Pedagogy og technology

Børre Stenseth, 1999

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Pedagogy and technology

A historical perspective

For more than 25 years I been involved in the use of information technology in education and learning. My role has been that of a producer, author of books on program design, consultant and teacher. Most of this time I have had my daily employment as a teacher in computer science. This has given me two perspectives on the the development, a technological and a pedagogical. My education and training is within the technological domain and my pedagogical reasoning is based on experience.

It is my hope that this article may provoke better schooled pedagogues to reflect and comment on the topic of the mutual influence of technology on pedagogy.

Børre Stenseth, August 1999.

A perspective

[Technology] [Pedagogy]

One of the most manifest characteristics of the public debate on technology and pedagogy is the lack of historical perspective. The field has been, and is, a area for strong meanings based on the present-day situation. The growth of the Internet as attracted great interest from pedagogues as well as more general observers. The challenge inherent in this technology is so fundamental, and in a lot of respects new, that we easily loose sight of the recent history and the experiences that we have. There are even participants in the public debate which takes a deliberate distance to the history based on a point of view that the changes are so profound that we have little to learn from history.

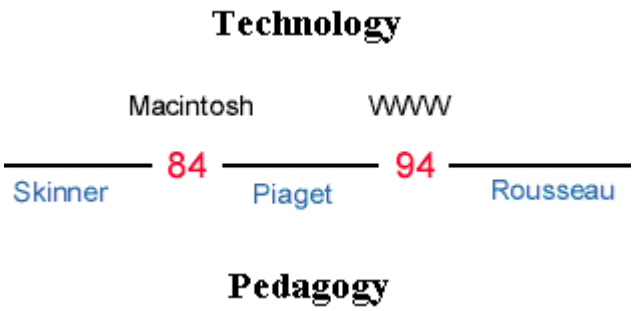
I do not share this opinion and claim that we have access to a lot of thinking and experience that can help us understand and analyse the situation we are in. Reflections based on experience are as useful in this area as in most other areas. This article has as its main objective to contribute to reflections of this kind.

A historical perspective on information technology and pedagogy can be made very comprehensive. Ideally we should include traditional media as radio, video and television.. We might even include other types of technologies like blackboards and overhead projectors. I will not take this broad view and will limit the perspective to computers and technology for digital communication as we know it from the Internet. I will limit the scope to digital technology, if you like. I will limit the historical perspective to the last 30 years.

The article is limited to issues related to the technology as an instrument, in one form or an other, to enhance or support learning or education. The technology as an objective for learning is not discussed, even if some of the reasoning is based on experience from this area.

The article is not precise when it comes to ages, and try to focus issues which are independent of age and subject.

I have chosen a simple approach to a time line that focus two points in time, and thus describes three periods.



One of the central points in the analyses is to look at the dependence between technological development and pedagogical thinking and praxis in the three periods.

Technology

It is necessary to make some comments on the technological time line. It is not as simple as it may seem, and it is a lesson to learn from the difference between what is technological possibilities and what is generally available and widely used. Availability has to do with a lot of

things: Marketing, standards, infrastructure, usability, support, economy and competence, or if you like literacy.

Focus is on the introduction of Apple's Macintosh in 1983-84 as an important milestone. This event is chosen because it introduced a new way of relating to the computer for the majority of users. Consistent graphical user interface were made available on the mass market. Concepts like "the desktop metaphor" and WYSIWYG (What You See Is What You Get) were suddenly there for everyone to use and understand. Everyone with some insight in the history of computing knows that such graphical interfaces and a lot of the concepts of the Macintosh has a longer history. We find parts of the technology realised on workstations as far back as Sutherland's Sketchpad[1] in the 60's. The software, which relies heavily on an object oriented approach, has it roots in Simula [18], also from the 60's. We know that Rank Xerox had a complete graphical user interfaces on their commercial workstations years before Apple's Macintosh and Lisa.

Similar reasoning is to an even greater extent valid for the next event on the time line, the introduction of the World Wide Web. When Berner-Lee at Cern i Geneva defined HTML[2] as a tool for exchanging documents on the net, he built on well-known technology. The net was there and the standards for encoding documents was established. The revolutionary growth of the web can only be understood in light of a mature user society. The concept of the web is described as early as 1945 by Vannevaer Bush [3], although he had an other technological solution in mind. Ted Nelson had for years, before Mosaic, advocated his Xanadu project[4] for seamless interchange of information. Many of the communication forms which we today use on an experimental basis were demonstrated as early as the 60's. Douglas Engelbardt demonstrated the use of mouse, cooperation on one document and parallel TV-communication in 1963[5].

Pedagogy

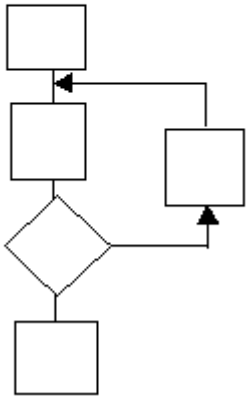
It is a clear connection between the generally available technology and the ideas and the thoughts that develops as basis for applications of the technology and the way we relate to technology in general. We can analyse this in a lot of areas, both in history and in present, and pedagogy is no exception.

