn about computers/ICT. There is also a small-scale effort aimed at providing them with proper software. Earlier, in the late 1980s and the beginning of the 1990s, the Ministry launched a major effort to develop a tailor-made system for Norwegian schools. The system, "Winix", was later abandoned and described as a costly failure. While the nature of the failure is still debated, the Ministry has later cautiously avoided any direct involvement in software development, even if some financial support is provided for outside initiatives.¹¹

In fact, the new curriculum plan for primary education, from 1st to 10th grade, has only passing references to information technology and multimedia, even if the technology is considered important. The matter is discussed briefly, following some short notes on traditional teaching tools and school libraries:

«The training shall contribute to pupils' development of knowledge about, insight in and attitudes towards the evolution of the information society and information technology. Pupils should acquire the ability to use electronic devices and new media critically and constructively, as practical tools in various subjects, topics and projects. Information technology should enable pupils to use domestic as well as foreign databases. Girls as well as boys should be stimulated to use information technology to counteract social and sexual bias in education».¹²

Clearly, quite traditional values and attitudes are frontstage in the curriculum plan, whereas new technologies are not.

Current plans for computers and ICT in education leave a clear impression that the Ministry's knowledge about the situation in Norwegian schools relies on rather standardised and quantitatively oriented written reports. It is regularly informed about the use of ICT in schools through large-scale national surveys (see Sundvoll & Teigum (1997) as a typical exemplar) and annual reports from the regional offices of education.¹³ They get statistical information about the

stock of computers in different schools (including teachers colleges), about the number of schools, municipalities, and counties that have plans for the use of ICT in education, about the number of training courses held for teachers, and how extra money has been spent through the ICT programme. The survey also tells about the number of teachers who report that they know how to use wordprocessors, spreadsheets, and the Internet.

This exchange of information could be interpreted as the backbone of a learning economy, but the Ministry has formatted its own social learning in a distinct way that we will term *learning by plan and paper*. Through its plans, the Ministry defines a set of topics and the relevant indicators. In this manner, the system of evaluation and reports that is established to feed the planning process shapes and limits the information made available to planners - and by implication - to politicians. While thoroughly rational in design, the resulting system of social learning is fashioned by the concern for availability of computers and does not facilitate exchange on issues of multimedia content and education practice related to ICT.

Learning by plan and paper is a concrete instance of learning by regulation (Sørensen 1996) and is shaped by the agenda-setting role of the central authorities. In the Norwegian case, the agenda of the Ministry of education is dominated by the following items:

- The need to mobilise interest and enthusiasm for ICT in the educational system. Thus, in the planning documents, we find many references to the importance of computer skills and to the importance of ICT in the future. In this kind of system, actors have to be motivated to do their part. To command, e.g., teachers is difficult and expensive.
- The need for teachers and administrators to acquire the skills required to participate in the implementation of the ICT programme. Many teachers do not know the first thing about computers.
- Political correctness plays a prominent role. The planning documents argue that the use of ICT in education should be compatible with Norwegian culture and values. In particular, equal opportunity issues are placed high on the agenda.
- It is emphasized that ICT initiatives should be compatible with traditional values of education in Norway. There should be no radical change through computers!

Thus, the Ministry's social learning through plan and paper is shaped by the need to address the above concerns, rather than by a more open explorative and experimental approach. In particular, the focus on issues like access to computers and equal opportunities has reinforced the tendency to produce mainly numerical indicators because they are well-suited for such monitoring purposes. From this perspective, the system provides a good overview, and it is made good use of in the planning documents.¹⁴ Arguably, learning by plan and paper represents - at

least in this case - a form of learning by regulation that is well adapted to the context of current Norwegian ICT and education policy.

On the other hand, such a system of learning by plan and paper appears to be ill suited to provide knowledge about new educational practices related to ICT. Such practices are difficult to monitor and analyse on the basis of crude surveys. A clear indication of this limitation is the abstract and non-consequential descriptions of actual pedagogical achievements made by the use of ICT. We are told that it is important to teach children how to use word processors, spreadsheets, and the Internet, and it is acknowledged that the multimedia computer represents an important resource to teachers. But what is achieved through the employment of ICT remains unclear. Examples of pedagogical gains are seldom provided. In general, the information about local processes of planning, learning and implementation in municipalities and individual schools in the Ministry's planning documents is sparse.

The Ministry's ICT programme supports experiments that are evaluated, as well as research projects that focuses on particular aspects of the programme, like equal opportunities for boys and girls (see, e.g., Håpnes & Rasmussen 1997). Through such contracts, researchers are hired to become intermediaries between the Ministry and the practising education communities. They provide supplementary information that, in principle, is a corrective to the deficiencies of learning by plan and paper described above. This may be described as another form of social learning; *learning by research and evaluation*.

However, if one is to judge from the planning documents of the Norwegian Ministry of education, this learning process is not so important. At least, there are few explicit references to concrete results, neither from Norwegian studies nor from international efforts. Thus, in this case, the role of researchers as intermediaries is not rectifying the above-mentioned weaknesses of learning by plan and paper. Still, the ICT plans compare favourably with the Curriculum plan¹⁵ in terms of concrete measures and analysis of the situation. Arguably, Norway has a tradition of using lean indicators as the basis of managing the education system from above. Detailed, qualitative information is probably perceived as relevant only to decisions made by other actors than the Ministry.

