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EDUCATIONAL MULTIMEDIA

- WHAT TEACHERS NEED TO KNOW TO CARRY THROUGH THE SOCIAL CONSTRUCTION OF INFORMATION TECHNOLOGY

BENT B. ANDRESEN (ED.)

ROYAL DANISH SCHOOL OF EDUCATIONAL STUDIES

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TABLE OF CONTENT

INTRODUCTION

The three major themes of this book are teachers' competences, pedagogical innovations, and the application of educational multimedia into schools[1].

Pedagogical innovations are a constant theme. Currently, pedagogical innovations are often made possible by the application of educational multimedia into the classrooms. Their potential for improving the quality of learning is significant and there is already a growing body of evidence that the integration of multimedia can foster learning[2].

Consequently, producers of educational multimedia have an essential role in the process of integration. By providing multimedia tailored to the needs of students and teachers, the producers potentially can foster innovations in schools.

Even more important, however, is the role of teachers in the modernisation of education. Since the teachers are in charge of the planning, running and evaluation of the use of information technology, they can transform the potentials of educational multimedia into reality in educational settings. The social construction of the information technology performed by the teachers is crucial to the way students may benefit from the digital tools and media.

Hence, teachers should be offered pre-service and in-service education in order to initiate them in the ways in which multimedia can be used to respond to the needs of the students.

The teachers have to learn how to locate, evaluate, and select appropriate teaching/learning resources and curriculum materials for various content areas and audiences of students. This includes multimedia-based products, texts, reference books, and other sources.

The teachers also have to know how to organise the use of such products and to make sure that it is appropriate for teaching objectives, relevant to students, and based upon principles of effective learning. Therefore, teachers need knowledge about 'best practice' with educational multimedia.

In other words, teachers need to know how to incorporate multimedia for teaching and learning purposes where appropriate, and to support student expression using a variety of multimedia tools. To be able to do this, teachers need a new type of competency – an ability to produce useful changes and results – requiring a combination of concepts, skills, and pedagogical capability. They need knowledge and skills about current multimedia products and tools to be able to use these products and tools by themselves. And they need didactical

[1] This book arouses out of the project PEDACTICE concerning educational multimedia in compulsory school (EEC Project MM1043).

[2] Abbott, C. 1995. *IT helps*. London: NCET.

competency – pedagogical knowledge and capabilities and an appropriate skill set – with respect to the application of multimedia into education.

The first competency includes familiarity with, among other things, word processors, painting and drawing tools, compression of images, digital cameras, scanners, and camcorders. The conceptual knowledge, intellectual capabilities, and appropriate skills needed by the teachers also include the ability to plan, record, digitise and edit video and plan, input and digitise sound from microphone and audiocassette player/recorder. In addition, it includes knowledge about how to access and use resources on CD-ROMs, DVDs, and the Internet. This includes knowledge about how to compose, search and send requests for information, retrieve, read, and process information of various types including text, numbers, images, animations, sound, and video clips. It also includes knowledge about the role of these tools and media in effective communication, i.e., the characteristics, strengths, and weaknesses of the different means of expression and communication.

Taking the best scenario (as the teachers are used to do), which often includes activities with educational multimedia, teachers can improve their teaching. Therefore, teachers need to be familiar with possible scenarios of integration of multimedia into education. They need knowledge about different types of learning situations with multimedia. In particular, teachers need to know some of the answers to the questions essential to pedagogical practices with multimedia, i.e., questions like "How can students use multimedia, for what purpose, in which ways, and with which results?"

The answers to such questions cover knowledge about 'best practice' with multimedia. This includes knowledge about scenarios concerning the students' reception of multimedia with different content and structure as well as scenarios where the students use multimedia communication tools to present their results.

The material in this book consists of three articles. The first article is *The Art of seeing the Forest and the Trees: Teachers' Information Technology Literacy and Multimedia didactical Competency* by B. B. Andresen. It reports from research, currently in progress, concerning the best way to identify, characterise and communicate knowledge about the use of multimedia in education to teachers. The article presents four sets of answers to the important questions related to the current widespread use of educational multimedia. The answers are identified as four distinct pedagogical scenarios:

1. Reception of the content of linear multimedia products;
2. Reception of the content of non-sequential multimedia products;

3. Reception of the content of multimedia products aimed at teaching;
4. Production of the students' own multimedia presentations by means of proper tools to handle texts, graphics, video, sounds, etc.

Best practise in line with any of these four scenarios, or with a combination of these, requires that the students and teachers become information technology-literate. They need certain knowledge and skills to be able to use educational multimedia effectively and appropriately. This includes the knowledge and skills needed to use the information technology to locate and collect information, analyse information, draw conclusions, and communicate results clearly in a variety of formats.

In the first article of this book, the application of multimedia pedagogical practices is considered in relation to new literacy. The article review the literacy needed to use information technology – in particular, educational multimedia – in teaching and learning. The perspective is twofold; the students as well as the teachers need this new literacy.

The third part of the article deals with teachers' pedagogical competences. It considers multimedia pedagogical practices from the point of view of teacher education, since teachers need suitable competences to be able to apply educational multimedia into their pedagogical practices. The article specifies these new requirements in pre-service as well as in-service teacher education.

The teachers' selection and application of multimedia products and tools should be driven by pedagogical considerations rather than technological. This means that the teachers need knowledge about learning principles that goes well along with the use of multimedia and are able to fully exploit the learning potentials of these new media. The second article of this book, *The Challenge of Problem-based Learning: How to practice Student-centred and Self-paced Project Work* by Signe Holm-Larsen, considers the learning potentials of project-based learning.

As for the project method this article is concentrated on three main aspects: the methodical key concepts, the central points in the students' working process and the role of the teacher in a student-centred and self-paced learning strategy. In each area, the project method and the use of educational multimedia can be combined in order to support students' responsibility of own learning giving more room to independence in choice of what to learn how and when.

The article represents findings from studies about the essential concepts of problem- and project-based learning needed by teachers to fully exploit these learning principles. In particular, the article defines terms as *problem and product orientation* and summarises the relations between project and curricula content, and outlines the important themes of interdisciplinarity and subject proficiency.

Moreover, the second article deals with different aspects of evaluation and assessment.

In particular, it deals with the different phases of project work in the classroom situation underlining how to develop the students' capacity to structure own learning process. It considers the whole spectrum of activities from the introductory event in the very beginning, through the range of activities directing the work such as choice of topic and working pattern, problem formulation and use of information, until the presentation of the final product.

The role of the teacher in project-based and self-paced learning is new for many teachers. Traditional teaching relies upon the principle of teacher directed activities, but in project work the goal is the student directed learning process. It demands a range of guidance competences such as how to support without overtaking the students' work. Therefore, the teachers have to assume suitable attitudes and roles. It includes the roles as adviser of the process, expert in special subject matters, inspirer when spirits are low, arbiter at group discussions, critical friend in order to provoke students to seek beyond the easy solutions, and evaluator with the objective to improve the students' learning capacities in general.

Information technology-literate students and teachers possess knowledge about terms such as hypertext, multimedia, and linear and non-linear narratives. Furthermore, they are able to localise and apply the information from linear multimedia presentations and non-linear, hypermedia presentations.

The third article of this book reports research concerning some of these basic technical competences a teacher must possess to be able to apply multimedia effectively into teaching and learning situations.

Considering the literacy, most of the multimedia products are built on a platform with a graphical user interface. Therefore, it is necessary to be familiar with the use of such user-interfaces, e.g., teachers must know how to handle files, windows, dialogue boxes, system-breakdowns, etc.

Still considering the literacy, teachers need the ability to understand and use the different symbols presented in multimedia products. To fully exploit a multimedia CD-ROM or the World Wide Web, it is necessary to possess knowledge about navigation in hypermedia. Search techniques are essential to the use of most hypermedia products and especially the web. Therefore, knowledge about the most basic techniques when using a search-engine is essential to find a particular piece of information on CD-ROM or on World Wide Web.

As mentioned above, teachers (and students) need to learn how to use and produce digitised material, in order to convert between digital and traditional, analogous material. For example, if the students are using a multimedia product, they may find a photo on a CD-ROM (Scenario No. 2), which they want to use in their essay or report. In addition, if

they produce their own multimedia-product (Scenario No. 4) it is a core-activity to produce and handle digitised material.

Together the three articles summarise findings from research on the teachers' competency in the field of information technology – in particular, educational multimedia. The target audience of the book includes decision-makers in the educational system, researchers, persons in charge of pre-service and in-service teacher education, and producers and publishers of multimedia products for education.

December1999

Bent B. Andresen

BENT B. ANDRESEN:

THE ART OF SEEING THE FOREST AND THE TREES:

TEACHERS' INFORMATION TECHNOLOGY LITERACY AND MULTIMEDIA DIDACTICAL COMPETENCY

INTRODUCTION

This article concerns the increasing application of educational multimedia into schools. The educational multimedia products and services are considered from the point of view of pedagogical practices.

The article addresses the following questions: How can the students use multimedia, for what purpose, and in which ways?

To be able to address questions like this, the article identifies four pedagogical scenarios that are all related to the current widespread use of educational multimedia.

The multimedia pedagogical practices are considered in relation to new literacy. The article identifies the literacy needed to use educational multimedia in teaching and learning. The perspective is twofold; the students as well as the teachers need this new information technology literacy.

Moreover, the article describes teachers' pedagogical competences related to the application of educational multimedia into schools. The article specifies these new requirements from the point of view of pre-service and in-service teacher education.

PEDAGOGICAL SCENARIOS

Currently, students are encouraged to use a growing number of multimedia products in a number of different ways. Some of these multimedia genres widely used in schools - and the typical ways in which students currently use these genres to foster their learning - can be categorised in four pedagogical scenarios, each of which is characterised by a particular function of multimedia products and on-line services.

It does not mean that the widespread multimedia pedagogical practices are considered limited to these four scenarios. The intention is to present a categorisation of mainstream pedagogical scenarios and not to present an exhaustive list of possible scenarios.

The four scenarios considered cover widely used multimedia genres in educational settings. Many approaches are similar to one of the scenarios presented. Alternatively, they consist of a mixture of these four scenarios. More specialised or advanced scenarios may, of course, also be found.

FOUR PEDAGOGICAL SCENARIOS

The concept of *pedagogical scenario* designates a postulated sequence of imagined events aimed at learning. Each of these is characterised by particular roles of teachers, students and educational multimedia

products. Scenarios No. 1-3 consider the students as end-users of messages from these media, whereas scenario No. 4 considers the students as producers.

Table 1 illustrates some of the differences between the four scenarios. Scenario No. 1 covers the use of linear multimedia products; the second scenario covers the use of hypermedia admitting linear as well as non-sequential reception. In Scenario No. 2, the locus of control is assigned to students. The students are assigned an active role, since they select topics and jump between these. The educational products used in Scenario No. 1 are designed to control the process of presentation. They so to say control the process, as soon as the students initiate a session.

The students are assigned the role as end-users	No. 1	Reception of the content of linear multimedia products
	No. 2.	Reception of the content of non-sequential multimedia products
	No. 3.	Reception of the content of multimedia products aimed at teaching
The students are assigned the role as producers	No. 4.	Production of the students' own multimedia presentations by means of proper tools to handle texts, graphics, video, sounds, etc.

Table 1. Students as Users of different Multimedia Genres

Scenario No. 3 covers the use of multimedia products aimed at teaching. The teaching strategies form a spectrum from provision of ordinary corrections and responses to comments and explanations out of the ordinary tailored to the particular needs of students.

Scenario No. 4 considers students as producers of multimedia. The producer role refers to the student as creator, inventor, producer, developer, and designer of messages, information, and knowledge. In principle, the process of production begins with an empty sketchpad and with a mind full of ideas.

The process benefits from the use of the information and communication technology. The computer is a versatile representing tool, probably the most versatile tool ever created by humankind (Nichol 1988). Students who work with at task or problem can for instance represent verbal and visual data in various ways depending on the purpose. They can use diagrams and maps and flow-charts. Information can be represented in hypertexts, tables, or as objects in databases. Numbers can be represented as values of cells in spreadsheets and then visualised graphically. Experiential knowledge about the relation between input and output of a process can also be

represented visually. Knowledge about actions and events can be visualised in networks or tree-like representations.

In addition, the interactive systems provide editing facilities that allow students to edit texts, drawings, graphs, tables of numbers, etc. This feature revolutionises the student-teacher interaction. Students can overcome to make several drafts before they finish the product to be handed over to their teacher or presented in public. At each stage, the teacher can supply verbal advice or written comments, so the students can rethink and improve their design. The new paradigms change the learning styles towards a process-oriented approach as opposed to a product-oriented approach.

Consequently, the concept of multimedia pedagogical practices has different meanings to students, teachers and producers. The following paragraphs attempts to answer questions like: What is the function of multimedia products and on-line services? What are the roles of the students? How does it change the roles of the teachers? The paragraphs identify four answers to these important questions that are all part of the current widespread use of educational multimedia.

SCENARIO NO. 1 - THE USE OF LINEAR PRODUCTS

Multimedia contains texts, graphics, animations, video, and sound in an integrated way. The content can be structured and presented in different ways. One multimedia genre has a linear structure that leads students through different sub-tasks in sequence. This mode of presentation is similar to the traditional narratives presented in films (Luckin et al. 1998).

These linear, digital products are distributed through the Internet, on CD-ROM, or on DVD. The students can use them for many purposes. They can for instance study a particular part of the news from yesterday, watch and listen to a dialogue in a foreign language, watch and imitate a particular process of work, and observe outlandish plants and animals.

Non-sequential clips like these are often integrated with advanced search engines that allow students to search and use suitable clips in their learning. For example, the multimedia encyclopaedia, Encarta, contains more than one thousand videos and animations clips and more than three thousand sound clips.

This kind of material is sometimes accompanied by texts that the students can use for selecting, organising, and synthesising the contents of linear systems. For example, the students can study outlines or lists of key words before they listen to a voice over, study an animation, or watch a video clip.

In principle, the students can pick the episodes they want. Once potential useful sources have been located, they have, however, very limited control during the narration. They can go backwards or forwards along the narrative line until they have seen all sections. Except from that, they cannot alter the content.

SCENARIO NO. 2 - THE USE OF NON-SEQUENTIAL PRODUCTS

Scenario No. 2 deals with multimedia products that are hypertext-based and thus more interactive than the linear products used in scenario No. 1. Students can use such non-linear products as information providers. For example, they can use CD-ROMs and on-line services like Encarta, Multimedia H. C. Andersen, Cinemania, and World Atlas in their processes of learning.

The students can use the content of such products to answer questions and solve problems in their tasks and projects. For example, they can use a multimedia encyclopaedia or a digital map to research a region of the world. How does Australia look like on the map, where are the landmarks, which ethnic groups live in the different areas, how is the climate, what is Great Barrier Reef, etc.?

From the point of view of the producers, this line of products is well known. The genre extends the use of analogue textbooks. Compared to the printed textbooks, the non-linear digital products usually integrate many different types of media including text materials, numbers, statistical data, pictures, speak, music, animations, video clips in an interactive context.

In a traditional classroom, the ability to achieve responsiveness is severely limited. In a classroom with more than a handful of students it is impossible for a teacher to respond to the interests of individual students (Schank and Edelson 1989/90). The use of interactive products, however, can encourage reflection and support the efforts of the teachers. The multimedia products can provide educational material and information according to the students' needs and motivations. Furthermore, they can provide feedback and answers tailored to the needs of the students.

Thereby, the use of these interactive media can help the students become self-directed learners.

Students who use such media have access to knowledge of remote experts. They are mentally free to go where they want within the content that is 'alive' in the sense that it is ready for use in the students' task and problem solving activities.

The use is exploratory with some constraints. The constraints are caused by the limited amount of topics covered in the multimedia products. Links to external sources might compensate for these limitations. However, in principle the information within a particular multimedia product or on-line service is always limited to the knowledge supplied by the producers.

The interface usually provides a search engine. Furthermore, it offers a variety of buttons and options that students must decide upon (Luckin et al. 1998). The students have to be active to benefit from the content of different sections. Typically, they can access different sections from a main menu, an index, or a word search mechanism at the top level.

Usually, the products offer no guidance through the different sections of the educational content. This leaves students to define their own task sequence. They have to use the multimedia genre in a way similar to the way one uses an encyclopaedia. They have to decide what type of answers and information they need and use the systems to provide this information. Students are assigned the role as explorers and encouraged to be creative and define their own tasks.

The interaction shown in figure 1 illustrates the typical function of an educational multimedia genre used in this manner. A typical interaction consists of the following steps: Students begin a session. They choose a task or problem to be solved. Input supplied by students thus includes questions to be answered and goals to be achieved. Eventually, the students supply some case data by picking alternatives in menus or deciding to use particular links. In response, the multimedia systems provide this information to help students to solve a problem, classify some objects, make an analysis, foster a plan, decide, etc.

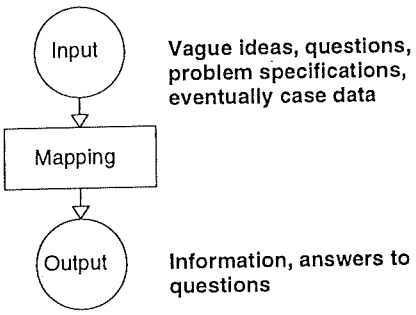

Figure 1. The Resource Approach

The roles are clear: The multimedia program provides the information needed to solve the problem; the students interpret and implement proper actions based on this.