The three names which are connected to the periods, Skinner, Piaget and Rousseau, is chosen because they stand out as very clear profiles for most of us who have only a basic education in philosophy and pedagogy. Skinner, with his association to a behaviouristic approach to human endeavour, will be an exponent for a mechanistic approach to education. Piaget is an exponent for a view that emphasis the different stages in the way we learn. The article will also stress the point that these stages are related to different channels which may, or may not, be used i parallel. Rousseau will, probably not voluntarily, be an exponent for a view where technology is considered as nature. A nature which we cannot understand completely, but which we can learn from, and at best live in balance with.

The article stress the typical aspects of the three periods, and does not attempt to be complete in any way. Some emphasis is put on experiences from the Nordic work in the field in the 80's. Note especially that Papert's Logo[6] is treated as a part of the Piaget period, even if it was introduced before 1984. Logo does in many respects illustrated some reasoning which are typical for the Piaget period, and it was realised on graphical technology which was available before Macintosh.

Skinner

We use a traditional flowchart as a metaphor. The learning material is chopped up in packages and the sequence through the material is predetermined. The learning is checked throughout the process and the only possible alternatives, if any at all, is governed by the answers to control questions. The education is planned as a predefined sequence of knowledge packages and is in principle based on an explicit cognitive model of a targeted body of knowledge.



This way of thinking **may** be understood as an art of what is possible in relation to the technology of the period. The technology offered a very narrow window for user interaction. The user could in principle only read text on the screen, and was given the possibility to respond to multiple choice questions with simple key presses, or in some cases with simple words or numbers. Extended use of written dialogs, as we found it and still find it, in text based operating systems, is based on expert knowledge and is not relevant for a general pedagogical approach outside the computer society.

The Skinner approach and the few products from this period was rejected by most pedagogues. In the Nordic pedagogical tradition this approach found little response, and was in general considered as uninteresting. The connection to economical savings, and phrases like "replacing the teacher" did not make it more popular. The consequence of this was that the technology in the school society was dominated by computer enthusiasts and there was little room for nuances or general pedagogical considerations.

The pedagogical approach based on Skinners behaviouristic model has however had a considerable impact on applications outside the school society. We find applications of this pedagogical approach for training of routines within industrial processes, and specially in training of security drills. Even if the technology has changed, these kind of applications are still relevant.

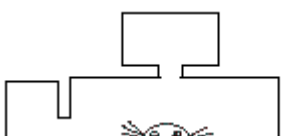
There is no reason to question the value of this approach in training and drill situations with very limited cognitive objectives. It is however interesting to ask if we are not experiencing a rebirth of Skinner as a pedagogical approach, or rather as a pedagogical emergency exit, in the technological situation we have at the moment. There is signs of this. Skinners approach is obviously a tempting way to bring order to chaos and reestablish the control of learning. We will come back to this.

In this perspective it is interesting, and quite a paradox, that the guides we find for designing pages and structures on the web has clear parallels to the guides for designing alpha-numerical screens in the 70's. Focus is on the balance of the trees, the depth of the trees and number of choices. We are in many ways in a situation where the limitation on the web for most publishers are severe compared to the flexibility of the general computer program. This is probably a transient period, but it will sustain for a considerable period for many publishers.

Piaget

[A Pedagogical Foundation] [Logo] [Nordic Experiences]
[Evaluating Results]

The difference from the Skinner period is the intention of making open learning situations. The student or pupil should have the freedom to act, experience and learn after his or hers own plan. The programs should be open and without sequences. This approach set the focus on **motivation**, while **control** is getting less important.



The openness does of course rely on the technology of the period which allowed graphical interfaces with dynamic menus, multiple windows, direct manipulation, access to many programs at the same time etc.

So what has this to do with Piaget ? The arguments are well put by Alan Kay. Kay is in many ways the main architect behind graphical user interfaces as we know them today, to the extent that it is possible to point at one person. Kay's reasoning, as it is put forward in a video distributed lesson [7], is basis for parts of the arguments in this section. In addition I discuss briefly an other interesting approach, Logo, although this as pointed out above is older than the Macintosh. I do also discuss some of the experiments and results from the Nordic approach in the 80's.

A Pedagogical Foundation

The key sentence in Kay's contribution is: **Doing** with **Images** makes **Symbols**. The cornerstone is Piaget's theory of a child's development, which (too coarsely) can be illustrated like this according to Kay's sentence:

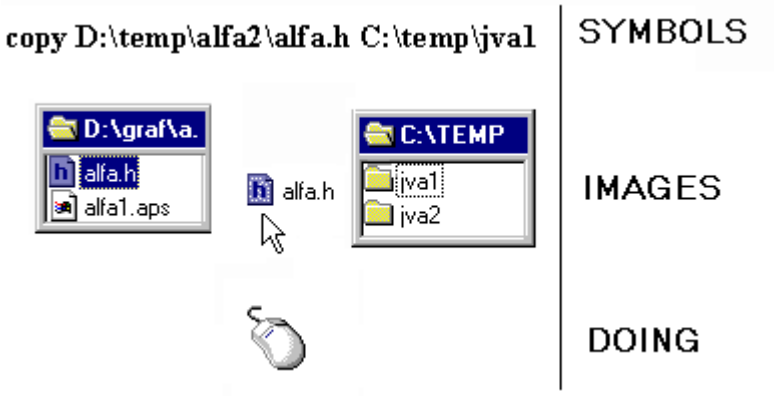
Bodily experience (Doing)	Images (Images)	Symbols (Symbols)
Early development	Childhood	Grown up

We usually think of this as three stages in a development, and consider the symbolic phase as the normal adult way of operating. We tend to think that we should strive to be as operable in this phase as early as possible, and that we do not need the earlier phases for intellectual work.