However, there is an important exception to this observation. During the early generations of the ICT programme, there used to be a unit within the Ministry that carried a special responsibility for computer in education issues. The *Datasekretariatet* («The computer office») generated a lot of experiments and even started its own software development (in particular the infamous Winix initiative). While the latter initiative contributed to the closing of this office, today, many of these activities have been delegated to the National Centre for Educational Resources (NLS).

Originally, NLS was established to aid schools to find useful tools for education and training. ICT and multimedia meant a modernisation of the concerns of the institution, but its previous functions meant that NLS was already

integrated in the Norwegian school system. The institution is managed by the Ministry, but since it is not part of the Ministry, it has a certain autonomy to act on its own in developing and implementing strategies to support the use of ICT and multimedia in schools.

NLS plays an important role in the shaping and implementation of the ICT programme, partly as an institution that oversees experiments and provides support, e.g., software development, partly as an advisor to other actors in the education system, and partly as a provider of information to the Ministry.¹⁶ Therefore, we have chosen to analyse the role of NLS in greater detail since this institution seems to be a particularly important intermediary. We will do this by focussing on two large-scale experiments that influence social learning of other actors in system and illustrates how the role of intermediary may be enacted. These experiments consist of two web services, the «School Net» and the «Guidance Net».

To summarise, the domestication of multimedia at the location of Norwegian education policy has resulted in a definition of this technology as an object of obligatory, instrumental skills, rather than as a reform tool of education. The Ministry has created an agenda where computers are focussed, and the effort to format local strategies are mainly directed towards the issues of access to computers and of providing competence to teachers. The resulting form of social learning, learning by plan and paper, provides a narrow perspective on the role of multimedia in education by focussing on crude numerical measures, rather than “thick descriptions” of ongoing activities.

Thus, the policy of ICT and education is formatting multimedia strategies in Norwegian schools to become conservative as well as open. It is conservative in its instrumental orientation towards skills like word processing and the use of spreadsheets and the Internet. It is open in the sense that the suggestions made about the use of multimedia in education are rather loose and non-directive. Arguably, the Ministry is leaving the issue of constructing educational multimedia to local initiatives, again with NLS as a possible exception. If this is the case, we would expect to find small learning economies at individual schools, with weak links to other schools or other parts of the system of education.

4. National experiments at a meso location: NLS and its web services¹⁷

The Internet has interesting qualities in its ability to provide flexible information. Thus, it is well suited to be an organism of social learning, a tool that facilitates, e.g., learning by interaction. Through the establishment of its web services, NLS has been able to situate itself as an intermediary in the process of social learning about ICT in education.

To begin with, one should note that NLS has been set up to inform about, supervise and certify teaching accessories. For example, textbooks to be used in

primary and secondary schools have to be approved by NLS. This means that NLS operates in several networks, like education policy, the publishing industry, and the school system. In this respect, it is an intermediary institution with strong links to relevant actors of the education system that enables it to mediate between policymaking and educational practice, between policymaking and the textbook industry, and between the textbook industry and schools.

We have chosen to focus on two initiatives that highlight the intermediary role in a very pregnant way, giving NLS a central role in the learning economy of the Norwegian education system. The first one is called the *School Net*. It is an Internet site for Norwegian schools provided by NLS. The target groups are teachers and other school-related professions, pupils and parents. It was "opened" on October 15 1996. The immediate purpose was to respond to a suggestion by The Ministry of Education to establish "electronic meeting-places". NLS, as responsible to develop and approve teaching aids for primary and secondary schools, got the responsibility to construct this new service. NLS had been engaged with computer issues for some time and had acquired considerable expertise in this field. They constructed Internet site that offered more than meeting-place functions. The School Net also provides information, documentation, discussion and advice on educational issues.

NLS had started to work with web technology a couple of years earlier, and they established their own homepage on the Internet in 1994. They had also been involved in the development and exchange of educational software as part of a Nordic group. This activity is still an important superstructure for the Norwegian School Net, even if the net is developing in country-specific directions. The Norwegian School Net has put a lot of effort into building resources to support the new national Curriculum Guidelines, "L97". Here, ideas about general education are transformed from written text into a world of electronic messages, pictures, sounds etc. It is considered important that L97 supports the abilities of pupils to manage these new complex symbolic ways of expressions.

An important function of the School Net is to support this development. NLS employees who are working with the School Net say that they want to make the access to electronic educational resources more democratic. The School Net is supposed to be a tool or a workshop for everyone. One of the goals is to be able to produce most of the content locally and in interaction with its users. In addition, useful links are to be offered. As the co-ordinator of the School Net states:

"One of our most important goals was to provide content for the schools, in keeping with the standards of the (the new reform programme) L97 (...) Nobody , when logging into the School Net, should have to be sent to another net site (...) We want our own self-produced content. It may be something that a teacher or someone else has found in the L97 (the reform programme), an

exiting new way of using the net, or other information about ICT applications. We want to distribute this information ourselves".¹⁸

Thus, the main goal of the School Net is to be a source of quickly distributed information, relevant to schools and teachers. It also aims to be a site for the mobilization of interest in the use of ICTs in school, a tool to develop competence in the management of electronic information and a forum for the exchange of experience and points of view. According to the director of NLS, the ideal is to combine new and old ways of developing tools for a good school, not losing sight of the merits of traditional ways of teaching.