Moreover, the use of this genre of multimedia might have a relevant side effect. By experiencing the content of the non-sequential media, students become more able to omit inappropriate sources of information and concentrate on the information which is essential for doing something, such as completing a task (Tapscott 1998: 109).

Where this genre of educational multimedia is introduced successfully, it is often used to support new teaching and learning methods. These methods largely pass over the initiative in the hands of the students. However, it also changes the role of the teachers. The teachers must spend more time supervising and organising groups of students whilst monitoring and assessing individual progress.

Although this line of multimedia products potentially has much to offer education, it also has some drawbacks. Students' efforts are focused on particular topics. The student may want some information concerning the problem domain, for example the peculiarity of a country, the feature of an animal, the description of a historical event, or the attributes of a substance. Typically, this does not include

preceding topics. Consequently, the construction of knowledge is a side effect of the process. Students may ask for explanations. They may ask an exhaustive series of questions if they want to reveal all the grounding topics and reasoning paths needed to reach a particular information. Many students may not have this persistence without the teachers' support.

SCENARIO NO. 3 - GUIDED DISCOVERY

A third multimedia genre compensates for this limitation since it offers guidance to students. This line of multimedia products can guide the students in breaking down different tasks and helping them to structure a task sequence. It does not structure the narrative as strongly as the linear version and its narrative style is broadly between the two versions considered in scenario No. 1 and No. 2.

The context often contains motivating factors such as games, competitions and explorations. Therefore, this line of products has some characteristics in common with the genre called *edutainment* that mix some kind of educational material with some kind of entertainment or adventure.

Typically, students are supported through the different sections by being offered paths through the material. This means that they are not able to jump around within the content at will. When running, the product displays several guides. When students choose a particular guide, it breaks down into several points that students can select (Luckin et al. 1998). Therefore, the students have to select topics and sub topics, although the range of choices they can make at any given point is circumscribed by the structure of the product.

Among the overall pedagogical strategies that these products embody, two different strategies can be identified. They are labelled 'the tutoring strategy' and 'the critiquing strategy'.

The tutoring systems contain knowledge about a subject matter as well as knowledge about instruction. Typically, these types of products present the subject matter in drill-and-practice sessions that allow students to practice immediately.

The tutoring genre teaches the subject matter, for example subtraction or adjectives, and presents problems to be solved by students as shown in figure 2. The program then checks the students' answers and monitors their overall progress.

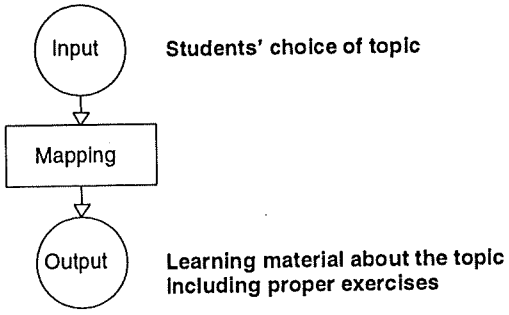

Figure 2. The Tutoring Approach

This multimedia genre as opposed to students defines the decisions, plans, judgements or the like. Students are active in the sense that they choose topics to be covered and propose solutions to problems within these topics, but the tutoring system has the overall control of the process and guides the students.

Alternatively, the critiquing genre has a different function and leaves a different role for the students. The students are the active part in the problem solving session in the sense, that the learning tool dictates the best way to solve the problem. They propose a solution of their own before they get support. Some examples are:

- Grammar checking of the students written productions;
- Number checking when students deal with fractions, equations, or magical squares;
- Responses on pronunciation in foreign languages.

This genre, which is not limited to multimedia products, is used to support, comment on, and evaluate learning. It is partly adaptive to the particular needs of problem solving efforts of the students. It is able to provide comments tailored to the needs of individual students. The interaction shown in figure 3 illustrates the use of this responsive strategy.

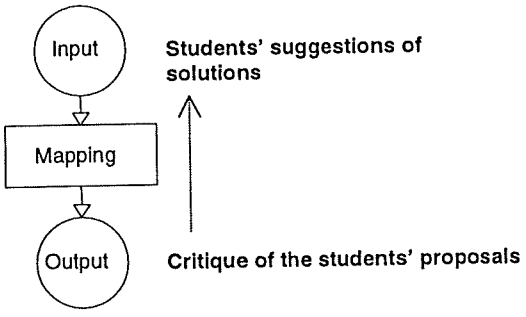

Figure 3. The Critiquing (Evaluation) Approach

For students who want to classify some objects, make a diagnosis, foster a plan, decide or the like, the critiquing (evaluation) genre can provide feedback tailored to the particular need of each student. The responses of the system can help them to confirm their hypothesis, refine their proposals, etc. The critiquing process is iterative. The

students propose a solution to a problem, get critique of this proposal, make an improved proposal, get new critique, etc. These responses are assembled dynamically and it is tailored to the particular case data and approach taken by students.

A critiquing system provides a non-threatening means to generate comments. Classroom experiences indicate that such support can be very useful (Miller 1984, Andresen 1990). The interaction between the students and the critiquing system can encourages students to formulate and explore creative hypotheses without fear of failure. It helps students focus on details performed successfully as well as negative details. It illustrates the value of failed hypotheses in learning.

Although the critiquing approach potentially has much to offer education, it has also some drawbacks. Advanced student models, which tailor the teaching to particular student needs, are difficult to develop in much subject matter. It is well known that most systems of this kind are partly adaptive. They are adaptive in the sense that the feedback provided is tailored to the students' input (Wenger 1987). However, they often provide the same type of response to students no matter how good or bad they are doing in the discipline considered.

SCENARIO NO. 4 - PRODUCTION

In scenario No. 1-3, the students use products that are completed by the producers. Students can jump to different branches and read at places of their own selections. However, they can not change the content. In that respect, this kind of educational multimedia is similar to textbooks, encyclopaedia, and films. To complete the scenarios, a fourth genre is considered, namely, the genre of multimedia tools.

Scenario No. 4 considers multimedia ingredients provided by publishers and others that are used by students to produce multimedia in the classrooms. Students are assigned the role of authors or producers. They can for instance use this kind of educational multimedia as productive tools for report writing and presentation.

From the point of view of the producers of multimedia, this is a newer line of products. The role of the producers is obvious, i.e., to supply multimedia genres that are not assembled but consist of building blocks. These elements should be indexed and described in ways that make it straightforward for students to localise and choose relevant and suitable elements. In addition, the elements should be free to use for students as long as they do not produce commercial products.

These tools could provide for instance text-based materials, numbers, graphics, images, sound, and moving pictures that students could process and combine with other materials in the way they wanted. Some examples of the content are:

- Maps;
- Photographs;

- Citations;
- Video clips;
- Music;
- Speeches.

The interaction shown in figure 4 illustrates the typical function of an educational multimedia genre used as a resource of material by students in their productions.

Students can use resources like these in several ways according to their particular tasks. For example, they can use them as communication devices for expressing or exchanging their ideas and sharing resources. They can also use the tools as means of communication when they have finished an assignment. Furthermore, they might use these means of expression and representation for problem solving, decision-making, and creative thinking (Abbott 1995).

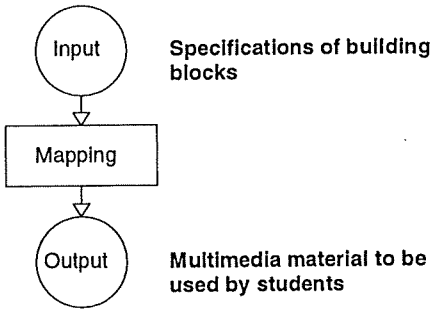

Figure 4. The Toolbox Approach

As opposed to the genres where the students are assigned the role as end-users, this line of products is open for creative student work in the same way as a brush and a palette of colours are. This approach is suitable in learning emphasising project work, team-based learning, self-directed learning, and self-paced learning. To foster these kinds of learning, the educational multimedia genres do not have to be completed or finished. On the contrary, they have to provide facilities that students can use to represent and present information and turn the information into knowledge.

Behaving as producers, the students do not build everything on their own. To some extent they can manage to shoot pictures by means of digital cameras. In addition, they might produce some video clips from their surroundings. Many topics, however, require texts, pictures, numbers, sound and video clips that students cannot produce by themselves. Dealing with themes like foreign capitals, the rain forests, the Great Barrier Reef, Mount Everest, the Moon, etc., students need to use building blocks supplied by producers or others.

In summary, the resource approach is a promising approach to educational software in the new millennium. The underlying pedagogical principle, however, is very old:

Tell me, I forget
Show me, I remember
Involve me, I understand
(Ancient Proverb)

THE FOUR FUNCTIONS OF EDUCATIONAL MULTIMEDIA

The previous sections have identified and characterised four scenarios that differ with respect to the role of the students, the teachers, as well as the function of the multimedia products and on-line services. These scenarios can be used to categorise the use of educational multimedia in the following manner:

- Multimedia linear educational sources;
- Multimedia hypertext-based materials;
- Multimedia supervising products;
- Multimedia productive tools.

As already mentioned, the four functions of educational multimedia should not be considered an exhaustive list of current products.

The scenarios can be used to analyse the needs for new competences, since they indicate some of the main applications of multimedia into schools. The scenarios can, among others, be used to identify some new competences needed by the students and teachers in order to benefit from educational multimedia. Both need to be literate in a way that encompasses multimedia. Moreover, the teachers need didactical competences – pedagogical knowledge and capabilities and an appropriate skill set – to be able to plan, implement, and evaluate learning with educational multimedia. The following chapters deal with these issues.

FROM READING, WRITING, AND ARITHMETIC TO INFORMATION TECHNOLOGY LITERACY

In the first decades of the nineteenth century, the current form of education that is based on teaching within specially constructed school premises emerged in Europe and the United States. The increasing use of written messages and printed mass media caused a need for reading and writing skills, and from the very beginning, the purpose of schools was to respond to individuals' needs of these skills.

In the twentieth century, new forms of literacy gradually began to emerge as a result of the appearance of media other than printed mass media such as books, periodicals and newspapers. First, literacy begins to encompass the ability to watch analogue media like television and video. Second, digital media extend the boundaries of literacy.

The students thus have to learn to access, analyse, evaluate and produce with screen-based media. The use of electronic media requires new analytic/critical thinking skills and production skills. In the new millennium, basic literacy is still considered important, but higher level of literacy is also needed to be able to access and interpret linear and non-linear digital sources.

The concept of literacy goes beyond simply being able to read and write; it has always meant the ability to read with meaning and to understand (Gilster 1997). It thus includes perception and cognition of what one see on the screen. Nowadays, this fundamental act of perception and cognition also concerns what one see on the multimedia computer screen connected to global networks. The users need skills already present in the context of printed media and the analogue linear media, but the digital media place new demands on the users. Not only must they possess skills of localising topics and finding things as described in scenario No. 2-4. They must also acquire the ability to use these sources in their lives. The skills of the information technology-literate have become as necessary as a driver's license.

The development of the literacy of the industrial society to that of the current society raises some important questions that will be addressed in this chapter:

- How can we define the concept of literacy?
- What are the characteristics of literacy that is adequate in the current society?
- How does formal education respond to the need of students and adults to acquire this new literacy?

THE CONCEPT OF LITERACY

The concept of literacy encompasses a complex set of abilities to understand and use the dominant symbol systems of a culture.

The concept of symbol is understood in a very broad sense. Symbols are the building blocks of our different sign systems. They are means of representation. They represent our ideas, thoughts, messages etc. Therefore, a symbol can be understood as anything that represents something for someone.

We change our symbols and representations all the time. Literacy is the ability to understand and use all the representations of a culture. Literacy encompasses a complex set of competences and abilities to understand and use different symbol systems.

The concept of literacy can be defined very widely as the ability to understand, use and produce symbols in different forms when they are presented via a wide range of media including multimedia computers.

Traditionally our culture has used symbols like verbal texts, omnipresent visual images, and dress. Digital media enable a new

view of literacy (Andresen 1992, Gilster 1997: 2, Tapscott 1998: 132). Currently the area of literacy is expanding to include the symbols of the digital media in addition to other symbol systems.

Many concepts are not logical concepts with short definitions. Instead, they can be considered prototype categories that encompass many types (Rosch 1983). This can be illustrated by three examples from everyday language. The category of 'animal' covers species like dogs, cats, lions, elephants, whales, etc. The category of 'vegetable' covers the whole range of carrots, potatoes, peas, beans etc. The concept of 'furniture' means stools, tables, couches, etc. Like this literacy can be considered a prototype category. It encompasses many types of literacy including the abilities required to use digital multimedia.

How many types of literacy exist? To be able to answer this question, we need to pose another. What are the important signifiers of a culture? The main signifiers of our culture are, among others, letters, numbers, image and sound. At a basic level literacy has to do with the abilities of individuals to receive and produce these signifiers and to understand the meaning they represent.

Considered a cultural phenomenon, literacy includes the full range of knowledge, skills, understandings, social values and attitudes. To be functionally literate means to be able to receive and produce the main symbols of the culture by versatile means including the multimedia computer.

The literacy required to thrive, study and work in society is evolving as society develops. In the information age, every person needs to acquire literacy with some level of proficiency in the following areas (Andresen 1996):

One area is the ability to read textual messages; another area is the ability to produce written texts. Still another area is the ability to understand numbers and make calculations, i.e., quantitative literacy or what the British call "numeracy". In other words, Reading, wRiting, and aRithmetic - the three Rs - are basic skills.

Media and Computer Literacy

Moreover, a newer area is the knowledge and skills needed to decode and understand messages delivered by means of linear electronic media like television, film and video. Media literacy covers the ability to access, analyse, produce, and evaluate information through a variety of these media. Included in media literacy is the ability to get hold of piece of equipment, know how to operate it, gather information, choose entertainment and understand the strengths and limitations of the messages on the screen.

Included are abilities to identify the myriads of individual elements in the media productions. This requires abilities to position each element within a message as a whole, to understand the relative weight of each element within the message, and to judge the worth of the parts and the whole (Downs 1996).

One more area of literacy is often called computer literacy. Initially in the seventies, computer literacy became synonymous with an understanding of hardware and software. Students were expected to know the parts of the computer such as the central processing unit, keyboard, motherboard, hard drive, monitor and printer. Furthermore, programming was considered very important. Students were required to become conversant in programming languages, since it was necessary to know the language to get the computer to do many of the actions required (Jensen and Andresen 1988).

In the eighties, the focal point shifted from programming to the use of a range of digital information and communication technologies and the content associated with them. Since the evolution of computer literacy, literacy covers the skills and knowledge required using digital technologies. This should not be defined as a minimal practical knowledge about computers. The sense of the notion *literacy* should be used to refer to someone as a literate person (Papert 1993: 52). A person with knowledge about phonics, spelling, and vocabulary (word level) but without knowledge about grammar and composition (sentence level) and comprehension (text level) would be considered illiterate. The same considerations ought to lead us to call someone who has an equally minimal knowledge about computers computer-illiterate.

The difference is not merely one of degree but of one of kinds of knowledge and skills. When one says: "X is a very literate person", he or she does not mean that X is highly skilled in deciphering phonics. One means that X has certain ways of understanding the world that derive from an acquaintance with literary culture. In the same way, the term *computer literacy* refers to the kinds of knowing that derive from a computer culture (ibid.).

In particular, it covers the ability to communicate and solve problems by means of computers. Computer-literate persons have an understanding of the application of the common software genres including word-processors, spreadsheets, painting programs, e-mails, and Internet browsers. Furthermore, they possess the necessary skills to be able to use the genres effectively at work, in the global classroom, and at home. The computer-literates can recognise, access and make use of many kinds of source materials, help screens and the like. They are comfortable with common activities like word processing, desktop publishing, calculations by means of spreadsheets, and sending and receiving of electronic mail.

The development of hypertext systems has made these abilities very important. Hypertexts materialise an idea of end-user as co-author. T. Nelson who developed the first hypertext system argued that the end-user should be assigned the role of co-author rather than receiver. The selection and combination of material should be handed over to the end-user. Whereas many drill-and-practise programs hardly give the user any freedom, the hypertext paradigm gives the user different entry and exit points and different routes through rich source materials.

This idea has become very influential; it has among others fostered the creation of a global hypermedia system (the 'World Wide Wonder'). Currently CD-ROMs, DVDs, and the global classroom of the Internet are used to foster flexible learning and make multimedia educational resources available in many classrooms. They make it possible to weave documents, graphics, sounds, and movies together into a fabric of thoughts, ideas, and experiences (Fillmore 1995).

Information Technology Literacy

Hypertext-based multimedia products give students immediate access to rich source materials. The use of such media can reinforce differentiated learning in a number of ways by offering a variety of experiences spanning all age groups (NCET 1996). The student audiences become the ones who select and combine the materials. The hyper-paradigm, so to speak, diminishes the role of the real author into supplier of educational material. The distributed and open architecture of hypertexts plays a determining role in the expansion of the definition of literacy. Due to the increasing use of interactive multimedia, the notions of *media* and *computer literacy* converge to *information technology literacy*.