Kay claims that all people, regardless of age, skill and task, will gain by communicating on all this "channels" simultaneously. He finds support for this view in surveys and observations that show that people which we consider theoretically, or symbolically, competent, often thinks in images and often has an almost physical experience of their models.

Einstein is often mentioned as an example of a scientist who reasoned in images. An other example close at hand is chess masters who are not able to give explicit logical arguments for their choice of the next move. In older technology history Maxwell and Faraday are often mentioned as an example of two complementary approaches to the same domain. Faraday as an exponent for the intuitive approach and Maxwell for the descriptive. See Bernal [8].

Kay's sentence is clearly illustrated and realised in graphical user interfaces as we know them on todays computers, with the possibility for direct manipulation of images.



One can always ask whether this type of reasoning actually has been an explicit basis for the development of user interfaces, or if is an after rationalisation. This is not so important. The important issue is that it gives us a foothold for extending the reasoning to learning environments.

Logo

An other person who has contributed to the understanding of the dependence between technology and pedagogy is Seymour Papert [6]. His Logo was developed before 1984 on simpler technology than what is typical for the period. Logo attracted a lot of interest, also in the Nordic countries, i the first part of the 80's. Papert's work is explicitly based on Piaget's theories.

The metaphor for Logo is a turtle that can be commanded to walk around and leave a track.

```
forward 100
right 90
forward 100
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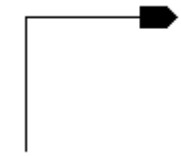

```
to square
forward 100
right 90
forward 100
right 90
forward 100
right 90
forward 100
end
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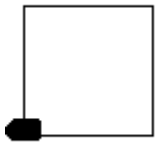

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square
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```
Repeat 4 times
square
end
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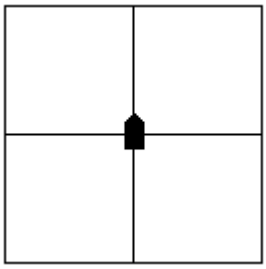


There are two main points in Papert's reference to Piaget.

The first is a direct parallel to Kay's reasoning. The user should so to speak identify herself with the turtle, and "do" the geometry before and after it is written as commands. It was even produced "turtles" who could be commanded to walk and draw on the floor so you could literally plan the track by going ahead.

The second is the possibility to make aggregate "verbs" that can be reused. This is an approach to support the development of concepts and understanding. It should be possible to build a powerful set of concepts for different purposes. Papert coined the phrase "microworlds" for such sets of concepts..

Logo was very popular for a period of time. To many pedagogues Logo was the first computer program which was explicitly based on a pedagogical idea. Logo was easy to learn and created enthusiasm in the classroom for a period. It was however some problems that appeared rather fast. For most users, children and teachers, the source of ideas dried up after a few hours. The microworlds became too small and too difficult to expand. It was difficult to design a teaching plan that lasted for a longer period. Logo was an interpreted Lisp-dialect and was a complete programming language with tools for treating lists as well as geometry. It was however few, if any, teachers or pupils who took the time and effort to learn other concepts of the language than the initial geometrical commands.

Nordic Experiences

What we have called the Piaget period coincides in time with a period of a planned and rather powerful effort for developing computer based learning material in the Nordic countries. A summary of some of he work done in this period is found at the IDUN centre in Copenhagen[9].

Important components in the Nordic effort in this period was the development of software and the education of teachers. National and Nordic design seminars were interesting laboratories for developing, understanding and testing tools and methods. The main method for design that was used is thoroughly documented in the book Brukerorientert Programdesign [10].

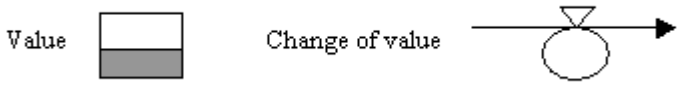
A central concept in the methodical approach was metaphors. It was evident that building an environment for learning had to be based on an understandable and motivating environment. Such metaphors for learning were of many types:

- Extensions of the desktop metaphor.
- Tool metaphors for laboratory-like programs.
- Game metaphors.
- Metaphors based on time, place, map and clock/calender.
- Theme specific metaphors that created strong associations to worlds existing outside the computer.