Till now, the School Net has been developed mainly to cater for the needs of schools where the children are below 15 years of age. Their homepage¹⁹ provides an extensive set of information on many different topics. Under the headline of educational plans, you may, for example, download or order National Curriculum Guidelines (L97) for primary to lower secondary school. Further, you find documents that deal with theoretical and practical implications of these guidelines and the new educational reform ("Reform 97"), and the page has a lot of links to relevant documents and books. The user of the School Net may also find a quite pragmatic guide that is supposed to help the individual school to evaluate and select educational resources for the coming year. This is a co-operative effort of NLS and The Norwegian Publishers' Group.

Another set of items is related to teaching resources. Here is a very detailed overview of recommended books and other educational tools (software, CD-ROM) for each subject in every course offered. There are also exemplars of tools for teachers, like games or Internet addresses.

NLS has also established an initiative called the "Guidance Net".²⁰ This homepage is basically an Internet version of an existing physical guidance centre, located at NLS. It aims to provide actors within the school system with information, ideas and possibilities of consultation about ICT-related subjects. The administrator or teacher may learn about different agreements with suppliers of soft- and hardware, established by NLS or how to make plans for the use of ICT in their institutions. Here, one may find planning documents of the Ministry of education, but also plans made by many different counties, municipalities and individual schools. The homepage also provides information about ICT projects that are carried out in other schools, on an national level or even internationally. This information is made available so that one may learn how others perform planning and projects. In addition, there is an overview over courses one may take, relevant literature and self study books. Of course, one will also find a catalogue of software made and/or distributed by NLS as well as Internet addresses where relevant software may be downloaded, educational as well as technical.

It is not clear if the two experiments have been successful, but according to the two representatives of NLS whom we interviewed in June 1998, there were on the average 1600 visitors to the "School Net" per day. By the end of the year,

the number had increased to 3 000. Regardless of the notion of success, the two experiments represent an interesting effort to use multimedia as a technology to do information brokering and thus to stimulate a particular sort of learning by interacting. While schools, teachers, or developers of multimedia products have little direct interaction, these web-sites allow a simulated contact that provides an opportunity for exchange of experiences and information that - in principle - is very important. Through these experiments, NLS provides exactly a kind of intermediary function that should stimulate the learning economy of the education system. Arguably, the experiments support social learning that transcends the learning by plan and paper set up by the Ministry. The two web-sites work primarily as links between schools, but they have the potential to mediate ideas and experience between the policy level and the schools. Thus, the "School Net" and the "Guidance Net" are interesting examples of multimedia as a tool of social learning.

In our opinion, NLS and its two web-sites have not been set up as a conscious part of a learning economy of the Norwegian system of education. As far as we can see, the role of such meso level institutions is not well understood, even if they play an important part in making the system work. This exemplifies the neglect of social learning in developing policies, e.g., for ICT in education. Or rather that the Ministry believes that new ideas may be diffused through formal training of teachers, so that exchange of ideas and experience is superfluous.

On the other hand, the kind of simulated interaction performed through NLS' web-sites is clearly affected by the formatting of the field by the Ministry. For example, the exemplars of plans from schools that are made accessible through the "Guidance Net", are very much shaped by the concerns to make computers available to children and to provide standards for the integration of multimedia into the curriculum. The quite formal structure of the plans, clearly influenced by the Ministry's learning by plan and paper-discourse, is obviously a barrier to the exchange of more valuable information about concrete strategies and classroom applications. However, one may find traces of such information in some documents. Thus, the conservative formatting of multimedia policy seems to have definitive effects on the multimedia-and-computer-in-schools discourse in Norway.

While the role of NLS as an intermediary allows a shaping influence, in particular through the provision of information and the setting of standards for teaching accessories, it has to work in the policy environment formatted by the Ministry. Thus, the schools are largely left on their own in their selection of information and ideas and in their practical implementations. This means that we need to look at what schools and teachers do when they domesticate multimedia. Since the formatting from the Ministry is rather open, we should expect relatively large variations in terms of concrete practices.

This means that we expect that the learning economy related to the use of ICT in the Norwegian system of education is complex and consist of different, loosely connected processes of social learning. While the learning by plan and paper that has been set up by the Ministry may have a hegemonic position as the main supplier of information to policy-makers, this form of social learning is so weakly embedded in the local practices of schools that we have to assume that other processes of social learning are at work as well. The *learning by brokering* that is set up by NLS may be important, but only if is linked to local learning processes.

5. The importance of strategy: Tales of three schools²¹

In this section, we will discuss the domestication of multimedia in three Norwegian schools. They have been chosen because they illuminate difference in terms of availability of computers as well as strategies of education. However, none of them have many computers, and they do not take part in any computers in education-experiments, even if school B is a privately owned, religiously oriented school with a particular pedagogical tradition. We will analyse three quite ordinary institutions of education in Norway to see how they translate official policy into practice, and how they react to the Ministry's formatting efforts.

School A²² is an old upper secondary school with 55 teachers and 450 pupils. It has six computers that are available to teachers, while pupils share around 50 machines (partly with Internet access). The latter machines have been placed in special IT classrooms that are occupied by obligatory ICT teaching during most of ordinary school hours. However, in the afternoons and evenings, pupils may use these machines on their own.

Some of the teachers used Internet and had their own e-mail addresses, but e-mail had not been established as a common communication system. Still, the school offers ICT as a subject (like all higher secondary schools), but ICT is only to a very small extent integrated in the ordinary subjects. One of our informants argues that this is an outcome of the centralised localisation of the machines. The computer rooms had to be booked a long time ahead, and there are only a few free slots. Thus, chances for "spontaneous learning" are slim.