Information technology literacy elevates the skills of traditional linear reading (Shneiderman and Kearsley 1989). The use of multimedia tools and communication channels requires analytical and critical thinking skills as well as production skills. It is necessary to develop adequate conceptual knowledge, intellectual capabilities, and an appropriate set of skills to be able to access, analyse, create, and evaluate information through a variety of software genres (Being Fluent with Information Technology 1999). As mentioned above, these concepts, capabilities, and skills are considered part of a new literacy – *information technology literacy*.

The information technology-literates are familiar with the networked computer and able to use it at the most versatile tool and means of communication ever created by humankind. For example, they know how to represent and process verbal and visual data in various ways for various purposes. Furthermore, they are familiar with the many ways in which words can be represented in hypertexts, tables, and databases. In addition, they know how to express formal knowledge, actions and events in tree-like formalisms. Moreover, information technology-literate individuals can edit photographs, drawings, diagrams, and maps via the computer. They also know how to create graphical representations of numbers. For example, it can be numbers represented as values of cells in spreadsheets. In addition, they have acquired skills representing sounds, animations, and movies in digitised form and integrating these with other means of expression.

Add to this knowledge about the *interactive* feature of the multimedia computer as described in the previous chapter. The hypertext structure and the tension between words, numbers, image and sound create a space for a new non-linear multimedial narrative (Downs 1996).

Skilled users of interactive multimedia are far beyond the unilateral receivers of linear messages via mass media. They do not receive the same message. They can negotiate meaning according to their need for information and depending on their previous skills and concepts, tacit knowledge as well as intrinsic motivation.

In addition, the information technology-literates know how to use the editing facilities that allow them to edit texts, drawings, graphs, tables of numbers, sounds, photographs, movies, navigable maps, etc.

This feature of the multimedia computer that was described in scenario No. 4 in the previous chapter can revolutionise the student-teacher interaction and increases the learning outcome. Students can manage to make several drafts before they turn in their final product. At each stage, the teacher can supply oral advice or written comments, allowing students to rethink and improve their work. The new paradigms are labelled *process writing*, *process geography, process math,* and so on.

Adequate conceptual Knowledge, capabilities, and Skills

The use of the digital tools and media requires adequate knowledge and skills to be able to communicate and to access, analyse, create, and evaluate information through a variety of media forms. These adequate skills are considered part of new information technology literacy.

Information technology literacy encompasses the ability to use digital tools and means of communication, and to create and construct personal products and messages beyond the styles and statements of others. Firstly, it elevates the skills of traditional linear reading and writing. Secondly, it elevates the audience beyond being the recipient and processor of information to being a participant in the content of multimedia productions. The audience no longer needs to be quiet about their experiences and conclusions. By means of the information technology, students can produce texts, illustrations, sounds and videos clips and join different discussion forums and carry their interpretation further (Fillmore 1995).

In summary, information technology literacy is a new form of literacy. Currently, electronic linear media and computers are converging into one new versatile technology. This technology is tailored to a variety of pedagogical settings, i.e., student-centred, project-oriented educational environments as well as traditional teacher driven educational settings. In parallel, media and computer literacy evolve to information technology literacy. This information technology literacy is the bridge to innovative ways of learning beyond the limits of linear media.

DIDACTICS OF MULTIMEDIA

The teachers have to develop didactical competences concurrently with the integration of multimedia into the learning experiences of their students. Teachers who acquire these competences can implement new pedagogical methods and ensure that their students develop up-to-date capabilities to collate, create, and express knowledge by means of educational multimedia.

This chapter describes the didactical competences in relation to multimedia that are needed to apply on-site and on-line extensions of the educational material of classrooms. In particular, it describes a model of pedagogical competences in the field of information technology, which h was developed for the Danish teacher education (Danish Ministry of Education 1998).

DIDACTICAL COMPETENCY

In this paper, it is decided to use the term *didactical competency* to designate the conceptual knowledge, pedagogical capabilities and appropriate set of skills needed by teachers to be able to implement information technology into educational settings. The notion of *didactical competency* refers to teachers' considerations and reflections concerning the best way to plan, implement, and evaluate the processes in which students develop their knowledge, skills, or values.

The didactical aspects of the use of information technology include planning, performance, and evaluation of learning where students use the technology in a number of ways. The new didactical competences are related to each of the current software genres. These genres are, among others, word processors, painting and drawing genres, spreadsheets, e-mail, digital information sources, etc.

The traditional curriculum related didactical competences and the new multimedia related didactical competences complement each other. In the future, the teachers have to be capable in both areas of competences. The two didactical aspects are illustrated in figure 5 (ibid.).

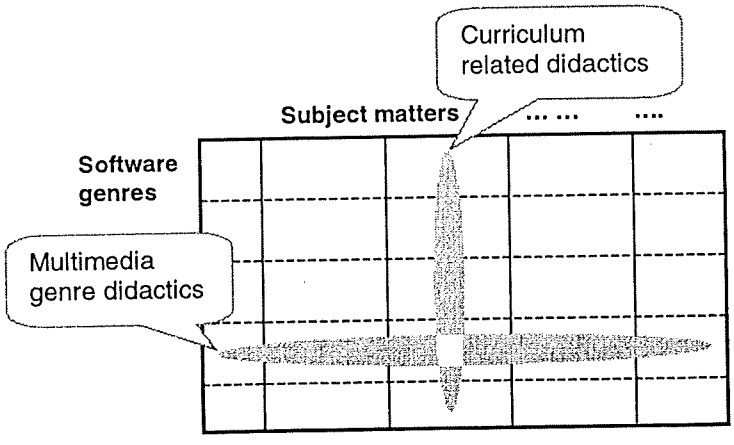

Figure 5. Two Perspectives considering the Application of Multimedia information and communication Genres into the Classrooms

For example, the genre of word processors can be used to foster students' learning in several manners. The didactical competences in relation to the application of word-processors into the classrooms deals with teachers' planning, implementation and evaluation of students' learning in which students outline, write, revise and print their work by means of computers.

Like word-processors, multimedia products and on-line services are becoming an integrated part of learning environments. Thus, teachers must be capable of deciding how to use these multimedia genres according to the overall goals of the students' learning.

In making these decisions, teachers need knowledge on how to use multimedia products most effectively in relation to subject-related and cross-curricular learning objectives. In particular, teachers must know how to (DfEE 1998):

- Review a range of generic and subject-specific multimedia products critically;
- Take account of the various functions of these products;
- Choose and use the most suitable functions and products to meet learning objectives;
- Recognise and judge the specific contribution that the use of these products can make to students' learning (in particular the benefits for students with special educational needs).

To fully benefit from the integration of multimedia into their class-rooms, teachers consequently need to be knowledgeable as regards the different ways in which multimedia can reinforce teaching. This is a question of a pedagogical and not a technical set-up. The significant question is not 'what can multimedia do to students?' but 'what can students do with multimedia, and what will the be the main outcomes?'

For those aspects of learning where multimedia is to be used, teachers must be able to identify in their planning the way(s) in which multi-media can be used to meet learning objectives. This encompasses knowledge about (ibid.):

- Ways of teacher intervention in order to stimulate and guide student's learning;
- Ways to assess students' progress;
- Ways to make sure that the use of multimedia is appropriate to the particular students' capabilities, taking account of the fact that some students may already be very competent due to home activities or participation in extra-curricular activities, and some may need additional support.

The teachers also need to be acquainted with most effective organisation of the use of multimedia to meet learning objectives. This encompasses knowledge about how to:

- Organise the use of multimedia with whole class, group of students, or individuals for introducing or reviewing a topic;
- Make multimedia resources available to students for their research ensuring that these resources are used profitable to achieve subject-related and cross-cultural objective;
- Organise the work of groups of students, pairs, or individuals dealing with multimedia for collaborative efforts and means of expression ensuring that reporting by students and teacher coaching take place when appropriate;
- Organise work with multimedia that is linked to work away from the screen allowing multimedia products to support learning rather than dominate students' activities.

In other words, teachers have to be capable of planning, implementing and evaluating activities with multimedia that reinforce the teaching efforts and foster the students' learning. The successful application of multimedia into schools requires knowledge about best practice with these means of representation and communication.

By the way, is scenario No. 1 more efficient than No. 2 in terms of students' acquisition of knowledge? Please, give it a thought. Research findings indicate that scenario No. 2 is superior to No. 1 (Luckin et al. 1998). The reason is that the students' recall of concepts is better and their amount of misconceptions is lower when they are able to control the media. This is not the case in scenario No. 1 where the narrative, so to speak, controls the students. Compared to this, the role of the students in scenario No. 2 is more active. The students use the media in an interactive way. This can help them to get rid of their misconceptions and to generate a narrative coherence of the subject matter for themselves.

Whereas scenario No. 1 described in the previous paragraphs leaves the role of the teacher unchanged, scenario No. 2-4 implies substantial changes in this role. Compared to the traditional teacher role, the role of the teachers elevates. Each of the scenarios No. 2-4 define a way of application of multimedia into classrooms characterised bye a particular extended teacher role.

Teachers must be able to decide when a particular scenario is beneficial to achieve their teaching objectives, and when the use of multimedia would be less effective or inappropriate.

THE COMPUTER AS MEDIA

For those teachers who have acquired didactical competences with respect to multimedia, the multimedia computer can be a valuable aid to education in terms of its function as media and tool. The scenario

model presented in the previous chapters indicates that the students can benefit from both functions. First, they can benefit from the communicative function of the multimedia computer when they look for answers and search information. Second, they can benefit from the use of multimedia authoring tools when they express and distribute the results of their learning efforts. Both approaches can thus enrich the learning environments in several ways.

To make that happen, the teachers have to deal with a number of didactical and methodological questions. An adequate multimedia didactics encompasses a complex set of capabilities to deal with questions like these:

- Are the objectives of the multimedia activities clearly stated, i.e. what could the students do with the content provided and how are these activities expected to enrich learning?
- Is it evident that the multimedia activities will be effective in meeting these objectives?
- What will be (a) suitable role(s) of the teacher when the information technology is integrated into the classroom to meet these objectives?

Most often, there will be more than one answer to these questions. Consequently the teachers should be able to plan, implement, and evaluate learning processes where the students access and use information from linear sources as well as non-sequential sources. Furthermore they should be able to plan, implement, and evaluate learning, where the students use multimedia products as information provider or means of expression.

MULTIMEDIA AS INFORMATION SOURCES

The following steps represent some typical steps of students using multimedia as information providers.

Generally, the students consider the information needed following their assignments. They have to determine what they need from the digital sources: Information about who, when, where, why and how?

The students can formulate the problems using one sentence, and continue their work parsing a variety of questions, or eventually classify, group, or label their inquiries. Sometimes they want to apply subject categories or use visual ways of representing the content. Furthermore, they can select particular multimedia sources containing information in particular formats that are appropriate for their learning styles and prior knowledge and skills.

Teachers can encourage these activities in a number of ways. They can coach and guide the students when they move from vague ideas to problem specification. Once the students have formulated the information problem, they often want to identify potential sources.

Then they may want to develop a plan for their use of multimedia sources taken into consideration.

The teachers may decide between different ways in which they can support the students in their use of these sources. In particular they may decide on how to tailor the support to the individual needs of the students and the different levels or abilities of students.

Students, who have learned to vary their reading process according to the purpose, can use a skimming procedure to determine the usefulness of the source. At first they can skim or scan for major ideas and essential concepts. Later, they can select potential useful sources and read them more carefully. The different forms of reading are illustrated in figure 6 (Andresen 1999).

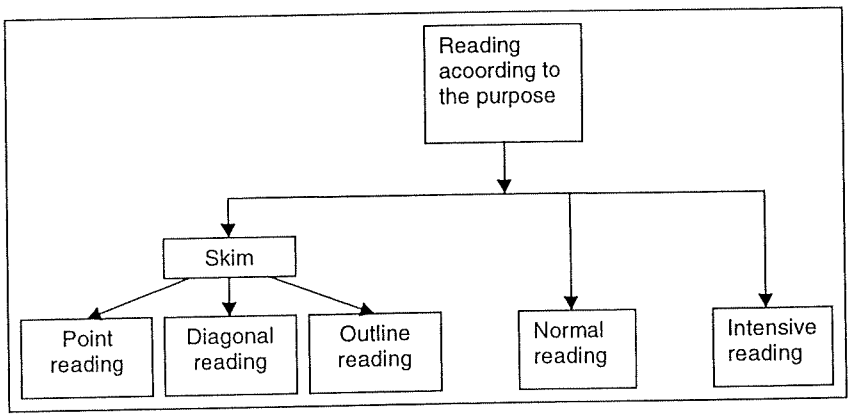

Figure 6. Different forms of reading according to the particular purpose

Because the journey through hypertexts is flushed with choices, search skills have become a core competency. The students have to develop the different reading skills together with critical reflection skills that then can govern what they find and read on the screen.

Other competences branch from these abilities to search and reflect critically. These competences require that students develop abilities to target their reading processes by using a strategy for searching combined with non-sequential reading. Consequently, the teacher must support students to learn how to navigate in Cyberspace as well as to assemble bits of information from divers digital sources and use them to construct their knowledge. Extensive reading supports intensive reading and deeper studies supports browsing for further information.

The sequential reading supported by non-linear jumps to alternative information should inevitably lead to increased comprehension. The journey through the multimedia learning resources is enriched with so many choices that it might distract or confuse the students. Increased comprehension requires critical thinking. The teacher should thus encourage these processes and help the students to question the authoritativeness, correctness, timeliness, appropriateness, or reliability of the content provided.

It is often hard to differentiate among facts and bias, i.e., opinions, personal points of view, propaganda, and to recognise omissions if any. Thus, teacher provided comments and guidance can be very valuable for the students concerning biased information.

Following an assessment of the information, students often need support by the teachers in their efforts to interpret and draw conclusions. The students have to develop their abilities to summarise the narrative with their own words, paraphrase important points, relate the content to prior knowledge, organise it, etc.

FROM IDEA TO STUDENTS' OWN PRODUCTS

The following steps are often at stage when students produce multimedia products on their own:

- Development of ideas and synopses;
- Visual representations in diagrams and production of storyboard;
- Listing and choice of the building blocks of different media, i.e., text, graphics, pictures, sound;
- Production, selection, and editing of the building blocks;
- Design of screens including means of navigation;
- Completing and evaluating.

There is not just one method for the students' design, production, and evaluation of educational multimedia products. A successful process that ensure learning can never be guarantied, but most often it enriches the learning when the students use a method called experiential prototype development. This method is illustrated in figure 7.

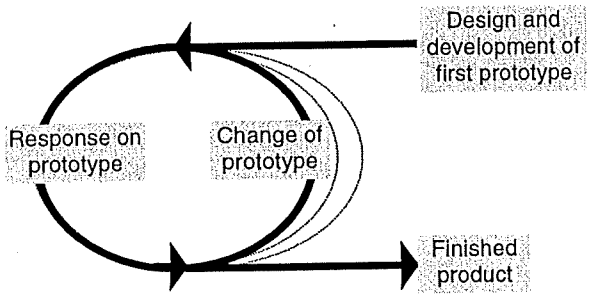

Figure 7. Experimental prototype development

This approach leaves room for the teacher to comment and provide feedback to the students at the different steps of the production process. It is, among others, considered important to coach the students while they write texts and assemble text and illustrations to ensure proper and suitable use of concepts and language.

CONCLUSION

In the information society, familiarity with information technology – in particular, educational multimedia – becomes essential to work and thrive for teachers. They need to know how to support their teaching efforts and their students' learning efforts by using multimedia products as versatile tools and means of communication and expression.

Teachers who have acquired genre didactical competences in relation to multimedia can frame the learning of students so that they fully benefit from their use of hypertext-based products that integrate several modes of representation.

Information technology literate teachers in the pedagogical sense of this concept are capable of guiding students who are accessing the educational content of multimedia products and on-line services. Furthermore, they are familiar with digital encyclopaedias, the Internet as an electronic extension of the classroom, as well as multimedia products that comes along with textbooks. In particular, they know how to encourage their students to access and gather knowledge, analyse and sort it out, apply it, produce, and create personal media messages, and to evaluate and judge them.

In addition, by virtue of acquiring and practising multimedia didactical competences, the teachers can teach students to become authors of multimedia products. These didactical aspects include planning and performance of learning where the students 'write' multimedia products in different genres. For example, the teachers can encourage students to use multimedia authoring-tools to develop, and publish web pages and multimedia products of many kinds. These products can include linear narratives, non-sequential presentations, or a mixture. They can, among others, be used to 'publish' and distribute the result of individual student's work as well as in co-operative project work between communities of students.

As mentioned above, the students benefit the most when they are assigned an active role in their learning process. The significant question in terms of didactical theory is not 'what will multimedia do to students' learning?' but "what can students do on their own with different multimedia genres?'

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SIGNE HOLM-LARSEN:

KEY CONCEPTS OF PROBLEM- AND PROJECT-BASED LEARNING:

HOW TO PRACTICE STUDENT-CENTRED AND SELF-PACED PROJECT WORK

INTRODUCTION

A review on project work as a pedagogical method reveals that the term problem- and project-based learning has been used frequently in many countries during the last 30 years at least. Such a review would, however, make it clear that project based learning can be understood in many different ways, reaching from a strictly structured method, totally defined by the teacher, to an independent way of learning, where the students decide on topic, material, working method and other educational aspects.