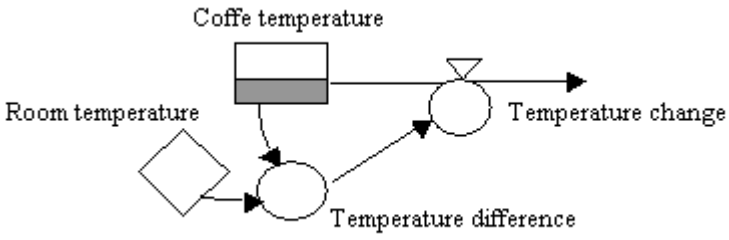
Common to all these approaches was that they described a limited, controllable world. Even though the structures within this worlds were relatively open, they were planned and controlled by the designer and had an absolute barrier against the rest of the world.

Dynamic simulation

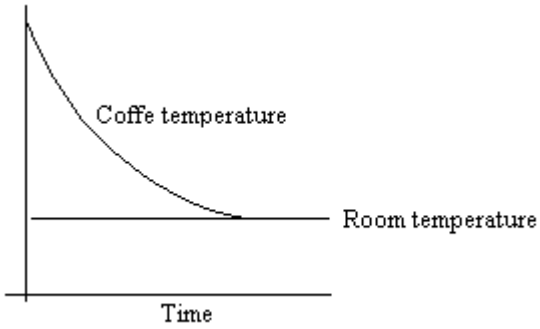
Dynamic simulation is one of many areas that was developed as a tool for learning in this period. The area can serve as a good example of both possibilities and limitations. The group of pedagogues at Stord Haugesund College[11] was the main contributor to this development. The software and the ideas have been developed further and commercialised by PowerSim [12]. The concept build on a simple metaphor which mainly consists of valves to control flow and containers to accumulate flow.



Modelling of the temperature fall in a cup of coffee can be illustrated like this:



The result of running the model, the simulation, can be illustrated like this::



This tool is apparently very simple, flexible and useful for analyses of a wide rang of problems. The ambitions of those who get in touch with the system grows fast. It turns out to very difficult for untrained designers to estimate the complexity of a model. The wish to take on real world problems, in say ecology, almost without exception led to incomprehensive or oversimplified models. This was due to lack of domain knowledge or lack of competence in general system dynamics. The problems with interpreting the results are of course difficult, and will in many cases lead to erroneous conclusions.

The interesting aspect is however the process of building the model. Used on a model with limited complexity and a relatively clear interface to the surroundings, the learning involved in building the model is an interesting pedagogical endeavour. It does however, as is the case with Logo, presuppose a certain level of mastering, creativity and insight from the teacher.

Problems

A general problem associated with the use microworlds of different types is that they have a tendency to become too simple seen from a learning point of view and to difficult from a users point of view. It takes a lot of design and programming effort to include easily available flexibility to the extent that the product can be useful in a longer period of time. Many of the products have a lifespan of a couple of hours in the classroom before they are exhaustively investigated and further use tends to be boring and predictable repetitions.

General, extendible metaphors, like Logo and PowerSim, are a challenge to teachers that too often is not met. The assumed pedagogical value is not considered great enough to invest the necessary time in planning, understanding and mastering the tool. This assumption may very well be wrong, but it is common.

An example of an attempt to meet this challenge is the program suite "Vi på vindusrekka" [13]. This is a series of programs that is designed to be useful in mathematics education in a three year period for children in the age 10-13. The programs are laboratories, simple games, assignment generators and hypertextual texts for explaining central themes in the curriculum. The programs are designed for different purposes in a long term pedagogical plan. This concept runs into similar problems as those mentioned above. The threshold for evaluating the program suite as a useful tool is to large and the programs are at best used at random with very limited effect.

The programs with the longest lifetime in the classroom are probably simple game-like programs based on drill and repetition, programs with a rather simple pedagogy and which can benefit from an advanced technology.

Evaluating Results

Surprisingly small efforts have been made to evaluate the effect on learning of the products developed during the Piaget period. There may bee many reasons for this. One obvious reason is that we do not have good methods to carry out such evaluations. An other reason is that most programs have a too narrow learning objective.

Some have asked for this kind of evaluation to justify investments in technology in schools, while others have emphasised the meta learning that takes place when children get used to the technology as a tool. The latter point of view has been dominant in this period.

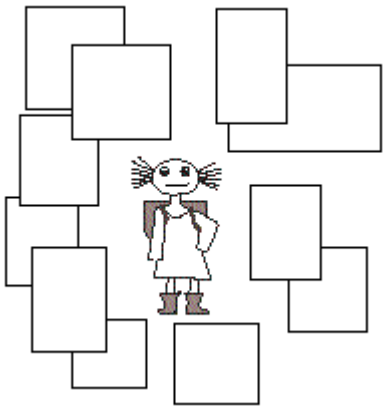
Three problems are evident in evaluating learning effects from use of technology:

1. The obvious Hawthorne effect when technology is introduced in a learning environment. As long as technology is considered a scarce commodity, the access to technology will be a motivation for increased activity, and learning.
2. The effect that that takes place when a situation is established in a way which is not feasible as a daily situation. There are examples of experiments where a combination of technology, staff, planning and working conditions gives astonishing results. The reported experiments with Smalltalk at Xerox Parc is one example, see for instance [7]. Own experiments with software design seminars with 16 year olds is an other example [14]. (What can be learned from this, is of course that it is possible to achieve results if you are willing to pay the costs)
3. The results are connected to a certain product or a certain technology which are outdated at the time the results are published. This weakens the interest in the results, and impede the sharing of experiences.