Our informants were not satisfied with the present situation. The financial situation of the school limited the potential possibilities, they argued. The amount of software available was too small, and there were far too few courses available to train teachers. One of them told us that he had organised some internal courses "last year" about Word and the use of Internet. These courses seemed to be offered by chance rather than as a consequence of planning. ICT support was not deemed satisfactory either.

None of the informants claimed to have an overview of the ICT situation of this school. Thus, there is a theoretical possibility that this school might have had a few enthusiasts that integrate ICT in their own teaching. What seems to be a major barrier to our informants to get this overview, is the lack of lateral communication between teachers:

"I would like to have an hour in the middle of the day, for co-operation oriented meetings between teachers, where we could exchange experiences".²³

What also seems to be missing is a systematic plan to train the staff and to provide aims and resources for the educational use of ICT in the classrooms. It seemed as if the use of ICT in teaching was delegated to the individual teacher. What you wanted to learn and how you wanted to use ICT, you had to find out for yourself.

School A has domesticated multimedia in accordance with the policy formatting in providing the obligatory ICT courses. Moreover, there was an emerging use of ICT as a tool for some teachers in preparing their teaching. The meaning attributed to computers was conservative, and the social learning strategy was quite individualised. The school did not, as far as we could see, interact with other schools, nor was there any effort to create any kind of internal learning economy among teachers.

School B²⁴ is a combined primary, middle and lower secondary school with 450 pupils and approximately 45 teachers. They have invested in seven multimedia machines, and the schools' policy is to make all pupils into personal computer users. In addition to the computers, they have bought digital cameras and projectors. This interest among the teachers started when the school needed a new encyclopaedia. Instead of buying these books, they decided to buy multimedia machines and get access to the same information through CD-ROMs. In other words, they were already working with ideas and plans before they got the machines. They managed to get the equipment by writing applications to different school programmes.

The school has developed plans for integrating ICT through planned training of pupils and teachers. In seventh grade, all pupils get a basic training in how to use computers. After having tried out different approaches, teachers chose to divide pupils into three levels when training them. The Norwegian school system prides itself in a long tradition of giving every individual equal education. Dividing pupils into groups according to their computer skills breaks with this tradition. However, the rationale behind the move was simply that there were substantial differences in computer skills among the pupils. If pupils unfamiliar with computers should have a fair chance to receive proper training, they would need to start with the basics. But then the more skilled ones would get bored and disturb the others, or press teachers to speed up.

When pupils have the required skills, they are left to themselves to decide how much they want to use computers. The machines have been placed in a lab

that is open to use whenever they need it. Pupils use the Internet and CD-ROM when collecting information in most subjects. They also use a word processing programme when they write essays or papers. Some of the language teachers also allow the pupils to use chatlines. They chat, e.g., on German chatlines when having a German lecture.

In this manner, it seems that this school has managed to integrate ICT in many subjects. They have a flexible use of the machines. Some of the machines are even made mobile by being placed on tables with castors. In this manner, they may easily be moved around when needed.

In spite of the low number of machines, access to computers is seen as quite good. Three days a week, pupils may use the lab for three hours in the evening. They can use the Internet, CD-ROM or use the PC to write. Most of the pupils are just playing around on the Internet or chat on MIRC, which has become very popular. They pay a small amount of money for every half-hour they use Internet. There are no teachers around, but one ninth-grader is employed to be in charge.

An important key to this quite successful integration of ICT is an active and positive response from the teachers. All teachers at this school have been through several courses. As with the introductory training of pupils, they set up courses according to level of difficulty, so the participant may choose. This is very important, according to our informant. Another important factor is to keep the training close to the reality of the school:

"It is very important that training is based on practical realities. I see no use in having big courses in big halls with excellent machines. We have to relate to our everyday life. And they (the participating teachers) should have to push the same buttons in the courses as they are to push when they practice for themselves".²⁵

A main feature of school B is that they have set up a *local learning economy* among teachers. Clearly, teachers learn from each other and exchange ideas and experiences. Some produce new ideas, some use them, and they all produce teaching. The establishment of a local learning economy means that the school has created a climate for interaction and exchange, rather than just individual problem-solving. Thus, social learning is promoted in its most basic form as collective learning by using.

Moreover, the school has developed a strategy of integrative use of ICT. Thus, their domestication of multimedia computers has produced a meaning that transcends the conservative formatting of education policy. Their computers are not just for acquiring basic computer skills, but also for exploring new options of learning, including the management of information.

School C²⁶ is an upper secondary school with 450 pupils and 45 teachers. This school has 44 computers to be used by pupils and 8 machines for teachers' purposes. Every pupil has e-mail access, her/his own address, map for storage and home-map. The computers are located in different places: 30 machines have

been placed in a computer room, 4 machines in the library, and ten machines in a workshop-room (where there are a few scanners as well).

The teachers have 8 machines at their disposal. They are located in an office. In addition, there are a few portable machines. The intention is that there will be additional portable machines with Internet access. Like most teachers in Norway, they have only a small desk at their disposal at school. This makes portable machines a more practical tool - also for homework.

Our informant tell us that procurement of new equipment strictly follows the strategy plan of the school.²⁷ According to this plan, in the near future, they will establish a video-workshop and a project room with 20 machines. They also want to develop a video/sound studio and to establish an internal network. Each subject will be represented with a homepage, and the teachers can for instance present papers, tests, etc. here.