Project work can be used successfully as a learning method not only with young or adult persons, but with younger children too - in fact from the very beginning of the schooling and even before. Amongst the early proponents of the project method seen from an international point of view are for instance John Dewey, W.H. Kilpatrick and Maria Montessori who worked with persons of different ages, from children to adolescents and adults. The project method was introduced into the Danish educational circles in the 1960's at the university at Roskilde, RUC. Since then it has been tried out by many teachers in the pursuit of new ways of improving teaching. And as a matter of fact, with the new Act on the Danish Folkeskole of 1993 project work has now been fixed as a legal requirement also in the basic education in general. Thus, project work in Denmark is now integrated by law in the primary and lower secondary education, both as a general part of education and as the project task in the 9th form, where the students carry out a compulsory project assignment, for which the assessment shall be given in the form of a written statement and a mark, if the student so wishes.

Most important in the Danish approach to project work are the following points: the concept of a project, what to understand by problem oriented learning and formulation of problems, and how to consider student interests in relation to general educational concern in selecting the learning content. Very important is also to assure the model value of the educational activities. The focus on model value implies special care with respect to choice of main and sub topics, to interdisciplinarity and to other key points of cross curricular learning. Project work is fundamentally product oriented and this might call for including a wide variety of means of expression in the learning process. Finally, the demand of completing a product intensifies the working process by visualising the necessity of personal time planning.

A serious challenge, too, is how to implement in practice the ideas of project work in the students' working process and the use of continuous evaluation during the project. The realisation of projects is not always easy to combine with the every day school activities. Therefore, the issues above will be further developed in this

presentation of the project method, which focuses on 12-18 year old students. With small modifications, the considerations can hopefully be valuable in the teaching of all age groups, from children to younger students and adults.

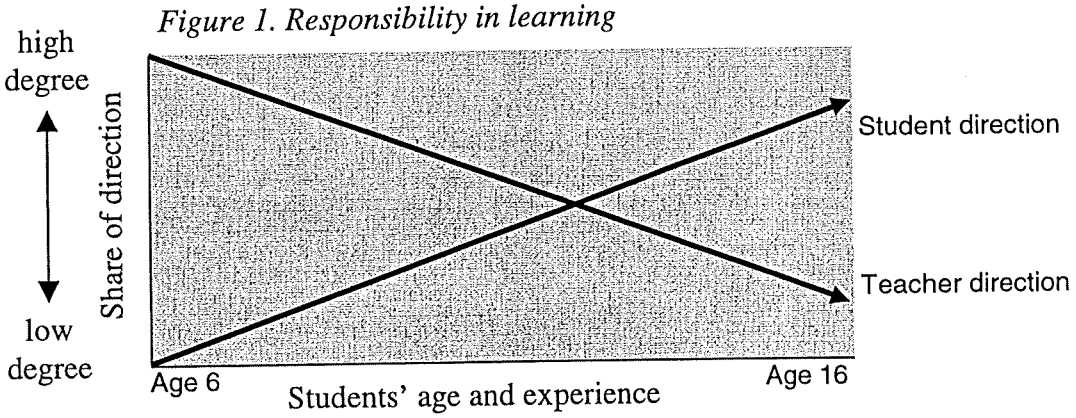
WHAT IS PROJECT WORK?

Even if project work as an educational term has been frequently used through many years, it does not always cover the same reality. Therefore, it might be useful to try to define the concept of project work as applied in this context, where the term describes teaching that

- Is concentrated on one topic
- Takes place over a period of a certain, but limited time
- Favours a student-centred learning situation
- Involves the students in the choice of topic
- Presupposes that the students collect and organise their own documentation, produce an end-product and present it for evaluating purposes to the class and the teachers rather than the teachers alone
- Transforms the teacher's function into the role of adviser

The concept of project work includes quite a number of varieties, especially due to the different degrees of structuring the projects. Growing with the age, experience level and maturity of the students, it is possible, little by little, to transfer the choice of an increasing number of aspects of the project process from the teacher to the students towards the goal of a working situation, where the students can work fully independently and self-paced.

Figure 1. Responsibility in learning



The students' experience potential to practice self-paced learning is based on development of communicative and functional skills, extension of social knowledge, and acquisition of ICT-competences.

In student-directed and self-paced project work, an essential element is the ability of the students to structure their own learning situation. In strictly structured projects, the teacher decides the topic and chooses the project period, the source material, the means of expression and the presentation form. In self-directed projects all this is the responsibility of the students in order to support the autonomy in the learning process. It is important for the students' educational outcome in general that the handing over of responsibility of learning direction at any time runs at an optimal level, i.e. as high as possible. The concept of structuring the project work is further developed p. 63 in the passage "Guidance procedures".

Project work has proved itself useful as a pedagogical method for many reasons, in particular because it supports the students' personal development in various directions. A number of these reasons should be mentioned here:

- The demand for the students' taking care of their own working process increases the feeling of responsibility, the level of self-direction and the drive to take initiatives
- The obligation of fulfilling a self-defined task during a certain amount of time develops inventiveness as to choice of appropriate procedures and explanations
- The requirement of a problem formulation as an overall steering tool for the project expands the students' use of problem solving activities and analytical skills
- The demand for interdisciplinarity develops the students' decision-making skills as to distinguish what is more or less relevant and to integrate ideas, information and experiences from different disciplines
- Finally, project work hones communication and collaboration skills because it is often organised as pair work or in bigger groups, and because the students have to communicate in order to collect information and present the results of their project to others.

FUNCTIONAL INTERDISCIPLINARY PROJECTS

Different sorts of product oriented work have been implemented in Danish schools during the last thirty years, representing a wide variation as to concepts of purpose, starting point and result of the projects.

An analysis of the *purpose* of a certain project would reveal, if the educational goal is transmission of knowledge alone or if it also implies that the students should be able to use the acquired knowledge in different contexts, as in the case of the functional interdisciplinary project. The different *starting points* reflect the learning goals and

underline the demand of a problem in functional interdisciplinary projects. The *results* show if the students could fulfil the demands just by reproducing the thinking of others - books, peoples etc. - or if they have to analyse the problem and document their findings in order to approach a solution of the problem - in other words: to think for themselves.

Figure 2. Different sorts of product oriented work

Sort of projects	**Subject related projects**	**Topical projects**	**Functional interdisciplinary projects**
Purpose	Increased subject related knowledge	Increased topic related knowledge	Increased functional knowledge
Starting point	Subject	Topic	Problem
Result	Description of subject areas	Description of interdisciplinary topics	Interdisciplinary subject and topic related analyses with solution models

The challenge of the functional interdisciplinary project is the demand of personal observations and independent thinking.

Examples of a subject related project could be "Our national literature in the 1960's", of a topical project "Australia" or "World War Two" and of a functional interdisciplinary project "Use and misuse of genetic science in the new millennium". The essential points are that when topics are distant as to time or place, it is more difficult for the students in the project to draw on personal observations and thinking. All three sorts of projects invite the students to seek knowledge, but in the first two cases, the students may get round independent thinking and feel satisfied by reproducing information on the topics. In a functional project, where an important objective is that the students feel involved and are interested in finding a solution to the problem, this is not the case. That is one of the reasons why functional projects create a more intensive learning situation.

Working with functional interdisciplinary projects is a very intensive process demanding a special effort from each student as to encircle the central content of a topic, which at the first glimpse may appear unstructured and obscure. Problem analysis is not an easy phase in project work, but it pays back in making possible a much more intensive learning outcome.

PROBLEM ORIENTATION

One of the basic principles behind project work is that learning has to deal with something important, something of real interest. In short, it must represent a worthwhile activity in the eyes of the students as well as the teachers. The students must experience that they can use what they have learned through the subjects of the school to solve problems they find relevant and necessary to cope with.

But why the word "problem"? Why not "issue" for instance - less loaded as it is with controversial connotations? According to The Oxford Popular English Dictionary the word "problem" means a "doubtful or difficult matter requiring solution" or "something hard to understand, accomplish, or deal with", whereas the word "issue" is an "important topic of discussion or litigation". If one accepts these definitions, one will realise as a significant difference between the two terms that problems present a certain urgency, require solutions and are really necessary to deal with - they are never merely interesting, as might be the case of issues.

When using the term "problem" as a working tool, it must be stressed that according to project theory the word is to be understood in general terms, not as private problems. In several languages it is possible to distinguish between these two concepts of the word "problem". In Danish and German for instance, in project work the terms "problemstilling" and "Problemstellung" are to be preferred instead of respectively "problem, Problem", the latter term indicating something more subjective.

But why not just omit the idea of problem orientation? What difference would that make for the benefit of the students' learning? An answer to questions like that, which are often put forward by students and teachers struggling hard to find a verbal expression on a main point of their project, deals with one of the key points of project work, because the formulation of problems is the foundation of the whole work and indispensable as a counselling tool. Used in the right way, problem orientation is the most important contributor in making it obvious through the guidance process to the students themselves, if and when they have diverged from the mainline of their project and how they can find back again.

The nature of a problem formulation is characterised by needing analysis and documentation, before a solution can be found. A quick and easy "yes" or "no" as answers of closed questions should never be acceptable results of a prolific problem formulation. The formulation of problems is a challenging part of project work for the students as well as the teachers. The guidance of the students in this phase is an important task for the teachers. Also during the project process it is a serious counselling responsibility to help the students to adjust the project formulation in order to assure its function as a steering tool of the whole work.

Therefore, in every project the central problem must be analysed by the students in order to find documentation to argue for the different points of the conclusion. Preferably, the problem has to reflect contradictory points of view, illustrating that it might be permissible to represent opposite points of view on the same question. This aspect of problem formulation might be referred to as bifocal, i.e. that the same problem includes a contradiction, where two facts or points of view appear to be incompatible or inconsistent. The purpose of the problem formulation is to present the inconsistent aspects and point towards a possible solution.

Figure 3. Examples of bifocal aspects of problems

Main topic	Sub topic	Contradictory aspects	Problem
Our generation 1980-2050.	Career opportunities in a small town.	Hope and fears for the future, concerning career. What will be the impact on the family situation in case of a successful career, which imposes on family and leisure time activities?	Why are we so preoccupied by planning, when we can be sure of nothing? What can we do to minimise risks and use advantages best possible?
9th form's window to the world.	Justifications for national peace keeping forces.	We see a lot of different conflicts when we look around, locally, nationally and globally. Many people strive to make a better world to live in, and at the same time others think only of themselves.	Should one join the national peace keeping forces? Why? Why not? What counts for and what against?

The incompatible facts of the problem – in the first main topic the wishes of minimising against the exploitation of possibilities, and in the second one the conflict between selfishness and responsibility – form the field of tension of the project.

The demand for problem orientation has consequences for the relevance of the subject and accordingly for the choice of main and sub topics, because the problem must be relevant both for the individual student and for others. It is not sufficient that the student finds it important. It has to be of more general significance in order to be considered a worthwhile activity. The project method gives the students the opportunity to become absorbed in studying. In return, this method demands a certain amount of time, mostly taken from the

learning time in school - the qualifier "mostly", because students often get so interested in the project work that they continue after school in their spare time. Due to the time-consuming aspect of project work, one of the important criteria in the choice of the main topic must be that general relevance of the learning content is a main target in order to facilitate the use of acquired knowledge later on.

Another criteria of the usefulness of a certain problem is that it must invite to further investigations and/or experiments so that the students are motivated to seek more knowledge. In order to favour the acquisition of knowledge and enlarge the scale of action possibilities of the individual student, it is an important part of the counselling to make clear to the students, if the problem of the intended project is either too "narrow", so that it does not imply any substantial acquisition of new facts and relations, or too "wide", so that the students are tempted to rush superficially through the project. In both occasions, the learning profit will be insufficient.

It is also important that the problem concerns an issue, where the students feel involved and want to improve the situation. One of the essential tasks of the school system is to assure not only the cognitive growth of the students, but also the global development of the personality including ability in using problem solving strategies and development of affective aspects. This can not be done without making visible the fundamental values, which are the foundation of the educational intentions, on the individual as well as on the social level.

Presented with explicit and visible values as the educational basis at school, the students have the possibility and should be encouraged to face different opinions. Equally, the students have to make use of the right and the responsibility of any individual in a democratic society to make own choices - and to take into consideration that all options are not of equal value. Most convincing is, when the students personally obtain the experience of the usefulness of knowledge and skills, and when they come to see subject skills as efficient problem solving strategies.

So, focusing on problems in a functional interdisciplinary approach to project work stresses the importance of those aspects of learning that develop inventiveness and sense of democratic values.

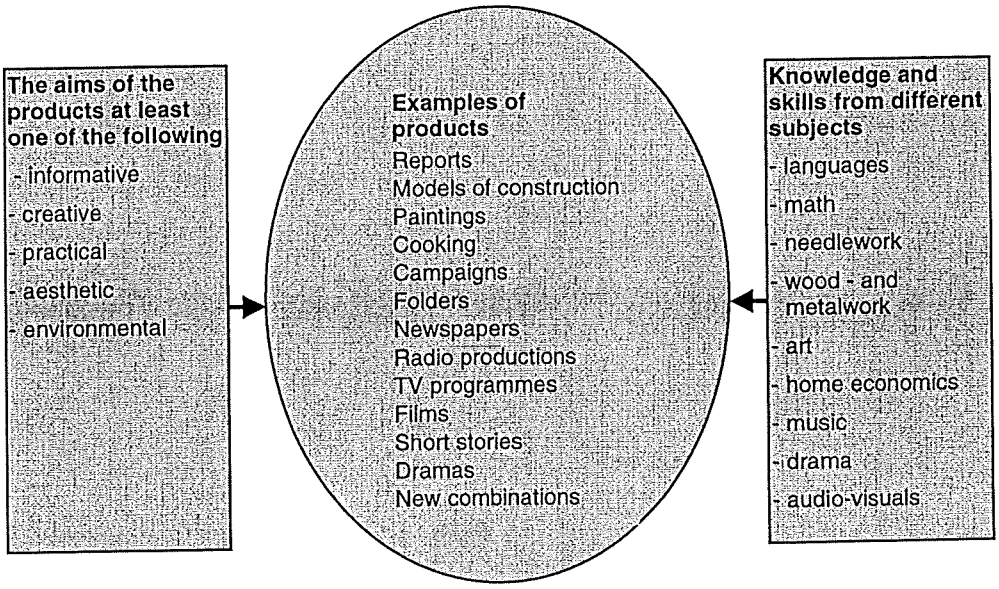
PRODUCT ORIENTATION

One of the key concepts of project work is that the students have to produce a visible result of the project process as an evidence of their learning. This demand gives them a possibility to demonstrate in practice that they are able to direct their work and plan the time allocated to the process. A successful product depends on previous learning, because the planning and implementation of the project imply that the students have a general knowledge of different means of expression, so that they can choose the right framework for

realising their intentions. It is important that the students know the basic principles of the most common means of expression, i.e. using words, sounds, pictures, constructions and combinations of these categories, used as a part of communication.

The product has succeeded, when it in a suitable manner reflects a result, is finished in time, provides an answer to the central problem of the project work, incorporates a creative dimension, is technically and practically sufficient and is communicated in an understandable way. If the product is a written report, it should include an analysis of the problem as well as documentation of own opinions. If the product is of a more practical craftsmanlike or artistic character, it has to fulfil the practical and aesthetic demands according to the genre and the media.

Figure 4. Products are more than written reports



In order to assure a well assorted and operational choice of varieties, products have to be based on a wide range of students' knowledge and skills in order to assure the global learning and personal development. The choice of means of expression must consider not only intellectual aspects of learning, but also formal, practical, aesthetic, environmental and creative aims.

The technical quality of the students' products is not always sufficient. Practical experiences with videos, for instance, prove that manufacturing products might not be a simple process. Therefore, it is important to extend the students' knowledge of different means of expression. One way to do so is to establish so called *spot courses*, i.e. early and concentrated introductions of selected ways of expression. During such courses it is possible to concentrate on one means of

expression through a limited period, a week for instance, and to reach a certain level of skills, where most of the students master the fundamental techniques. Experiences have proved that it is possible to work successfully with photo, for instance, from the 2nd and with video from about the 5th form.

All in all, the principle of product orientation in project work makes visible for the students that within self-directed learning there are some basic conditions that one has to master, such as ability to plan the phases of the process, to make use of information, to prove creativity in manufacturing products and - last but not least - to complete the project work in time and in a sufficient quality.