It is my general impression that the learning effect of the pedagogical software on the market to day, as it is used in day to day work in the school society, is low. Some of the reasons for this is discussed above. The access to technology, and the way the access is organised, is also an obvious reason.

Rousseau

The main characteristics of this period, as compared to the Skinner and Piaget periods, is the absence of pedagogical control. In the Piaget period we did for pedagogical reasons give up the control of the sequencing of learning, but we kept the control over the boundaries of the world . In the Rousseau period we don't control this. We can not predict or control what will be learned or in which sequence it will be learned. The contrast to the "microworlds" are apparent.



The pupil and the teacher are facing a situation where the technology for learning cannot be separated, neither in form nor in accessibility, from the technology for entertainment or communication in general.

We started this article by pointing out that technological possibilities is not the only condition for the technology to be used, and that it is difficult to foresee exactly when and how a technological possibility will be utilised. There are however little doubt that the changes inherent in the present technology is more dramatic in many areas than most of us can imagine. The possibilities are there, far beyond what we actually utilise, and the market seems to be ready for new services and new types of applications.

The question whether information technology will be used in education and learning has no meaning. Technology is, and will increasingly be, used within or outside the organised school society.

I did choose Rousseau as label on this period based on an analogy between nature and a complex information technology that surrounds us, and which we tend to relate to as if it were nature. There are other associations to Rousseau that may be interesting and fruitful as a bases for reasoning.

It is clear that the absence of control related to nature does not match Rousseau's thoughts of education as it is expressed in Emile. Rousseau argued in favour of a detailed control of the education and introduction to "the natural".

Secondly we may observe some interesting parallels to Rousseau's view of the conflict between nature and civilisation. There are signs that the free access to information and communication tends to create conflicts between our established institutions and the individual.

I will discuss these and other challenges in the next section.

Challenges

[Information] [Information and Knowledge] [Complexity and Models]
[Contexts and Quality] [Anarchy] [A Media Culture]
[Time and Space]

I have used Rousseau as a label on the the "after the web" period, and we have used an association based on the "technology as nature" metaphor. This may hopefully provoke some thoughts and debate. It may however be useful to try to discuss in more detail some of the challenges we are facing as pedagogues.

Information

The amount of information which are available at a click is overwhelming, and increasing. This is not only due to the number of contributors, but also of the form of the contributions. Some numbers may illustrate the point:

The 10 commandments	100 words
The American declaration of independence	1300 words
The Starr Report on Clinton - Lewinsky	~120000 words

It is hard to see that the volume is proportional with the significance. The three pieces of text have been generated in different periods, and with different technology. The technology itself will underpin the growth of available information in at many ways. For the first time i history it is probably easier to publish than to read. We can make our texts available for millions with a simple click of the mouse. The threshold to do this click seems to decrease. We will also see a tremendous growth in volume because of our tools for automatic, semiautomatic or manual generation of information based on extracts from other sources.

Information and Knowledge

Information is not the same as knowledge, and access to information is not an assurance that it will be used. It is a widespread misunderstanding that pupils and students become "little scientists" merely because the framework of accessible information is available. This misunderstanding is a easy way out for many teachers and it invariably leads to the conclusion that the learner is to blame when the expectations of scientific behaviour is not met.

Own experience with students in computer science is that the important difference between those who succeed and those who does not, is not the experience they have in using computers, but the training they have in learning. The general arguments that access to technology in school is important has only limited value if it is not combined with a training to learn. This may seem obvious, but it is a fact that most children has a lot of routine i being teached, and lack training in learning.

Complexity and Models

When I have used Rousseau and the association between nature and technology as metaphor, it is necessary to comment on the complexity of the surroundings. The table below is personal view of what I consider apprehensible dimensions, that is what I can relative to directly, without abstractions or instruments like clocks and meters.

Distance	1 cm - 1m - 100m
Time	1s - 1 min - 10 min
Speed	10 km/h - 100 km/h
Structure	Tree structure, lists, tables
Amount (of text)	1 page - 1 book
Number (of choices)	7 +/- 2

One of the foremost characteristics of todays technology, cyberspace if we like, is that all this limits are systematically superseded. This in contrast to my desk, bookshelf and physical working conditions. We should ask ourselves if our relation to this "nature" is as unproblematic as the relations we have to nature in general.

We have as a civilised species experienced quite many centuries with changing authorised and nonauthorized models of nature. The earth have been flat, it has been the centre of the universe and a satellite. We have seen a number of models to describe our natural surroundings, some of them based on religion and some on science.

Seen from a pedagogical perspective it may be reasons to investigate what this complexity does to learning and what kind of models are dominant as seen from the learners in different ages. We can use the telephone as an example of models and understanding. The main reasons why many users have problems to understand and utilise modern telephone systems are probably that their mental model of the technology is that of a line connecting two instruments. A more fruitful model is probably that of two terminals hooked up on a (network of) computers.