An important factor concerning the amount and the quality of the equipment is a flexible organisation. School C is not "richer" than other schools, but investment plans can be changed and realised within a short period of time.²⁸ Besides, a driving force is, as for school B, one particularly interested and competent teacher and several quite interested and competent colleagues who follow the lead.

The ICT responsible teacher/enthusiast realise that the processes of educating the staff and creating interest, has to take time. They arrange some basic courses, but they also see a good effect of learning from each other - and some of the pupils. It is important that the teacher has to be allowed work in his/her own tempo. As our informant at school B, they were in favour of offering courses at different levels and tried also to give some individual basis training. They mean that each school has to develop a strategy plan towards the technical as well as the pedagogical. The computers have to be of a certain quality, but that is only one part of it:

"One has to use the personnel resources available (...). One way is to try to get everyone interested at the same time. Or one may differentiate. I believe that the enthusiasts should be offered good opportunities, but at the same time one has to help all the others in a way that fits their needs. We can't expect everybody to march in step and reach the same goal".²⁹

According to our informants, this school has enough machines, but that is not the only key to a positive process of integration. Strategy-plans, specific goals and a flexible organisation are important factors. However, they still have not reached the wished-for level of integration in every subject, mostly because of the above-mentioned reasons: Every teacher has to work in her/his own tempo. In addition, they complained about the level of technical support (hardware as well as software).

Like school B, school C has domesticated multimedia in a way that transcends the conservative meaning of the national plans. Also, they have

developed a practice of social learning that amounts to a learning economy of interacting teachers. However, the two schools differ in the way their learning economies function. In school B, interaction is a reasonably frequent, while in school C, they are more dependent on the use of a planning document as an intermediary.

The computers-in-education discourse has been formatted to be particularly sensitive to the issue of access. The three tales narrated above indicate that availability of ICT is a more complicated phenomenon than just the number of computers per pupil and teacher. In fact, given the level of variation in Norwegian schools, these numbers seem to be much less important than assumed by politicians. Availability is also a question of how computers are made accessible. To locate them in one classroom has very different consequences from making them mobile or placing them in different localities within the school.

Most schools have one or more computer labs/classrooms where the ICT teaching takes place. These rooms are booked most of the day. For many teachers it was a problem to have to reserve this room days ahead, in case you had to use the computers. School B was an so called "open school". They had no classrooms. The computers were placed on tables with wheels and transported to wherever needed. That is perhaps the reason that they managed successfully with a low number of machines. School B illustrates clearly that the number of machines was less important than a distributed access to computers, some enthusiastic teachers with ideas and plans, and an active integration of computers in teaching.

Plans for educating teachers were another crucial factor. In many of the schools, as exemplified by school A, this training seems to happen more by change then through an overarching plan. Schools B and C illustrated the opposite. Here we also saw the importance of individually adjusted computer training, as close as possible to ones ordinary work tasks.

As expected, we found local learning economies among teachers, systems of interaction with weak links to the administrative offices of municipalities or regions, not to talk about the Ministry. Probably, this is the logical outcome of the Ministry's learning by plan and paper-system, since this form of social learning does not cater to local information and knowledge needs.

It should be clear from the above tales that teachers have considerably leeway to decide how ICT should be used (or not) in the classroom. Efforts to create local learning economies may lead to the establishment of a facilitating mechanism and a resource, but not any firm structure. The plans do introduce some limitations and demands, but there is still a considerable need for the ordinary teacher to domesticate multimedia on his/her own in order to place the technology in his/her own teaching practice. Thus, we will now have a look at what happens in this locality of the ICT-in-education efforts.

6. *Teaching transformed?*

In the standard literature on technology and work, there has been the frequent assumption that new technologies are used to change the skill structure, to increase control of work, or to change the division of labour. However, few of these studies address the situation of the professional worker which probably is rather different. A rather extreme example is provided by Sætnan (1998) where it is shown how professional interests in a hospital may completely corrupt the technology and the aims of its introduction.

While teachers have less professional strength and autonomy than medical doctors, they still have considerable discretion in terms of form and content of teaching. National plans place demands on topics to be covered, and they may also suggest didactic strategies, but these plans also offer considerable flexibility of interpretation. In relation to computers and multimedia, as we have seen, the plans are rather vague and conservative in their orientation. If multimedia should be a reform tool in education, that would have to be the outcome of local efforts.

In our interviews with teachers, we believe we can identify three main ways of domesticating the new technology:

- The traditional teacher who continues to teach in the same way as before, with little use of ICT as an educational tool.
- The lonely innovator who is eager to put computers to use in his/her teaching, but operates mainly on his/her own.
- The supported enthusiast or the teacher who really wants to make ICT part of a modern education, who puts in a lot of effort to realise this aim at the whole school and not just in her/his own teaching, and who gets moral support to do so from colleagues as well as the administration.

Due to the selection of informants, we have probably missed out on a fourth type, the ones that are not very interested in using ICT in education and avoids using the technology. Probably, this is the most common outcome of the domestication process.

Per Olsen³⁰ is an example of what we called *the traditional teacher*. He works at an upper secondary school, teaching biology and mathematics. He has a computer at home (owned by his partner), which he mostly uses for writing. Thus, he has some experience with computers. However, he does not use ICT as part of his teaching. In his account, the main reason is the difficulty to get access to machines. The computer room has to be booked in advance, and that means that teachers have to plan many days ahead:

"The rooms where the computers are placed are generally occupied by ordinary ICT classes. Thus, I cannot just bring my biology students to these rooms to work there. For some time now, we have been wishing for at least one computer in every classroom - also in the biology room. Then we could search the Internet for information on subjects we are working on (...). I believe I would

have used the computer a lot more in teaching if we had one available in the classroom".³¹

The problem of availability arises also in relation to his tasks outside the classroom. The informant was not comfortable with the working conditions offered by the school, where he would be sharing a few computers with many other teachers. For this reason he prefers, like many of his colleagues, to work at home. Of course, this tradition of doing all non-classroom tasks at home, makes "spontaneous" learning and sharing of experience difficult.