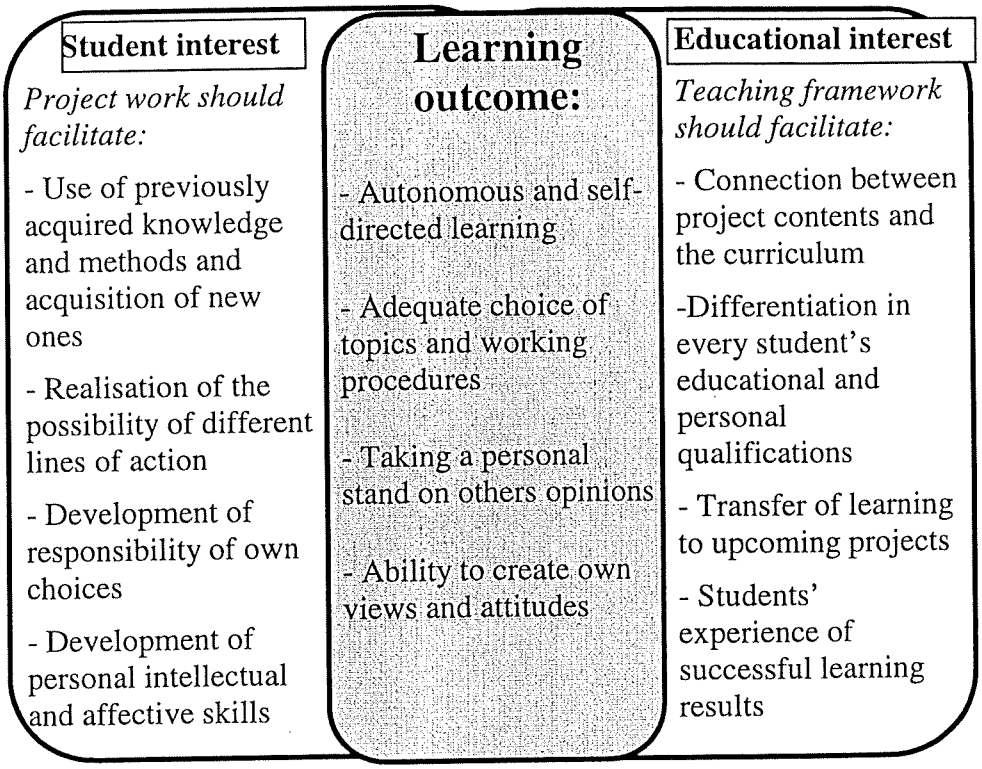
STUDENT INTEREST, GENERAL EDUCATIONAL INTEREST AND MODEL VALUE OF TOPICS

As mentioned as one of the main points in project work, the topic has to be seen as interesting by the students - if not, the project work will only insufficiently support student autonomy in the learning process. It is evident that previous student interest in a certain topic is a factor of great motivational value, and it is not enough that the teachers or other representatives from the non-student environment find the topic interesting.

The high priority of student interest, however, does not mean that students choose the topics quite alone. As both the main and the sub topic have to be relevant to general educational goals, the educational content has to be of general value, being of interest to more people than the individual student. This is a must for every subject which claims to get a place of its own in general basic schooling. If a certain subject or activity does not convey knowledge or skills alone or better than any other subject, it should never take up space and time in general basic education, whether the teaching is organised as project work or traditional education.

Yet, the teachers often have to discuss with the students what is interesting on short terms and on long. Often the students might overlook or not be aware of their own long term educational interest. Some 13 year old girls, for instance, place their predominant interest in their personal riding horse. They would love to devote a period only studying horses. But considering the limited time for learning at school, the educational perspective should never be pushed into the background. The topics of project work must deal with worthwhile activities and possess a certain amount of model value. Consequently, they should never be approved, if they are so private that they might be considered irrelevant in general.

Figure 5. Meeting point of student interest and social interest



The learning outcome relies both upon student interest and educational interest. Without a sufficient amount of student interest the learning outcome might show less personal involvement and without an equal quantity of educational interest the students' autonomous learning strategies will not increase sufficiently.

Project work is a student working pattern that takes time - more time than traditional class teaching. Therefore one has to choose the content of project work carefully in order to secure the most relevant transfer value of the education in general. This selection of model content implies a claim for relevance to the students' learning in general. So the topic shall allow students to use previously acquired knowledge and methods and obtain new ones. Likewise, it should be used in relation with other learning strategies and not isolated and it should never repeat earlier work - educational time is too precious for such activities.

It is a general experience that students in their choice of topic more or less consciously ignore the difficulties in the different phases of the process. So, it is a teacher responsibility already at the choice of topic and problem formulation to draw the attention of the students to the aspects, which it is obvious that they have not considered sufficiently. It is the responsibility of the teachers, for instance, that it is noticed by the students if there are any difficulties in providing information on

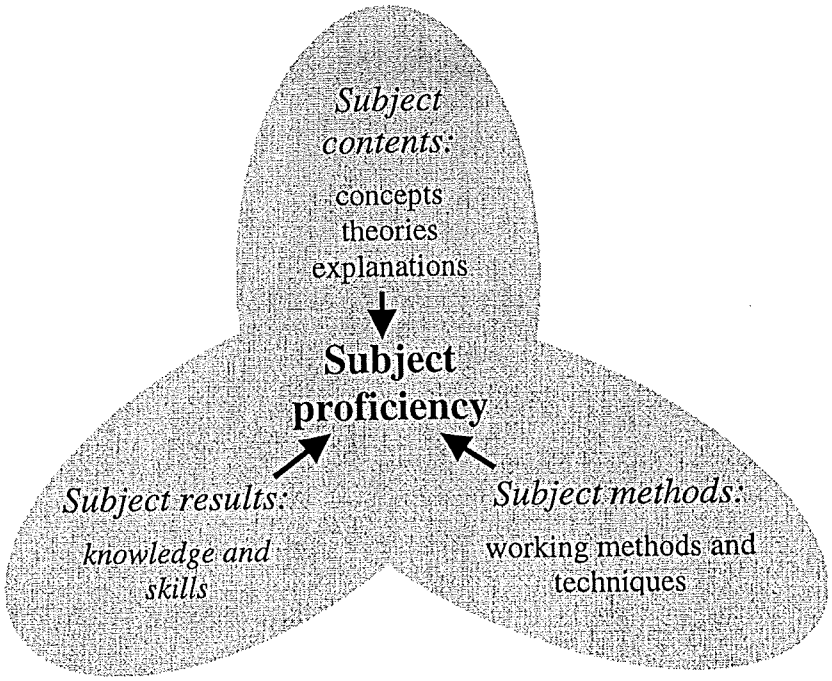
the topic, lack of resource persons to interview or scanty technical equipment available to implement the planned product.

INTERDISCIPLINARITY AND SUBJECT PROFICIENCY

Interdisciplinarity should make it possible for the students to draw upon content and techniques from a broad scale of relevant subjects at school and demonstrate knowledge and skills from more than one of them. It is also important that the students are able to form a general view of the circumstances of a case and estimate a good solution. So it will be possible for students to experience themselves the value of the subjects and through this be motivated to continue learning in the future.

Some of the characteristics of cross curricular learning are that it has to rely upon content and methods as well as results from several subjects. It might be useful to look closer at these terms as basis of interdisciplinary learning, for instance to analyse what are the conditions of how interdisciplinarity in practice can rely upon subject proficiency.

Figure 6. Quality in interdisciplinary learning



Only when project work relies on subject proficiency, interdisciplinary teaching lead to learning. Subject proficiency might be considered a combination of contents, results and methods.

But what can be meant by the terms subject contents, subject results and subject methods as constituent factors of project work:[3]

- The concept *subject contents* might be explained through the corresponding interrogative pronouns and adverbs. As for concepts and theories, they should be the answers of questions introduced by interrogatives as *who, whom, whose, which* and *what* , after which descriptive answers will often be the result, or by *why*, which generally provoke explanatory answers.
- What *subject results* concern, it is important that the students realise that interdisciplinary work implies the use of previous learning from the different subjects. In foreign languages, for instance, a typical example of knowledge is the vocabulary of the language in question and the skills to speak it. It is obvious that knowledge and skills differ from subject to subject.
- Concerning *subject methods*, the working issues and techniques also vary. In language learning, for instance, a useful technique is to be able to look up new words in a dictionary, in math to make graphic representations etc.

All in all, it is important through the application of interdisciplinarity to give the students the possibility to see that contents, results and methods from different subjects are important when they have the ambition to make a product of quality.

EVALUATION AND ASSESSMENT

Evaluation is an important tool in all educational activity, especially in a self-directed learning process such as project work. For the students, it is easy to overlook the need of evaluation and just go on working more or less at random. Consequently, it is an important obligation for teachers to point out in any project the adequate points as well as the moments to evaluate the work.

As for project work, evaluation is far more important than assessment, evaluation being a broader term. A. Rogers (Rogers 1996) puts it this way:

> "*Assessment* is the collection of data on which we base our evaluation. It is descriptive and objective; if anyone else were to do it, they would come up with much the same findings. *Evaluation* on the other hand is a process of making personalised judgements, decisions about achievements, about expectations, about the effectiveness and value of what we are doing. It

[3] Description of the central parts of project work in the explanatory memorandum of the law on the Danish Folkeskole.

involves notions of 'good' and 'bad' teaching and learning, of worth."

There are two main components in the evaluation, the students' progress and the effect of the teaching (Skov 1992). In a self-directed learning process, knowledge of the students' progress is essential to the teachers. In consequence, it is fixed by law that running evaluation "shall form the basis of the guidance of the individual student concerning the further planning of the teaching" (Ministry of Education: Act on the Folkeskole, 13 (2)).

A basic condition for evaluation is that the analysis and the appreciation of the students' work is shared between the teachers and the students at suitable intervals. This implies that the objectives and the planning of the learning process have to be agreed upon between teachers and students in advance. It is an important part of evaluation to reassure that it takes place as a two part communication. The teacher should never just pronounce his or her unchangeable judgement, but present observations as well as conclusions as matters of consideration to share.

In the process of observing students, the teachers have to show caution in interpreting the students' reasons for reacting in a special way in order to avoid misunderstandings in the evaluation dialogue between students and teachers on the project work - this dialogue being one of the most important tools in the guidance. The main objective of the evaluation dialogue is that the students reach a better understanding of their own learning process and realise where to concentrate efforts in the future. It is not a valid objective for the teachers to try to persuade the students just to accept their opinions. A one way communication is not only a waste of time, but even counterproductive with respect to the objectives of forming the students' personal integrity. One way communication reflects a not uncommon teacher attitude that might be interpreted as a sign of inequality in the student and teacher relation.

Figure 7. What topics to evaluate when?

Topics	Daily during the project	Evaluation before start	Halfway evaluation	Final evaluation
Analysing utility aspects of main topic		X		
Analysing possibilities in sub topics as for general relevance, interdisciplinarity and problem orientation		X		
Topics' relation to previous and subsequent learning		X		X
Elaboration and use of problem formulation	X	X		
Students' progress during the process	X		X	X
Students' collaborative relations during the process			X	X
Students' individual learning results of the project				X
Teachers' teamwork before, during and after the project				X

A recurrent and fundamental question on evaluation is what to evaluate and when to do it. In project work, evaluation is an ongoing process, but still it is possible in connection to certain areas to point out guidelines for the most appropriate moments during the process to interfere.

The dialogue will always involve the teacher, but the number of students varies according to the purpose of the dialogue. Some topics and some situations invite to a dialogue with all the students of the class at the same time, for instance when the central idea is information on the framework and the general aspects of the project work. In other cases the issue concerns only a group of students and sometimes just a single student, for instance when personal problems risk to disturb the working atmosphere of a group.

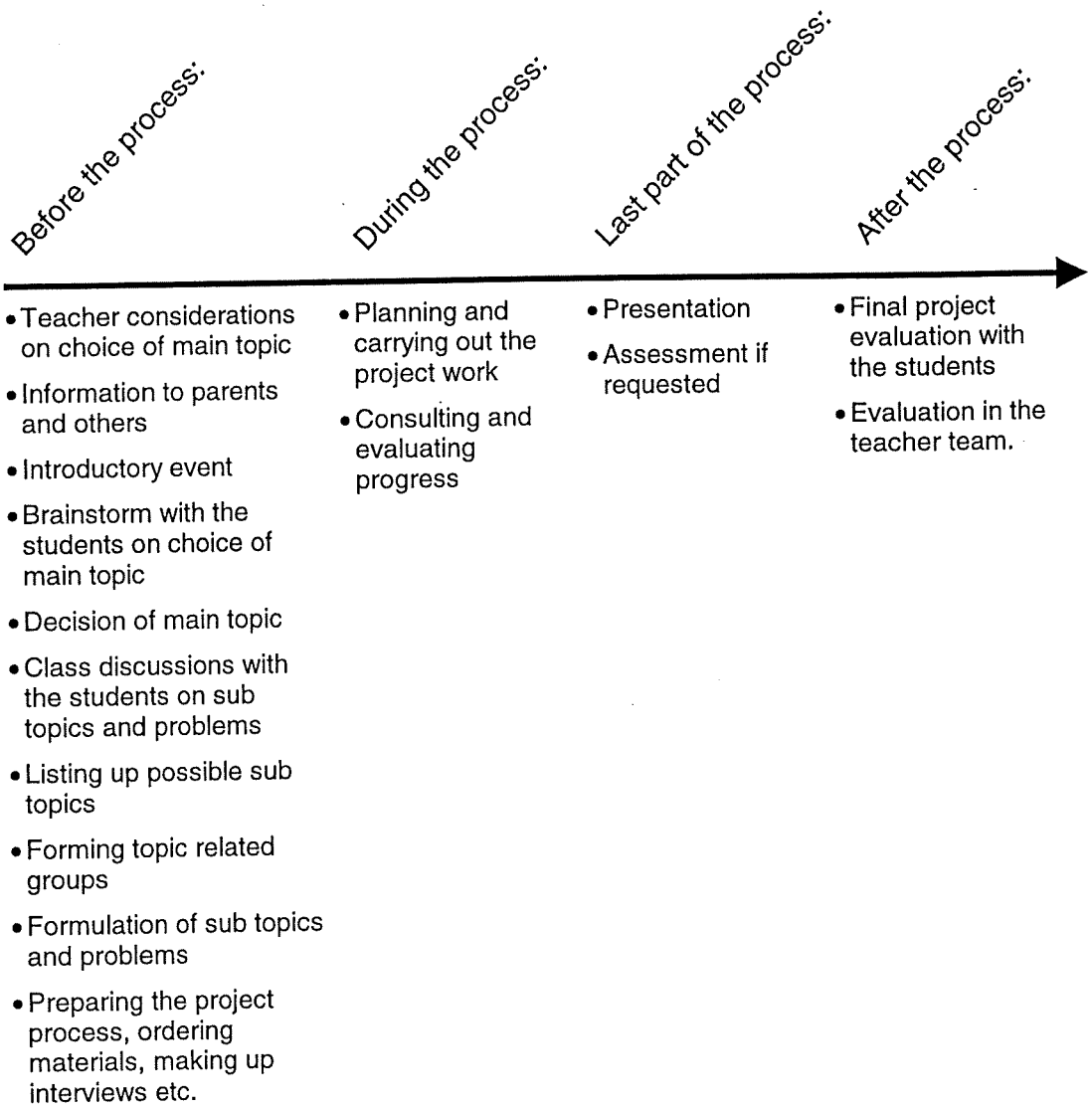
However, evaluation is not only relevant in relation to the students' work. Also the teachers can take advantage of this tool to improve the team collaboration and common projects. The issue is further developed in the passage on planning a project in teachers team, p. 65.

As evaluation is one of the most important means of improving learning, its nature as a non-measuring and non-controlling tool for guiding the work has to be underlined. As such, self-evaluation promotes the students' critical attitude to own results and indicates ways to improve quality.

STUDENTS' WORKING PROCESS

It is one of the main objectives in project work to facilitate participant directed learning. What counts is that the students through learning arrive to the point, where they will be able to continue alone without always being told what to do next. All the same, it is important for the teachers to know and to plan in common with the students, *when* and *how* to go through the different phases of the project work.

Figure 8. Process line of project work



The phases can be run through as indicated, but other procedures might also be adequate depending on the conditions and framework of the project in question. Most fruitful is a planning that fortifies students' ability to cope with and take over responsibility of the project.

Even before start of the project, the teacher team should consider the different aspects on choice of main topic, among others try to ensure a

cohesion between the ordinary teaching before and after the project. This should be done in order to make a better use of the students' knowledge and skills, acquired through the ordinary teaching as well as through the project.

Depending on the age of the students, the importance of information of the parents of what is going to happen during the project varies considerably. With young students up to the age of 14-15 many parents are still involved in school questions, feel the responsibility of supporting their children and are ready to be at the school's disposal for instance for transport, company visits or interviews. A parents' meeting on the occasion of a project work might have a double purpose, i.e. general information on their child's life in school, as well as presentation of the points where the parents' assistance is wanted by the school. Older students most often expect and are expected to cope with the situation on their own.

Information from the school or teacher team on future projects might in some cases be useful for persons outside the school other than the parents, for instance people with special knowledge targeted for interviews by the students. In smaller places it could be the business community and local authorities, where the students may be received in a more positive way when their enquiries are expected.

Some of the steps of the working process, such as choice of introductory events, topics, working patterns, means of expression, procedures in problem formulation, use of information and carrying out the planned activities, need more specific comments as follows:

INTRODUCTORY EVENTS AND CHOICE OF TOPICS

When the students are not accustomed to working problem oriented, a way to get started is to establish an introductory phase, where the chosen main topic is exposed through a special event, such as a theatre play, a movie, an exposition or an excursion. It is important for the effect of this introduction event that it opens the eyes of the students for the different aspects of the central idea, not only intellectually, but if possible also emotionally. This introduction phase is essential both for the choice of main and sub topic.