Contexts and Quality

The information we reach on the Internet is to a great extent without context. Our safe and protected microworlds have disappeared and scientists, advertisers, politicians, entertainers tries to sell us their information, ideas or concepts of reality. We don't know who they are, we don't know what they are and we don't know what they want to achieve.

My preparation of this article may serve as an example. Two of the first results of a search on the Internet with the "declaration + independence" was a porno site and a vigilante group who used the declaration of independence as an argument for their activity. Many teachers would probably have chosen an other perspective on the introduction of the document, even if the two references mentioned may be interesting enough as actual sociological and political phenomena.

The absence of context is of course a general problem with implications beyond teaching and leaning. It is part of the fundamental challenge that any society meets when information cannot be controlled. We are reminded that we are living with a few institutional and explicit control mechanisms, but most of all that we are living with a lot of unnamed controls, based on moral and tradition.

The absence of context is a great challenge to any reader. It has one perspective that is interesting seen form a teachers point of view. That is the quality control of material used in schools. This is probably handled differently in different countries. In Norway we have two actual mechanisms for quality control.

First of all the publishers of books for schools have maintained a quality control in their mixed position as business- and culture institutions. There are no signs that indicates that the established publishers will be as dominant as they have been in producing educational material.

Secondly we have an official clearing of teaching material that is used in public schools. It is hard to see how this clearing can survive as anything more than advisory information in an open information situation.

Anarchy

The Internet is anarchistic in its structure. From one point of view it is also reasonable to say that the culture it nurtures has strong anarchistic characteristics. Many of the subcultures that emerge in a symbiotic relation to the net, in the sense that they get their input from the net and feed the output back in to the net, shows a expressed distance to our established social and organisational institutions. Many of the institutions that we consider vital for a democratic society, such as the press, the political institutions and the school system, seems to be considered in opposition to the culture found on the net. It is no denial that the Internet has a great democratic potential, but it is very dangerous if this is considered as something else and in opposition to the institutions we have relied on so far.

This is an area that should be considered with interest. Those who are willing to draw the Rousseau metaphor a little further may look back at Roussaeu's description of the conflict between nature and society.

A Media Culture

The integration of all our known communication technologies as a digital digital technology leads to a situation where the technology for learning and education is the same, and is indivisible from, the technology for entertainment and communication in general.

What we get in the bargain is the remote control. As adults we may have a perspective on the technology that is not necessary the same as the pupils or students. We have, as we say, access to information that scientists could only dream about a few years ago. On the other hand the Internet is an el dorado for uncensored entertainment and participation in all kinds of activities. If we shall use a television metaphor we will probably experience that in the choice among some millions of channels, the channel directed towards schools may not be the preferred one. There are a lot of pitfalls in this battle for the remote control, censorship is one.

Someone, I don't know who, has coined the term "homo zapiens" as a fairly accurate description of the human as media consumer. There seems to be a dominant reaction among learners, as well as others, to switch channel when thing gets boring or difficult.

Time and Space

Many observers of the field of technology and pedagogy has up to this day stressed that we are in a very early phase, and the things we have done is at best preliminary exercises to gain experience. Serious applications is not meaningful until the access to technology is almost unlimited. The technology must be part of every learners daily tools. This idea was first expressed as the idea of the Dynabook in the work at Xerox Parc, and has been elaborated on a number of times since then.

We are now, much faster than most observers would have anticipated, getting closer to this situation of general and unlimited access. We are not prepared for this. One of the greatest challenges we are facing are the organisation of time and space in learning situations. The organisation we know from the school with "computer laboratories" is not a suitable way to face this challenge. It will put the schools in a situation where access to technology is better in most

homes and in a lot of other public situations.

The organisation of time as 45-minutes lessons with a break and change of subject will be put under pressure. The "one teacher speaks to 30 pupils for 45 minutes" will not work. The lesson as an event for distribution of information will loose its relevance relative to organised project work. The school system, on all levels, must justify its form as a consequence of the learning that takes place or the learning that we want to take place. This will be a frustrating situation for teachers and student for quite some time.

The ultimate issue of this challenge is that the public schools system will tend to loose ground compared to alternatives. This will happen on all levels in the school system, from kindergarten to university. If we want to keep a public education with high quality we do not have much time to make the necessary changes.

Praxis

[CD-rom] [School Networks] [Distance Cooperation]
[Metaphors for Learning] [Web Courses]

The situation we are in does in many ways carry the characteristics of a transient period. The technology is changing rapidly and a lot of the interesting thinking and doing in education is described as experiments, often with a rather radical distance to the dominant traditional praxis.

I have suggested that one of the most important frameworks from the Piaget period is no longer valid: We cannot construct closed, protected microworlds and we cannot take as granted that no one escapes or finds other sources for information, and knowledge. On the other hand it is obvious that the challenges we have discussed, massive access to information, knowledge vs. information, the lack of context etc., is leading to a lot of thinking about alternative structures. Much of the praxis that we see to day may be considered as attempts to regain control.