This point is very much related to the idea of local learning economies. Such learning economies presuppose that interaction flow easy, a condition that is not satisfied by the long-standing tradition of teachers doing their preparation and follow-up work in the individualised space of their homes. Many of our informants emphasized this observation by reference to a form of interaction which they called the "neighbour effect". This made it worthwhile to create an environment that facilitated working side by side, enabling you to ask someone for advice when you run into difficulties. Combined with some introductory courses, this is viewed as an effective way of learning.

Per Olsen and the other "traditional teachers" had not been offered much introductory training, nor stimulated to create a more collaborative working environment. They are positive to the use of ICT in education, but not at any price. Thus, the "traditional teachers" represent a considerable resource that may be mobilised, but they will usually not take any real initiative to promote the use of multimedia.

Hans Johnsen³² is an example of a *lonely innovator*. He is a teacher at an upper secondary school too, and an ICT enthusiast to the extent that he is making his own methods for the use of ICT in teaching, even if he has the same (poor) conditions as the "traditional teacher". The decisive difference is a genuine interest for this type of work.

He uses ICT frequently in one of his subjects (language). Moreover, Hans Johnsen's class have their own page on the net. Here, he distributes questions, essays, books to read, etc. His pupils are supposed to reply in the same manner. To manage this, Johnsen uses a lot of free time, four to five hours every evening, to work out his different pedagogical arrangements:

"The main reason is that I like to make these Internet applications (...). For instance, I may scan a piece of text (...) and I make links to different pieces of the text ... words that are difficult to understand, persons that are introduced and where I present a picture and a short biography (...). Then I work this into an analytical model and give them a lot of detailed questions. And then they have to move between Netscape and Word. And they must write down the answers".³³

His class have access to one room with multimedia machines, but there is not enough computers so the pupils have to work together. He does not use ICT in

the other subject he teaches. It was difficult enough to get access to the computers the four hours a week that he needed for this subject as he put it. He is first and foremost interested in the pedagogical aspects of ICT in education and it frustrates him that the hardware often is the main discussion theme.

The "lonely innovators", like Hans Johnsen, have acquired most of their skills on their own. They are active, using ICT in their own teaching, but their plans and methods are not diffused. They have no substantial impact on their colleagues, due to critical deficiencies in the local learning economy. This contrast with the situation of the third type, the "*supported enthusiast*". Anne Petersen³⁴ belongs to this category. She is a frequent ICT user, like Hans Johnsen, but her conditions of work are more favourable. Anne Petersen developed her interest in ICT through her work as a teacher. Together with some colleagues, and in a school with no computer equipment, she established a successful ICT project.

The ideas behind it have met a lot of support by the administration, and Anne Petersen has been given some of the responsibility to develop an ICT plan at the school. The plan includes pedagogical ideas, suggested courses and requests for hardware and software as well as for other multimedia equipment. In the near future, it is supposed to be realised.

Since Anne Petersen mainly works with pupils at 13-16 years of age, it is very important to provide them with a basic introduction to computers and multimedia. The goal has been to make each pupil manage some simple but fundamental tasks like word-processing, scanning of pictures and text, presentations, use of CD-ROM, basic applications of the Internet like the application of search engines, navigating the School Net, and using chatlines and e-mail.

ICT is presented as a very good tool, but with limitations. In teaching situations there has to be some social interaction. Thus, Anne Petersen does not want too many computers in every class. Her main interest is the pedagogical content of ICT. That is the part she is continuously working on.

A main conclusion from this discussion is that individual domestication strategies have a crucial effect on the integration of ICT in Norwegian schools. Enthusiastic teachers are able to establish ICT as a pedagogic tool across their school, even if they lack local ICT support. They may even work in an institution with very few computers.

The enthusiastic teacher that experience or elucidate positive feedback, like Anne Petersen, may become a driving force to integrate ICT in a successful way. However, if local feedback is lacking or not mobilised, the enthusiastic teacher will, like Hans Johnsen, end up as a "lonely innovator".

In other words, ICT in education is not just a question of regulation, or a reform that can be directed from "above". The different individual strategies, and the different local cultures in every school illustrate why the domestication of multimedia seems to be a "learning from below" project.

7. The Ministry and the classroom: Deficiencies in the learning economy

In this paper, we have explored the dynamics of the learning economy of the education sector in Norway in relation to teachers' use of computers and multimedia. We have analysed domestication of ICT in different localities of this system, with the main emphasis on the Ministry, the intermediary institution set up to supervise, support and standardize textbooks and other teaching tools (NLS), individual schools and individual teachers. A major finding is the flexible understanding of what ICT represents in relation to education. Some, like the Ministry, define the technology in a quite conservative manner and see the challenges as related to the skills needed to use computers. Some schools, and in particular some teachers, have more radical ideas about ICT as a reform tool to improve teaching in general.