It is important to try to find an inspiring and motivating introductory activity, if possible something extraordinary that might give a new view on well known topics. The introductory event is successful if it gives an outline of the content possibilities of the main topic, that might inspire the choice of sub topics and indicate possible problems relating to interesting topics. And it is even better, if the event also provokes attitudes to the problems in the students' minds. From this point of view, the introductory event is essential for the students' engagement in the project. Many teachers have obtained fine results in using movies, expositions or even student exchanges etc. as a project starter.

CHOICE OF MAIN AND SUB TOPICS

Next step is often brainstorm with the students on choice of main topic. In this phase it is important to get as many good ideas and associations as possible. After listing good proposals on the blackboard or the flipover, the critical selection of appropriate main topics can begin.

Before the final decision of a main topic, it is important to go through class discussions with the students on possible sub topics and problems that promise to be productive in offering possibilities of in-depth-analysis and hypotheses to prove or disprove. As teacher, one might be eager to get on with the project, not willing to spend too much time on the discussion on working possibilities in the different topics proposed. But the time for discussion might turn out to be well used, because this activity opens the eyes of the students and make it possible for them to spot and agree on productive sub topics.

Criteria for choice of main topics have already been touched in the passage on student interest etc. at p. 42, but need to be developed in further details, as far as classroom practice concerns. As already mentioned, the main topic should be relevant both for students and others and have multilateral connection to the teaching in general. During classroom discussions on choice of main subject, the students should be given the room to discuss on their own. It takes time to agree on a prolific topic. Sometimes the discussions are really difficult, and the students prove absolutely unwilling to compromise. In such cases it might be effective to take a break and reopen the discussion again after a couple of days - in the meantime the students are often brought nearer to each other.

Before the final decision of topic, it is important not to forget the phase of delimiting the subject. If the subject area is too vast, it is not possible to work into depth. A delimitation to the essential parts of the topic facilitates a more profound learning process, where the students concentrate on the central part of the subject and avoid aspects that lead away from the essential problem.

What is the reason, however, for only one main topic and several sub topics? The limitation to only one main topic in every project is one of the central requirements of the Danish project task. This claim has been introduced in order to favour the global outcome of the project. It is intended that when all sub topics relate to the same main topic, at the presentation they will fit into a greater unity and in this way function as an eye-opener and make visible dimensions, to which the students may earlier have paid no special attention.

As already mentioned, the main topic must offer possibilities of problem oriented sub topics. Experiences show that it is a good idea to present not only the problem formulation, but also the main and the sub topics in the shape of questions. In this way the topics lead more

directly to the problem formulation. Criteria of a suitable main topic are that it should

- Give possibilities for the students to demonstrate independent choice and to reflect on other opinions
- Allow the students to use well proved knowledge and methods and to acquire new ones
- Be used in relation with other educational activities and not isolated
- Avoid a repetition of earlier work - time for learning is too precious
- Be substantial enough to hold student interest over a longer period of time
- Be limited so that the most important topics stand out

When the students have decided on the main topic, it is time to pin down the sub topics. This part of the project work might already have been touched during the discussions on the main topic. As a matter of fact, it is an advantage, if there is an interaction in the reflections on the possible sub topics at a given main topic. The starting point of these reflections could be visualised by drawing a mind map on the main topic, where the branches give a first idea of possible sub topics.

Important criteria of choice of sub topics are among others that they should

- Pertain to the main topic
- Contain one or more problems
- Be of interest for students as for others
- Offer possibilities for interdisciplinary work
- Be analysed and documented by suitable materials and methods
- Invite to creative and surprising presentation forms
- Include the possibility of being individually modelled

CHOICE OF STUDENTS' WORKING PATTERNS

When proposals for sub topics have been listed, it is time to form working groups. One of the first questions will be, if the students want to work individually or in groups. For many reasons group work may be preferred, among others because teamwork reflects the most common way of working outside school, and because it gives the students the possibilities to try out and develop their capability to collaborate. At project work in practice, many students choose the pair work pattern.

When groups are formed, some students wish just to work with good friends. But it is essential for later on in life that the students get the

experience that collaboration can be successful, also when it takes place outside the usual circle of friends.

The most important criterion in forming groups is to find a common interest in the topic. Forming topic-related groups depends on several aspects, and it is important that the students are aware of them. Some teachers have obtained good results in letting the students agree on some general rules for group composition, cf. this example from a 9th form:

- Topic interest has the highest priority
- Leisure time friends and boy and girlfriends should never go to the same group
- The members of the group are at a somehow similar intellectual level in ordinary schoolwork

Even if the groups are formed with a maximum of care, some of them turn out to be unable to co-operate. An essential question in guidance is to consider what to do in such cases. The extent of collaboration indicates that it must be a goal in guidance not just to give way for the students' possible wishes of splitting up their groups when they can not agree. Compromises and other collaboration strategies have to be tried first. Yet, from time to time it is necessary to break up a group which still does not function, and where it is obvious that the obstacles of working together are insurmountable.

FORMULATION OF THE PROBLEM

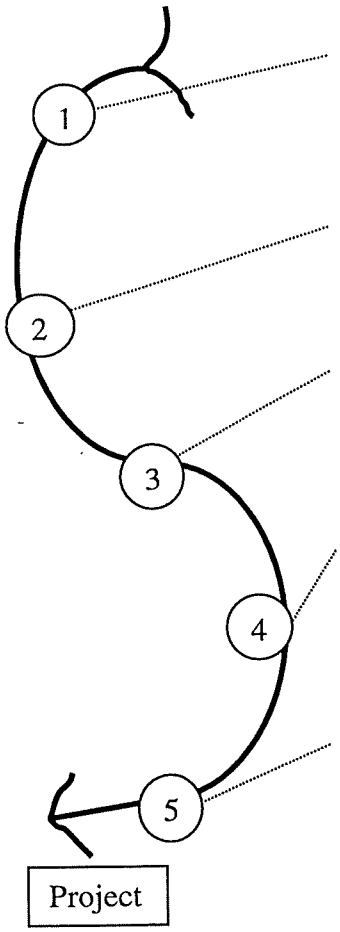
Formulation of the problem is often seen as the most difficult point of cross curricular learning. The process of expressing the problems is complicated and may in the beginning appear vague to students as well as to many teachers. But it is possible to find a way to implement the process.

The process starts when the students are wondering why reality looks different from their presentiments as of how things should be. Sometimes teachers fret over their students failing to identify the crucial points in a certain matter, but if the students can not see the incompatible aspects of a subject, then it is up to the teacher to create a teaching framework that makes these aspects stand out.

After the introduction, the students should be able to pin down the most central and important issues of their sub topic and to formulate the most important points in a problem formulation. This phase of the process goes from preliminary analysis and collection of information, where the delimitation and the content of the sub topic is considered more and more specifically all the way to encircle the central problem.

Figure 9. The steps of a problem formulation

A typical example of problem formulation on the topic "the use and abuse of genetic engineering" might cover the following stages:



1. *Looking for general background knowledge*

   We know from the media that genetic engineering is looked upon differently; some people consider it an important step into the future, while others think it is a dangerous threat in environmental questions and human reproduction.

2. *Collecting information*

   We have to find factual documentation through books, media, interviews etc. on what is the real point of disagreement.

3. *Specifying the problem*

   We now know that genetic engineering is an efficient tool that might accelerate the development of a cure for certain diseases, but sufficient information on the long term consequences is still not available.

4. *Analysing the problem*

   What motivates people to work with genetic engineering? What are the consequences? Which are positive? Or negative? Why are negative effects often considered more important than positive ones? Do the advantages compensate for the disadvantages?

5. *Formulating the problem*

   Can the results of genetic engineering justify an increased application? Why is this question important to us? How can we assure a positive development for our society in this area?

It is important to try to make the problem formulation as constructive and precise as possible. So, when putting the problems into words, the students must be prepared to give their reasons for the chosen terms.

The problem formulation is the overall question to the project process and must not be mixed up with a more detailed level of investigation, where the questions focus on the description of different aspects of the project content. Problem formulations often begin with the word "why" and the more detailed questions with "who, what, when, how".

Once the problem is formulated, it is time to re-examine the topic, verifying if it still needs to be delimited, and if it is of genuine interdisciplinarity as far as subjects and methods are involved.

Before the project proceeds, it is a good idea to check if the problem formulation is productive. The criteria of a good problem formulation includes that

- It is possible to recognise a problem in the chosen topic
- The problem meet student interest and general educational goals
- Problem solving strategies invite to application of interdisciplinary knowledge and methods

- It implies aspects that can be documented and analysed
- There is a hypothesis of a solution of the problem
- This solution has positive social values

Seen from a verbal view it is an advantage if the problem formulation includes a

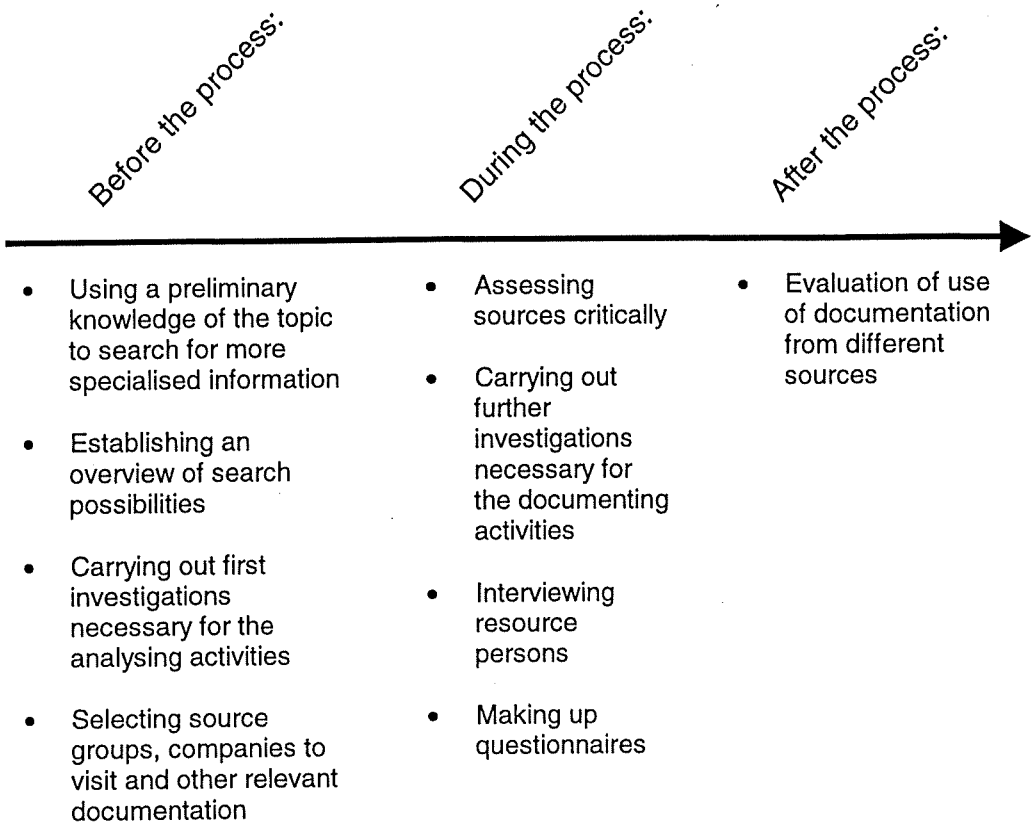
- "Why" to look for explanations and perspectives
- "We, us, I, me" to assure the personal involvement
- "Today, now, in the future" to avoid mere historical descriptions without use of problem solving strategies

COLLECTING INFORMATION AND MATERIALS

This phase of project work is essential for the students' working possibilities. The importance within project work of curricula-related topics with a broader social orientation in the content underlines the necessity of breaking the traditional framework of school, giving the students alone or in smaller groups the possibility to seek information on their own outside the school. It is a challenge for the personal development of the students to try out the contact to people, they have not met before, under circumstances they are not accustomed to.

It is not infrequent to meet students who overestimate personal resources and time and take in too much information. If they begin in one end, they sometimes never reach the other. So guidance is necessary concerning the efforts spent at selecting information sources and establishing a reasonable time table. For instance, when students make use of the Internet, it happens that the search is not precise enough. The result is maybe more than a hundred titles of books, and most of them without any value for the project in question.

Figure 10. How to get on in collecting and using information



The introductory phase in collecting information is often underestimated. It is not too early to start the search of source material about 3-4 weeks before initiating the project work.

Important methods in collecting and using information in project work is to learn how to sort out the most central material from trustworthy sources, how to apply them in an purposeful way in order to convert the information into personal knowledge, and how to avoid just to take over others attitudes and points of view.

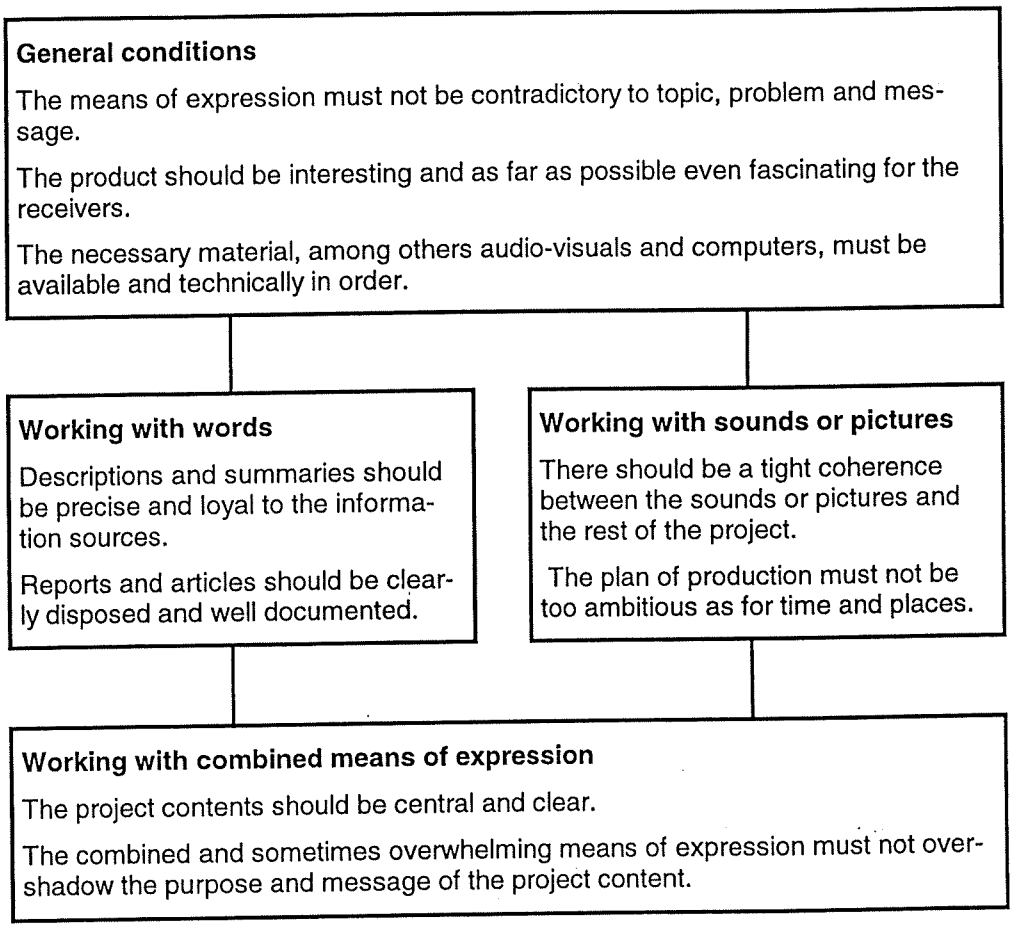
CHOICE OF MEANS OF EXPRESSION AND PRODUCTS

This choice implies that the students have a certain knowledge of communication relations and have tried before to use them in different situations. They should be familiar with concepts as communicant, receiver and message. Equally, they should develop sensibility to recognise when and hopefully to prevent that messages are told in an unsuitable manner or even misunderstood, and how one can simplify information in order to make the message clear and unmistakable.

The students should also be aware of communication forms as how to write reports, short stories and maybe poems, and they should have a

certain experience in producing sound and picture. That is why it is important that the students have had the occasion to get explained and to try out the chosen means of expression before they decide a product that requires skills beyond their ability, such as complicated audio-visual material.

Figure 11. Considerations for selection of means of expression



The quality of the product depends on several aspects, among others the students' capacity of effective communication, careful planning, and steady work.

It is mostly necessary to draw the students' attention to some central aspects of quality, among others, that the products are expected to prove good craftsmanship, i.e. finish in layout of wall pictures, home made newspapers or video movies etc. Characteristics of quality in project products are for instance

- Relevance to main topic, sub topic and problem formulation
- Inventiveness in transmitting the message and putting components together

- Technically and aesthetically good finish, whether the project is a written report, a drama or a model of a windmill

It is a main point in guidance concerning the choice of means of expression to encourage the students to avoid the pitfalls of on one hand being too over-ambitious, choosing products where they lack fundamental experience and technical qualifications, and on the other being so afraid of trying new procedures that they again and again choose the same sort of product and do not allow themselves to obtain experiences with a broader scale of means of expression.