CD-rom

CD-rom is a media for archiving and distributing piles of data limited to about 650 Mb, and nothing else. CD-rom is however in some contexts becoming some kind of pedagogical unit. There are pedagogues who speak of "CD-rom as a method". In itself a meaningless statement. What can be suspected is that this is an evaluation of a CD-rom as a reasonably great amount of structured, or less structured, data for "free search". One may consider this as an attempt to regain control over chaos.

We see a lot of 650 Mb units for educational use which are some kind of mixture between effects, data and more or less random media clips. The usability, beyond entertainment or mere browsing, is difficult to grasp.

School Networks

We see the emergence of a lot of what is often referred to as school networks, although they are web sites which are meant to be resource centres for pupils and teachers in a local or national school society. The sites publish a lot of different things, from technical "how to" material to news form the ministry, and tips for teaching and even news that is considered relevant for students homework. This is probably a necessary and useful development, but there are a few things to watch out for.

Firstly the common experience that it is a lot easier to establish a web site than it is to maintain it. The resources needed to maintain a good website is usually underestimated. Specially the web

sites which are based on contributions from the readers are vulnerable in this respect. There are quite many examples of sources for information that is drying up after a fresh and promising start.

Secondly there is a danger that the content will be bad copies of material that is in the schools already. There is easily a clash of cultures if we try to use the new media to present existing material in traditional form.

Distance Cooperation

A very promising development is the establishment of cooperative projects between schools, often across geographical, cultural and language borders. A scheme that seems to be usual is the treatment of a common theme based on contribution from the participants. Measurements of pollution is an example. The compilation of reports based on distributed observations or measurements prepares the ground for important learning.

It is necessary to agree on explicit contexts to make sure that the results are comparable. This opens up for a valuable reflection of the value and reliability of sources of information.

Participants in this kind of cooperative projects will through personal relations disclose other sides of other cultures than those filtered through the problem oriented press.

The strength of this approach is that the technology is used as a **tool** in a planned pedagogical process. The technology in itself is neither the target of education nor the anonymous source of information.

Metaphors for Learning

A key issue in designing technology based learning material has been metaphors for communication, motivation and learning. There is a considerable danger for some shortcuts in the design of metaphors on the technology we see at the moment. The metaphors which was necessary and useful in closed microworlds may be out of order in an open distributed technology.

A project is described shortly this way: The objective is to create contact and mutual understanding across borders in Europe by discussing actual political and cultural questions. The metaphor is is a virtual parliament where everybody can meet and participate. The parliament has a structure with agendas, voting etc. The project has students at European teacher colleges as a target group. See The Demeter Parliament [16].

To me this project represents a paradox. I can easily understand and appreciate the intentions. It is an illustration and even a training in formal democratic decision making processes. The main problem is that the technology is used to simulate a process that the technology can be used to implement in reality. As a teacher student I would probably have problems to motivate myself to play democracy with this metaphor in stead of taking up real issues with students in other countries. It would be a far more interesting challenge to implement actions and attempt to influence real decisions. The learning effect would a little different, but probably greater and more valuable.

This example may serve as an illustration of two different methodical perspectives. On one hand we may have an easily accessible illustration of a phenomena, with or with out active participation. On the other hand we may have an interesting action based version of a project oriented approach.

Web Courses

The production of web based learning material is growing at a fast rate, specially in higher education. Universities, colleges and private commercial operators produce courses of different types and quality. This development is interesting at it will probably lead to rather fundamental changes in the organisation of higher education. The competition in this market will become very hard.

It is difficult to point at common factors or to make classification of the available products, the differences both in approach and in quality is large. It is however possible to discuss a few principles and look at e few key issues.

Sequential lessons

Although the phrase "open and distributed learning" is used frequently, many of the available courses are built as traditional sequential series of lessons, typically one each week. The only change from the traditional mail based courses is the technology with which the students and the teacher communicate. It may seem a paradox that the students possibility to work in her own pace is ignored. The arguments for this structure is partly of administrative nature. Advocates for this approach argues that the students appreciate this "pacing" of their work.

Student activity

It is still a fact that most of the web based courses are designed for teaching, not learning. The emphasis is on the course, the administrative overhead and the material, not at the students work. We are repeating old behaviour, conveying information, on new technology. The technology should lend itself to another approach with the students activities in the centre.

This paradox is probably the greatest challenge we are facing when it comes to web based learning. It will be of crucial importance to succeed in stimulating student centred activities, beyond the traditional mandatory assignments. If we do not succeed in this we will not succeed in what is probably the most important objective: To prepare students for a continuous learning process.

The qualities of the surroundings

Universities and colleges has an objective beyond the mere education in a subject. The institutions are expected to contribute to a certain socialisation and shall be the carriers of traditions, and what follows from that like ethics and a critical approach to knowledge. It is also a fact that a lot of the actual education takes place outside the courses. Students learn from each other and so to speak from the walls. This is the established institutions foremost quality as educating institutions. It is in light of this quite a paradox when universities and colleges strive to establish complete basic educations based on the web only.

The Teachers Role

[Blooms Taxonomy] [Teacher in Centre]

It is commonly agreed upon that a new role of the teacher is a key issue in connection with use of new technology. This is obviously true, but there are few in-depth analyses of what this role is, beyond some general statements that the role must put more emphasize on counselling and less on traditional classrom activities.