The learning economy of the education sector is formatted by the Ministry to establish access as the major concern of ICT in education, in addition to the emphasis on simple skills like word processing. The result is a system that we have called "learning by plan and paper", a system where plans and the information provided to evaluate the plans is dominated by simple numerical indicators of access and of planning and training activities. The formatting set in motion by the Ministry means that schools and teachers are induced to be access-sensitive and quite conservative in their visions. The resulting learning economy does produce interaction, but the learning that takes place is rather limited. The Ministry gets little information about what is really happening in the classrooms, while teachers are not learning much from the output of the Ministry.

NLS has set up two experimental web-pages that modify this impression. The School Net and the Guidance Net represent a very interesting effort to stimulate the learning economy of the sector by creating more efficient links to allow a flow of information and an exchange of experience. This represents a form of social learning that we called learning by brokering. By that we mean that NLS acts as a broker to facilitate the flow of experience and ideas and thus may facilitate the establishment of a more widespread learning economy related to multimedia in education. However, these efforts are also limited by the formatting activity of the Ministry. The resulting discourse about computers and multimedia in schools, as it may be observed on the two web-sites, tends to address the same issues as those that are highlighted in the documents from the Ministry of education.

Under such conditions, and given the traditional autonomy of schools and teachers, it comes as no surprise that ICT is domesticated in very different ways in different local circumstances. Again, we may note the importance of local learning economies. Schools that are able to establish interaction between teachers and stimulate the work of ICT enthusiasts, seem to have come a long way in finding quite innovative uses of computers and multimedia. However, as we have seen, many schools have deficiencies in their learning economies. This

results in a lack of interaction. Teachers, interested in ICT, work on their own, in the constant risk of reinventing the wheel. And, worse, teachers that are not very interested in the use of computers and multimedia may safely ignore the challenges.

It may be seen as ironic to state that the learning economy of the education sector is deficient. However, this is a rather precise diagnosis. There are substantial problems in creating interaction and exchange between teachers, not to talk about between schools. The NLS initiative to set up the School Net and the Guidance Net points to the interesting potential of multimedia technologies to help overcome the lack of interaction. By using the Internet as a medium of exchange of information and experience, it is possible to improve the learning economy of the education sector in a considerable way.

As announced in the introduction, there may be some more general lessons to be drawn. First of all, the findings from our study of multimedia in education show clearly the importance of analysing domestication of technologies simultaneously at several locations or levels. We may not be surprised by the observation that multimedia is domesticated in different ways in different schools and by different teachers. Few would be surprised by being told that what the Ministry thinks and what is going on in the classrooms are quite different things.

On the other hand, what happens in the classrooms is not independent of the actions and beliefs of the Ministry. The conservative construction of multimedia and the establishment of a learning economy dominated by the strategy of learning by plan and paper facilitates a conservative use of multimedia by teachers as well as strategic perversions. When the policy constituency is very concerned about the ratio of pupils and computers, such ratios may very well serve as an excuse to focus on how to get more computers and to excuse the lack of integration of multimedia in teaching by reference to the bad local ratio. Thus, there is an interesting potential of interaction of strategies from “above” and “below” that previously have been neglected.

In particular, we should emphasize the point that regulation should not be perceived just as a type of action that limits options and raise barriers to experimental uses of new technologies. In fact, regulation as it has been analysed in this paper, may have a very definite and productive influence on technologies. First of all, regulatory activities may push new technologies that otherwise would have been neglected. Second, regulation may mean the establishment of infrastructure, standards, and practices without which the new technology would not “work”. Third, regulation may imply the promotion of certain interpretations of the technology that have considerable influence upon the way it is configured and used.

Another set of lessons is related to the concept of learning economies. Previously, this concept have been used by economists in order to understand important aspects of the context of innovation (Andersen & Lundwall 1988). We believe that we have shown that it is fruitful to analyse such learning economies

in the public sector. Above all, the study of multimedia in education provides us with the insight that learning economies should be understood as potentially separated and with varying strategies of exchange of experiences and ideas. Further research is needed to clarify how such learning economies may or may not become linked, and the translation processes involved in efforts of setting up links.

9. Notes

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2. The interviews with the teachers were conducted at the different schools, based on an interview guide that covered various aspects of the use of computers and multimedia, including skills, practices, plans and visions. Each of the interviews lasted for appr. 3/4 - 1 hour. They were all taped and transcribed. Interview transcriptions are numbered as file #1-12. References are made to the file number. We chose originally to focus on teachers that were interested in ICT, so we have a clear bias in the interview population. This may mean that we paint a too rosy picture of the situation in Norwegian schools. On the other hand, interviews with teachers that actually use ICT are more useful in providing information about the way computers and multimedia are applied in Norwegian classrooms when the technology is utilized. We have found it less important to describe and analyse non-users.
3. The interviews with the representatives from NLS took place in Trondheim. They were taped and transcribed as well and referred to as file #13 and 14.
4. The interview with a representative of one municipal school office is in file #15, while file #16 is an interview from one regional education office. Additional interviews with representatives of teachers' unions are found in file #17 and 18. None of these interviews were taped, but the information was written down immediately afterwards.
5. See *IT in Norwegian Education*, Ministry of Education, Research and Church Affairs, Oslo 1997 (<http://odin.dep.no/kuf/publ/it-plan/eng>) and *IT i norsk utdanning*, Ministry of Education, Research and Church Affairs, Oslo 1997 (<http://odin.dep.no/kuf/publ/arsplan.html>).
6. See also *IT i norsk utdanning. Plan for 1996-99*, Ministry of Education, Research and Church Affairs, Oslo 1996
7. See *IT in Norwegian Education*, Ministry of Education, Research and Church Affairs, Oslo 1997 (<http://odin.dep.no/kuf/publ/it-plan/eng>) and *IT i norsk utdanning*, Ministry of Education, Research and Church Affairs, Oslo 1997 (<http://odin.dep.no/kuf/publ/arsplan.html>).
8. See *Stortingsmelding nr. 24 (1993-1994) Om informasjonsteknologi i utdanningen*, p. 16f.