CARRYING OUT THE PLANNED ACTIVITIES

The mere project process, where the content of the project is elaborated, the product manufactured and the presentation prepared, is in a Danish context often planned to last about a week. Many teacher teams have good experiences in breaking up the ordinary time-scheduling so that the students are occupied by nothing but the project during a long stretch of time and not interrupted by the split up in a number of short lessons in different subjects.

Experiences prove that it might be a good idea to start every morning with a plenary, where each group of students make an account of their work the day before and give a rough outline of how they have planned to continue. The accounts are discussed and the groups have to justify their choices by presenting their arguments in favour of activities, purpose and background of their project. This forces the students to reflect on and adjust the further work. After the plenary, the groups may get on with their work while the teachers have guidance dialogues with the student groups.

Some teachers are very reluctant to interfere into the students' work. They might take this attitude for different reasons, for instance because they fear to take over the students' ownership to the project work and spoil their motivation or to ruin their chances to develop competence in self-directed learning. Similarly, when the project is a matter of final assessment, as it is the case with the Danish project task, teachers might fear that ultimately it will not be possible to distinguish between the students' and the teachers' part of the work. But in none of the cases this attitude fertilises the learning of the students. More fruitful is a sharing attitude, where the teachers convince the students of a professional interest in their learning.

A sharing attitude is not always enough. From time to time the students must be provoked by the teachers' questions in order to gain awareness of hidden contradictions in content. If the students do not realise that some problems still might be overlooked, they may encounter unnecessary difficulties in making further progress in the learning process. So, it is an important part of the guidance during the project period that the teacher takes up the role as "critical friend" of the students; cf. the passage guidance procedures p. 63.

A useful tool of managing the project process is for many students to keep a journal of their work. This helps them to summarise what they have already accomplished and what still has to be done. Some teachers find that keeping the journal is the right way to finish the working days during the project period, because they feel that when they read the students' journal at the end of the day, it gives a concise impression of the achievements and the difficulties the students have experienced, - an appropriate background of a differentiated guidance.

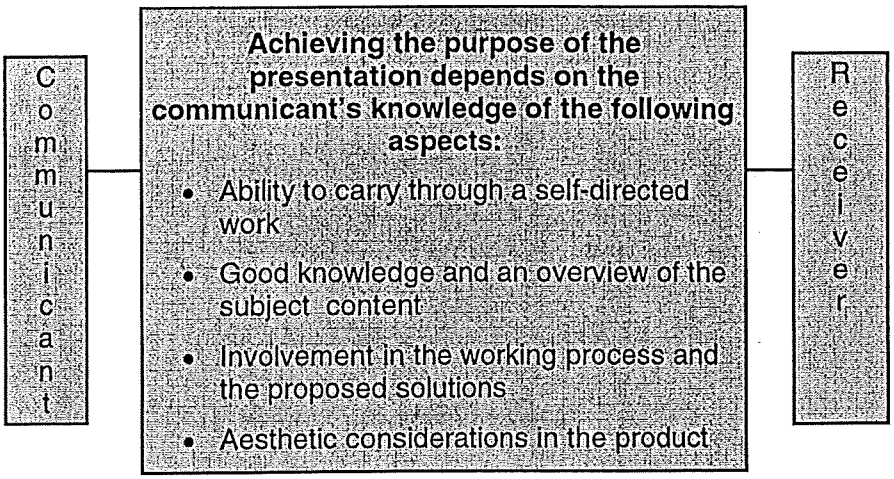
THE PRESENTATION - A COMMUNICATIVE CHALLENGE

The final part of projects is to present the results to others. In fact, the group "others" varies according to the different types of projects. When the purpose of the project is assessment, the teachers have to be involved, but not necessarily the teachers alone. Very often the rest of the class or groups from outside the school are present too. The students' ability to manage the discussion on the project results after the presentation plays an important role in the students' communicative achievement, seen from an overall point of view. That is why it must be considered advantageous that the other students are present and take part in the discussion after the presentation.

If the product is a drama, it needs a public. According to the topic and the performance, the audience might be chosen from the nearby day nursery, if the product is a drama of a fairytale, or from a group of elderly people, if it is an exposition of items from World War II for instance. In any case, it is evident that the parents always make up a grateful audience. But whoever the public is - it has to be chosen carefully.

The students are not always sufficiently aware of the importance of planning. Many students think before their first presentation that the session will just run along without further preparations. But they will be surprised. The good presentation needs planning of every part, considering the time table, the AV-equipment etc. If the presentation is a group performance, it has to be planned how to hand over the initiative during the performance.

Figure 12. Communicative aspects of the presentation



A prosperous presentation gives access for the receiver to new subject areas.

It is also an advantage, if the students manage to clarify the relationship between their project and the main topic in order to visualise the different aspects of the common topic combined with work in depth.

The role of the teachers at the presentation is to be facilitators as well as spectators and assessors. It happens that teachers are so accustomed to the role as assessor that they interfere with critical remarks during the presentation. This is rather disturbing for the students who might be unable to maintain the planned course of events.

The presentation is the students' possibility to show that they are able to carry through a self-directed learning process in time, to collaborate successfully in groups and to present their work in an interesting way. This should not be spoiled by inappropriate teacher attitudes.

THE ROLE OF THE TEACHER

In student-centred and self-paced learning through project work, the most important issues of the teachers' tasks concern the degree of structuring the project work, how to make guidance function in practice, and the practical organisation of the project work.

Concerning the degree of structuring the project work, it might be considered a general rule that the more need there is for structuring the students' learning, the less possibility of realising the intentions of autonomous learning through the project method. What counts in a student-directed and self-paced project is the widest possible degree of freedom and responsibility for the students combined with educational

considerations of time frame and model value of the topic. The target is the learning and the motivation of the students. So, the framework of teaching has to be set in a manner, where the students can acquire experiences with problem solving strategies.

However, a number of learning conditions may under certain circumstances necessitate restrictions in the participants' independent planning of the project. Such learning conditions might include students' young age, lack of experience from former projects, insufficiency of students' personal learning capacity or environmental or other local aspects that make students' information collect difficult.

Regarding the guidance process as such, there are in every sort of project work some critical points, where the teachers should make a special effort to foresee and hopefully to prevent the most stressing points such as the students' over-ambition in relation to the extension of the topic, lack of time or materials etc. Difficulties can be met at every stage of the project work.

Another complicating factor in project work is that many students do not use the guidance at the optimum. This might happen for different reasons. The students may be shy or try to cover their feeling of insufficiency - real or perceived - whatever it might be within the area of subject matters, in working relations to the other students or in the contact to the teachers. It is one of the most important responsibilities of the teachers in project guidance to pay attention to the students' need of guidance - even unspoken - and to meet every student with diversified and appropriate counselling.

The teachers' tasks vary throughout the project process, cf. the following outline of guidance areas in project work and teacher business:

Figure 13. Areas and main points of guidance

Guidance areas	Main points of guidance
Choice of main topic	Students' interest and teachers' knowledge of curriculum contents to meet Is information available?
Choice of sub topic	To counterbalance students' eventual anxiety and over-ambition versus feasibility of the intended project
Problem formulation	To help clarifying the central focus points, and to make the formulation precise and solution oriented.
Planning the process	Appropriate and realistic time allocation in the planning phase Collection of materials in time
Choice of working pattern	To support a topic related group formation
The project process	Coping the variability of the information sources. Clearing up misunderstandings of data Provide contact to adviser when difficulties emerge.
Product	Considering creative and aesthetic aspects of the product Completing the product
Presentation	Planning the presentation Managing a two way communication of the plenary
Assessment and Evaluation	Orientation of assessment framework Making the evaluation prolific for future learning

The dimensions of sharing the decisions of the students throughout the process vary as any other counselling task in project work with the competence of the students; important, however, is their awareness of the presence of teacher support when needed.

It is evident that the teacher role in project work is in many ways different from general classroom teaching, although the two types of teaching also have many aspects in common, such as the general teacher responsibility to assure constant progress in the learning process during the schooling. This responsibility emphasises the need of co-ordination between project and non-project teaching periods. The assurance of constant progress is a basic teacher responsibility in

all educational activities, and it needs special attention in project work that might easily end up in edutainment, if the teachers are not sufficiently aware of the importance of the teaching progression.

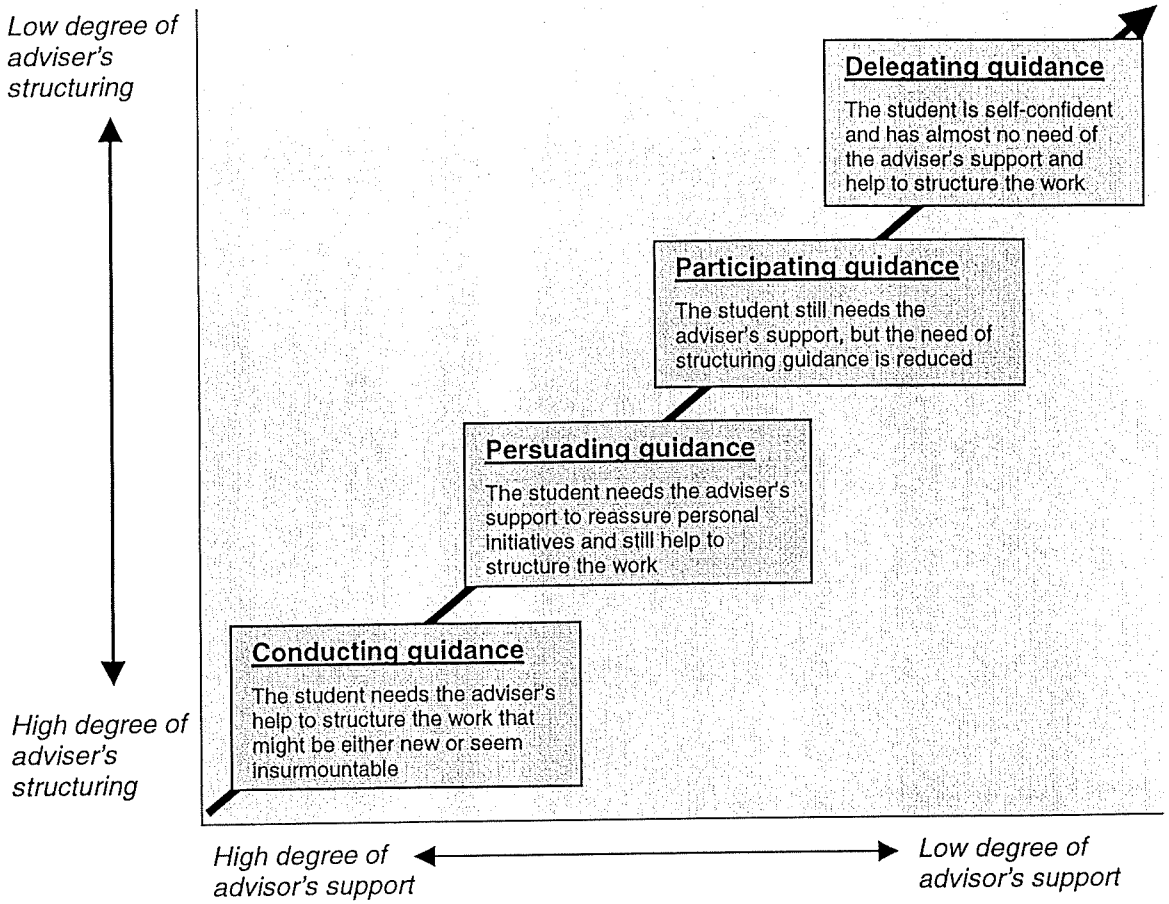
GUIDANCE PROCEDURES

In project work, the teacher role in many aspects differs from the well known earlier teacher role of lecturing. The focus has changed from the teacher's teaching to the student's learning. It has no purpose in it self that the teachers try to get on teaching in order to cover the syllabus, when the students only find themselves listening, not learning. Sometimes teachers feel that this change from lecturer to adviser reduces the teacher's authority, but experiences with project work prove that there are no obvious contradictions between the two attitudes. Most students recognise that the adviser function is important and complicated. Only part of this function can be prepared at home in advance, such as looking for special materials. The most demanding impact of the guidance procedures lies in taking part in the dialogue of the different groups, this is highly exacting as far as the teachers' personal resources concerns.

Guidance must encompass all the phases of the project work. The teachers' functions in project work are multiple and include among others the role as

- Expert, being able to provide qualified answers on different topic areas
- Adviser, when the students need help to formulate new questions for their research
- Explainer, able to demonstrate ways out of difficulties or deadlocks
- Counsellor, ready to reassure and support when students feel uncertain
- Instructor, when new elements have to be explained for the whole class
- Inspiring leader, able to encourage the students and to help when they don't know how to cope with the project
- Arbiter, especially when a group member is at the point to spoil the project for the rest of the group
- Critical friend, provoking the students to think when they tend to choose the easy solutions
- Evaluator, assisting the students in their efforts to fulfil the objectives of the project and assess the work done

Figure 14. Structuring versus supporting teacher behaviour



The adviser has to look for both the intellectual and the personal student competence in order to optimise the individual learning process.

The model above underlines the necessity of differentiated guidance where as many parameters as possible are individually adjusted. It is a part of the advisers responsibility to estimate the total amount of competence resources of every group of students. And if the members of a group differ considerably in competence, the adviser have to try to assure that the stronger personalities in the group - maybe in the best meaning - do not take over the teachers' role in structuring the group work, so that the learning process for the rest of the group members will be less meaningful. It is noteworthy that the students in such situations often use the same arguments as teachers in ordinary learning situations, namely that they feel, they have to get on with the project in order to finish the product in time and in a good quality.

It is ambitious to try to implement principles on student-centred and self-paced learning with the students' independent planning of the

project work. But even if the process brings disappointments at first, experience shows that it is worth trying.

PLANNING A PROJECT IN TEACHERS' TEAM

It is important that the teachers' planning of the project work is co-ordinated before start. If not, it allows a number of misunderstandings and even mistakes between students and teachers and within the teacher group, as well. The practical organisation in the classroom includes questions as how to get started, how much time to be allocated at the whole project, which classes and teachers to be involved, and at what time of the year the project most suitably will fit in. It is obvious that different aspects may need different solutions according to the school system in question.

Many topics are of interest in the teachers' planning of project work. In the following figure a considerable amount of items are listed. That does not mean that they are all relevant in any case. The list is meant as a presentation of ideas that one can use if appropriate.

Figure 15. Planning a project in teacher teams

Items on the agenda	1st meeting period	2nd meeting period
Decision of aims and objectives of the project	x	
Decision of co-operation between classes - also from different forms	x	
Ideas of 2-3 possible main topics	x	
Discussions of sufficient interdisciplinary possibilities of the main topic	x	
Decision of degrees of student self-direction	x	x
Considerations of how to support the students in choosing creative means of expression and products	x	x
Possible relations to previous and subsequent teaching parts of the year	x	
Possible introduction of activities connected to the main topics which will be proposed to the students	x	
Resource possibilities concerning documentation, persons to interview, places to visit, audio-visual equipment etc.	x	x
Ways of informing the parents	x	
Discussions of the structure of guidance	x	x
Decision of assessment demands to contents, process, product and presentation of the project work		x
Use of evaluation		x
Rearrangement of class schedules		x
Procedure for choice of main and sub topics		x
Considerations of students' work in groups or individually		x
Guidelines for the students' presence at a broken up scheduling in school and in small groups outside school		x
Discussion of the way of keeping student diaries		x
Co-ordination of the students' final presentations		x
Decision of eventual marking		x
Considerations of how to inform the colleagues of the practical circumstances of the project period		x

Some decisions form a basis of the further planning. They have to be made in the beginning of the planning procedure. Other items should be deferred and elaborated later at maybe several subsequent

meetings. Some items - especially practical questions - can profitably be fixed just before the kick off of the project.

It is important in advance to tack together as much time as possible in order not to disturb the students' project period with other educational activities. In some class-centred school systems, where the teachers teach many subjects to the same group of students, project work encounters no major problems in allocating uninterrupted time. In other school systems, where teachers teach two or three subjects to a number of classes during the week, the class schedules need a break-up to facilitate the students' work in depth. But even if realising the wish of a rearrangement of the timetable may be complicated and met with opposition from the colleagues, it is worth trying to secure a number of uninterrupted schooldays, where the students are devoted only to project work.

Another practical problem in project work is that if it is intended to be truly interdisciplinary, and if the project can only mobilise a team of two or three teachers, it is difficult to offer access to sufficient teacher qualifications in the full scale of subjects. This underlines the need of resource teachers, i.e. teachers with a specialist's knowledge in areas as use of audio-visual means, or maybe subjects as physics, chemistry, foreign languages etc. So it is advisable to secure the necessary amount of time from key colleagues, who in this way can assist the students at crucial points throughout the project process.

Also the school library plays an important role in project work, often proving to be the primary source of information. At the school library, the students learn how to find information not in books alone, but also to use the search facilities in ICT. Here it is also possible to store evaluation results from earlier projects. In a number of schools, the library has successfully been the co-ordinating factor between teacher groups, classes etc. both in planning and running projects.

Project work might be an overwhelming task for a single teacher, which underlines the importance of teacher teamwork. For instance, teams of teachers will be more efficient in finding items lacking in the planning than one teacher reflecting alone at home. Thus, teacher teamwork must be considered a great advantage in the implementation of the project working method.