We may look for some footholds for a more nuanced description.

Blooms Taxonomy

Blooms taxonomy of educational objectives [15] in the cognitive domain from the 50's are well known to pedagogues. It may serve as a foothold for some central problems that challenge the teachers role.

Evaluation	appraises, concludes, confronts, criticizes, decides, defends, interprets, judges, justifies, reframes, translates
Synthesis	adapts, anticipates, categories, collaborates, combines, communicates, compares, compiles, composes, contracts, contrasts, creates, designs, devises, expresses, facilitates, formulates, generates, incorporates, individualises, initiates, integrates, intervenes, models, modifies, negotiates, plans, progresses, rearranges, reconstructs, reinforces, reorganises, revises, structures, substitutes, validates.
Analysis	breaks down, correlates, diagrams, differentiates, discriminates, distinguishes, focuses, illustrates, infers, limits, outlines, points out, prioritises, recognises, separates, subdivides
Application	acts, administers, articulates, assesses, charts, collects, computes, constructs, contributes, controls, determines, develops, discovers, establishes, extends, implements, includes, informs, instructs, operationalizes, participates, predicts, prepares, preserves, produces, projects, provides, records, relates, reports, shows, solves, takes, teaches, transfers, uses, utilises.
Comprehension	classifies, cites, converts, describes, discusses, estimates, explains, generalises, gives examples, paraphrases, summarises, understands.
Knowledge	defines, enumerates, identifies, labels, lists, matches, names, reads, reproduces, restates, selects, states, views

A rich, unlimited access to information will easily support an activity in the lower part of this ladder, both for students and teachers. At the same time the situation demands that we gives the learner training in operating on the top of the table. It is important that the learner is trained in evaluation of available information, and knowledge. To be conscious of own learning is crucial in a perspective of life long learning.

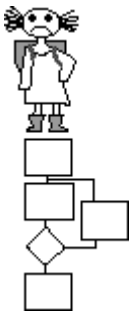
One of the fundamental problems we experience in higher education is that the students expect to be teached. This indicates and invites a communication on the lower levels.

There is a great challenge to teachers in all levels of education in this situation. The teachers role will in many ways be more difficult when the access to information increases and the control of the information decreases. A development in the direction of mentor or counsellor is not trivial. The probably greatest, or at least the most underestimated, demand is the demand for competence. Teachers who settle for a communication on the lower levels will inevitably be unmasked when

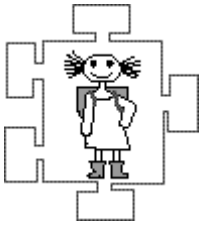
confronted with alternative knowledge. Such alternative knowledge must be explicitly evaluated, both to evaluate its value in the actual situation, but most of all to contribute to the students own training in evaluation.

Teacher in Centre

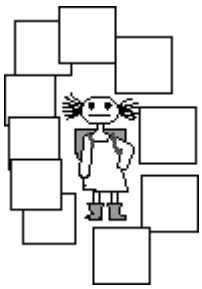
In the coarse models I have used to describe the three phases, Skinner, Piaget and Rousseau, I have without further comments placed the pupil or student alone in relation to a structure, and have said nothing about the position of the teacher in relation to these structures.



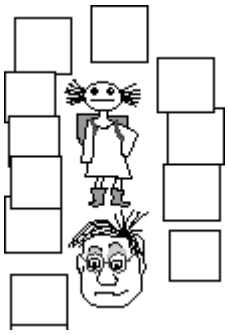
In Skinner's world it is clear that the teacher has prepared the whole learning process in detail, and during the learning takes on the role as observer and evaluator. The teacher is clearly outside the structure and there is no active participation from the teachers side once the setup is ready.



In the Piaget phase the program designer, teacher or not, has laid down the rules and the premises for the learning that takes place. There is a certain room for experimenting in a relatively open structure, but this freedom is limited and within frames, the microworld is closed. The existing freedom does lead to some of the difficulties discussed earlier. The distance from the teacher to the designer does also create a distance from the teacher to both the product and the learning process.



I Rousseau's image the teacher has voluntary or involuntary, given up control. Much of the praxis we see are implicit or explicit attempts to regain control over the structure. Such attempts are probably necessary and in some cases wise, but there is a great danger that it is done on wrong premises. It happens to a great extent after a model which are outdated by the technology. The teacher as a director and controller of information is no longer possible.



The challenge is to take part in the learning on the premises of the student and the surroundings. If we extend the metaphor we have used to illustrate the history, we must find a place for the teacher within the structure. Teacher and student must to a great extent share the challenges and cooperate in transforming information into knowledge, whether it is done in a project oriented approach or not.

There is of course nothing new in this approach. The interesting and challenging part is that it is the technology which provokes this situation, and suggests a solution. Papert, who introduced Logo in the 80's, have made some interesting comments on this situation[17]. He claims that the technology for the first time has made activity pedagogy feasible. It is tempting to say that it is not only possible, but necessary.

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...based on the futile hope that all the web sites exists

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