9. *IT i norsk utdanning. Årsplan for 1998*, Ministry of Education, Research, and Church Affairs (<http://odin.dep.no/kuf/publ/1998/itplan.html>).
10. Jon Lilletun: Utviklingen av informasjonssamfunnet. Innlegg i Norsk Investorforums «Utfordringer og utdanning i IT-sektoren», 2 mars 1998 (<http://odin.dep.no/kuf/taler/1998/980302.html>), p. 2.
11. See *Stortingsmelding nr. 24 (1993-1994) Om informasjonsteknologi i utdanningen*, p. 26-27.
12. *Læreplanverket for den 10-årige grunnskolen*, Ministry of Education, Research and Church Affairs, Oslo 1996, p. 78-79.
13. The annual reports of the regional offices of education from 1997 (in Norwegian) may be found at <http://odin.dep.no/kuf/publ/1998/tilstand/tilstand.html>.
14. See, e.g., *IT i norsk utdanning. Årsplan for 1997*, Ministry of Education, Research, and Church Affairs (<http://odin.dep.no/kuf/publ/arsplan.html>). *IT i norsk utdanning. Årsplan for 1998*, Ministry of Education, Research, and Church Affairs (<http://odin.dep.no/kuf/publ/1998/itplan.html>).
15. See note 11.
16. More information about NLS may be found at their home page <http://www.nls.no/>.
17. The analysis are based on interviews with NLS' director Sigmund Lieberg (interview file # 14) and project manager for the School net, Tore Nersland (interview file #13). In addition, we have explored the home page <http://www.nls.no/>, and in particular the web services found on <http://skolenettet.nls.no/> and <http://vs.nls.no/>.
18. Interview file #13, p. 6.
19. The School Net is located at <http://skolenettet.nls.no/>.
20. The Guidance Net is located at <http://vs.nls.no/>.
21. The tales are based on interviews with one or two teachers from each of the schools.
22. Interview files #1 and 2.
23. Interview file #1, p. 10.
24. Interview file #5.
25. Interview file #5, p. 4.
26. Interview file #6.
27. Interview file #6, p. 11.
28. Interview file #6, p. 13.

- 29. Interview file #6, p. 18.
- 30. Interview file #1.
- 31. Interview file #1, p. 2 and 5.
- 32. Interview file #8.
- 33. Interview file #8, p. 4.
- 34. Interview file #5.

References

- Andersen, E S & B-Å Lundwall (1988): "Small national systems of innovation facing technological revolutions: an analytical framework", in C Freeman & B-Å Lundwall, eds: *Small countries facing the technological revolution*, London: Pinter, p. 9-36
- Bijker, WE, TP Hughes and T Pinch, eds (1987): *The social construction of technological systems*, Cambridge, MA: The MIT press
- Bijker, WE & J Law, eds (1992): *Shaping technology/building society*, Cambridge, MA: MIT Press
- Brosveet, J and KH Sørensen (1999): "Fishing for fun and profit? National domestication of multimedia: The case of Norway", *Information society* (in press)
- Dierkes, M, U Hoffman and L Marz (1996): *Visions of technology. Social and institutional factors shaping the development of new technologies*, New York: St. Martin's Press
- Håpnes, T and B. Rasmussen (1997): *Internett - jentenett? Ungdomsskolejentes databruk og datainteresser*, report 7/97, Trondheim: Centre for women's research
- Latour, B (1987): *Science in action*, Milton Keynes: Open University Press
- Lauvdal, T (1994): *Pedagogikk, politikk og byråkrati. Om statlig styring av grunnskolen og reformintensjoner i den statlige forvaltning på grunnskoleområdet 1969-1991*, Ph.d.-dissertation, Trondheim: University of Trondheim
- Lauvdal, T (1996): *Makt og interesser. Stryking og forhandlingssystem i skolesektoren*, Oslo: Scandinavian University Press
- Lie, M & K H Sørensen, eds (1996): *Making technology our own? Domesticating technology into everyday life*, Oslo: Scandinavian University Press
- Silverstone, R & E Hirsch, eds (1992): *Consuming Technologies. Media and information in domestic spaces*, London: Routledge

Sundvoll, A and HM Teigum (1997): "IT i skolen 1997. Del 1, Tilstandsundersøkelse i skolene: Hovedresultater og dokumentasjon", *Working papers* 97/42, Oslo: National Bureau of Statistics

Sættnan, AR (1998): "Flexible technology vs. organizational stalemate - the story of PREOP", in KH Sørensen, ed: *The spectre of participation. Technology and work in a welfare state*, Oslo: Scandinavian University Press, p. 189-219

Sørensen, KH (1996): "Learning technology, constructing culture. Socio-technical change as social learning", *STS working paper* no 18/96, Trondheim: Centre for technology and society

Sørensen, K H, M Aune & M Hatling (1999): "Against linearity. On the cultural appropriation of science and technology", in M Dierkes & C v. Grote, eds: *Between understanding and trust: The public, science and technology*, Harwood publishers (in press)