CRUCIAL POINTS IN PROJECT WORK

Even after repeated experience with the project method, there are still areas and questions, where more and deeper reflection is required. The most crucial points of project work implies a number of questions that might function as a starting point of evaluation in the teacher team at the end of every project period:

- Has the project this time been experienced as learning more than edutainment by the students?

- Has the project work been an integrated part of every student's learning or an isolated interruption of the daily routine?
- Has the project succeeded in being functional interdisciplinary or did it - again - turn out to be topical and descriptive?
- Did the teachers succeed in making the project work problem oriented, or was it mostly a reproduction of others point of views?
- Did the students succeed in using content, knowledge and skills as well as working methods from more than one subject?
- Did the teachers guiding the project work find a balance between interfering in the students' decision making when necessary and respecting their ownership of the intentions, the content and the process of the project?
- If written assessment has been required, did the teachers succeed in being neutral and precise at the same time, avoiding assessing personal aspects instead of project results?

If the answers to all these questions are positive, congratulations: it has been an extraordinary experience for the students. If not, don't loose heart - the next step is an evaluation within the teacher team concerning the parameters to be adjusted when and how.

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LEIF ROTH HANSEN AND CLAUS WITFELT:

IDENTIFICATION OF THE NECESSARY TECHNICAL COMPETENCES FOR TEACHERS WORKING WITH MULTIMEDIA IN COMPULSORY SCHOOLS

IDENTIFICATION OF TECHNICAL COMPETENCES

The use of multimedia in compulsory schools calls for new teacher competences. But what kind of competences is it the teachers need?

It is necessary for the teacher to possess "information technology literacy", that is to possess the competences to understand, use and produce multimedia (Andresen (1), p. 12 ff., 1999). However, for a teacher it is not enough to poses these competences on a personal level. (S)he also needs possess them on a didactical level, so s(he) is able to guide the students to reach the educational goals with the use of multimedia.

The FIKS-model developed by Andresen (Andresen (2), p. 36 ff., 1999) is useful in an attempt to describe, which competences are needed by teachers in order to exploit multimedia.

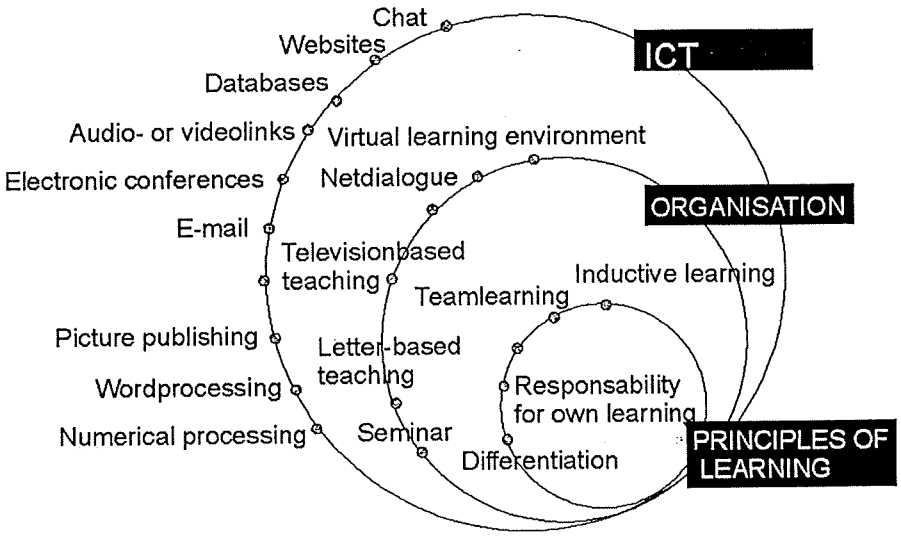

Figure 1. The FIKS-model

The model shows that the teacher after having decided on goal and content for the lessons must think about how to cope with the following three questions:

- Pedagogy: Which learning principles are to be used?
- Didactics: How is the teaching to be organised?
- ICT-genres: Which ICT-genres are the students going to work with?

The teacher must possess competences in all three circles of the FIKS-model in order to teach with multimedia (Andresen (1), 16 ff., 1999). It is indeed important to have ICT didactical and pedagogical competences, but it is also important to have basic ICT-competences to teach with multimedia. These basic competences, which have to do

with the outer circle of the FIKS-model, we denote *technical competences*. In this paper we will focus on these basic technical competences and we will describe the results of some investigations we have been doing in this field during the spring '99.

OBJECTIVE OF THE INVESTIGATIONS

The objective of the investigations has been:

> *To identify which basic technical competences a teacher must possess to use multimedia in class in compulsory school.*

In the investigations we have focused on the use of multimedia as described in the Scenario-model no. 2 and no. 4 (Andresen (1), 1999), because this will provide us with examples where students both are in the roles of "consumers" and "producers" of the multimedia message.

METHOD

To fulfil the objective two different methods are used:

- An analysis of a few multimedia products with focus on the need for technical competences for using the products.
- 5 usability-lab-studies with focus on what causes technical problems for the teachers when using a product.

The results are used in an inductive way and the hope is that the combination of these 2 methods will lead to a general conclusion upon technical competences needed by teachers using multimedia in education when working with the Scenario-model No. 2 and 4.

CASE-STUDIES IN USABILITY-LAB

The usability-lab at the Royal Danish School for Educational Studies is established in co-operation with UNI-C, a national Danish ICT-competence centre under the Danish Ministry of Education. The objective of the usability lab is to examine, test, evaluate and document the use of educational software, e.g. the use of multimedia.

The lab consists of a state-of-the-art workstation with CD-ROM-drive, Internet-connection etc. and some video-equipment. The video-equipment is used like this:

- The video signal from the computer-screen is copied to a videotape.
- A camera is recording the user and the user's interaction with the computer

The two video-signals are mixed together, so that an analysis of the user-interaction can take the users comments, moves, talks etc., into account or vice versa.

THE INVESTIGATIONS

We did 5 investigations in the usability-lab with 6 Danish teachers in compulsory schools. All six have participated in a course in ICT at the Royal Danish School of Educational Studies, and they had some experience with using ICT in education. 4 worked with Scenario No. 2 and 2 with Scenario No 4. In the first set-up, 2 teachers worked together, in the rest the teachers worked alone.

Before each study, the teachers got an oral presentation of the objective of the investigation and what they should do in the lab, and a written ditto. These can be read in appendix 1 and 2.

Each of the investigations lasted for 1 to 2 hours and consisted of 2 parts. In the first part the teachers were asked to 'get acquainted' with some of the multimedia-titles in the lab, while thinking aloud. The second part was an interview about the products and how the products can be used. This report deals with the first part of the investigations.

The usability-lab-leader was present under all video-recordings. After the investigations a log was made with the observations from the lab. When referred to in the following analysis it is done like this: [(5): 0.40.45], where the first number refers to the number of the log while the rest of the numbers are the time-code on the tape.

ANALYSE OF PRODUCTS

PRODUCTS IN SCENARIO NO. 2

As described in Bent B. Andresen (Bent B. Andresen (1); p. 5; 1999), products in Scenario No. 2 deals with genres of multimedia that are hypertext-based. These non-sequential products are often used as information providers, where the students can go looking for relevant information.

An example of a multimedia-genre stored on a CD-ROM in Scenario No. 2 could be multimedia-encyclopaedias, while the concept of World Wide Web in itself is an example of internet-based multimedia included in Scenario No. 2.

In the following paragraphs, the Microsoft Encarta Encyclopaedia will be described.

Encarta

Microsoft Encarta Encyclopaedia 99 is a multimedia encyclopaedia. Encarta consists of 2 CD-ROM's, but the product is integrated with a

web site with links to other web sites and updated encyclopaedic information. Even though the Encarta is rather complex, it is a product that is easy to use after a short introduction – also for a non-ICT-literate.

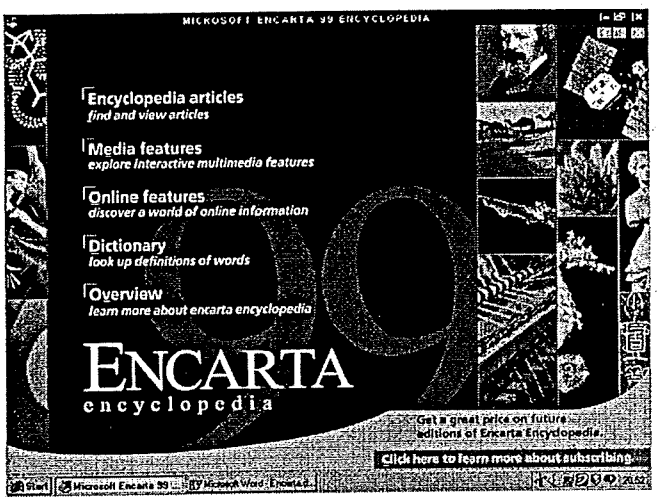

Figure 2. Microsoft Encarta Encyclopaedia

Encarta consists of a large number of articles about various subjects and different media-representations: pictures, videos, tables, graphical representations, sounds etc.

Pinpointer

Pinpointer is Encarta's basic search tool.

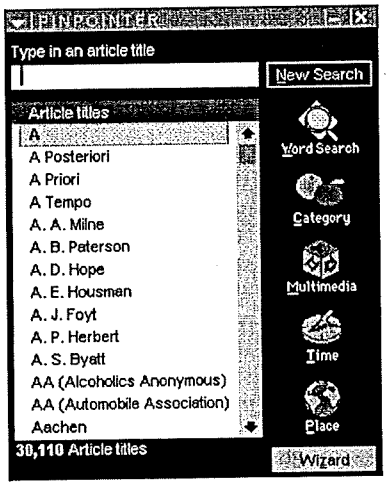

Figure 3. Pinpointer – the search-tool in Encarta.

The terms are written in the input-field and the results show up while typing. The buttons in the right side are filters for words, categories, time and place. With these filters it is possible to make rather complex searches.

Articles

The major part of the materials in Encarta is organised in articles.

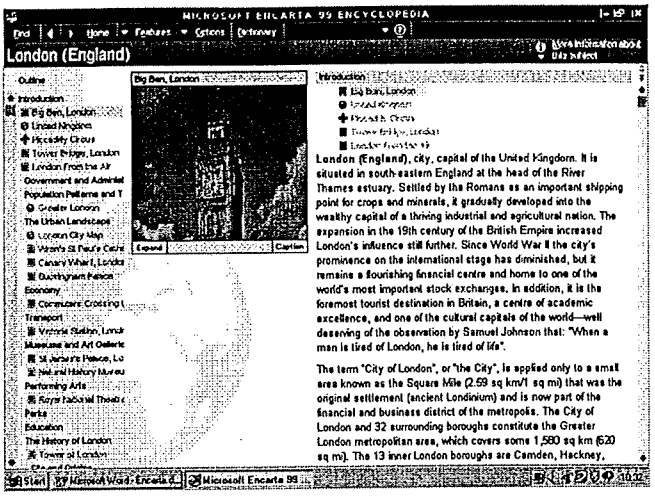

Figure 4. An article in Encarta. The Outline is to the left and the content is to the right.

In the left part of the window you find the outline of the article. This is click-able, so you easily can navigate through the content of the article. The actual content is shown in the right part of the screen. If there are pictures or e.g. video attached to the article they will be shown in the middle.

Words in the article-text that can be found elsewhere in the encyclopaedia appear as hyperlinks in red, and you can click to move to the relevant article.

Media features

Media features can be an integrated part of an article, but they can also be found in the Media Gallery. Also in the Media Gallery the Pinpointer is the central search tool.

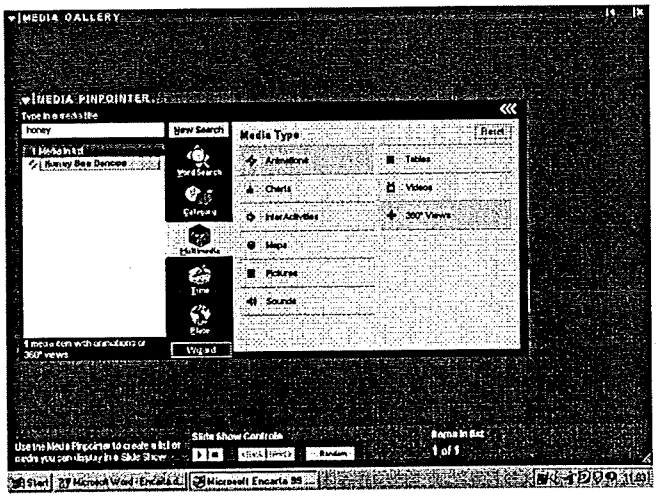

Figure 5. Pinpointer can be used to search for specific media types.

Internet-integration

Encarta is regularly updated (new versions each year), but in between new releases it is updated on the Internet. This update is called 'Yearbook Article Updates'. Clicking 'More information about this subject' in the rightmost corner of the Article-window will enable the user to search these new articles and article updates.

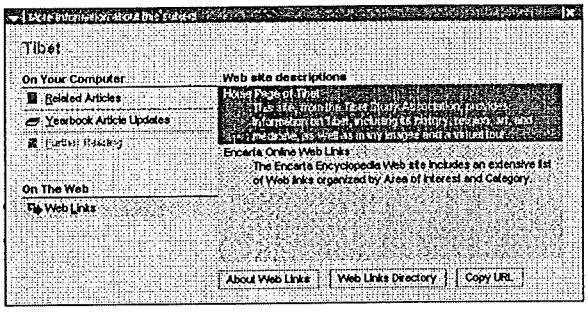

Figure 6. "More information about this subject". Here Weblinks is chosen.

In 'More information about this subject' there are 4 ways to search after related information – among others the possibility to see which web sites there exists about the current subject on Microsofts Encarta server.

Interactivities

Encarta contains a number of Interactivities, which are a kind of alternative entrances to the subjects than the articles. These Interactivities vary much in form and contents.

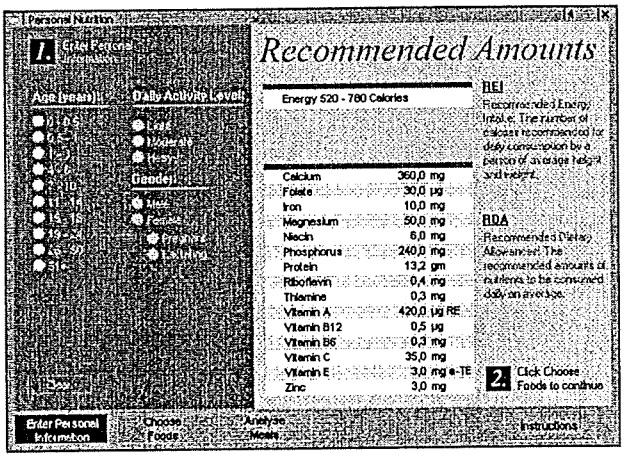

Figure 7. Encarta can help you to analyse your meals!

Bookmarks

When quick and repeated access to all these highly different topics is needed, Encarta's bookmark-feature will soon prove to be an

appreciated function. You can add bookmarks on the desktop of the computer to subjects often used.

Technical skills needed to use Encarta

Using Encarta requires that you know something about:

- how to structure a search in Pinpointer
- the concept of links
- navigation in hypermedia in order not to get lost, when browsing
- how to copy materials via the cut and paste-function
- how to make bookmarks
- the basics of the Internet and CD-ROM's

The set-up in the Usability-lab, Scenario 2

ICT literacy

The set-up in the usability-lab shows – not surprisingly – that it is extremely important for teachers to be familiar with the windows-interface, that is to have a basic understanding of working in graphical user-interfaces, including skills to use the *maximise-, minimise-* and *close*-buttons [(2):23.29.27]. And it is also necessary for the teacher to possess a minimum of "life-saving"-strategies that easily solves common problems as e.g. breakdowns, where he or she has to reboot [(2): 23.35.35].

As mentioned earlier searching is one of the fundamental characteristics of Scenario No. 2, and the ability to show the students how to use the search-result in another representation, for instance to use a picture in a report, is also very important in learning situations. When the material is found techniques for cutting and pasting the materials from the hypermedia to for instance a word-processor is needed. For instance to copy a picture from Encarta and paste it into a Word-Document. [(1):1.55.22, (2):23.26.24].

Information technology literacy

When a teacher works with a new multimedia-product for the first time, first of all (s)he will try to decode the myriad of signs shown at the screen in order to "get the message" [(2): 23.23.49, (2):0.03.46, (3):1.28.41]. This can be quite a challenge, but if s(he) is going to use the product in class s(he) has to succeed to some extent. This is not always the case which can be seen at [(3):1.34.42, (3):1.46.15, (3):1.47.38]. This ability to decode the signs has to do with what in literature has been described as *media-literacy* (e.g., Andresen (1), p. 12, 1999).

If the user doesn't succeed in this decoding-process the result can be two different scenarios:

- s(he) can begin to experiment with the content at the screen in an attempt to decode the signs [(1):1.32.07].

- s(he) gets alienated and feels that s(he) is out of control of the situation, which can be very frustrating feeling [(3):1.50.50].

There is no discussion about that the first of these scenarios describe a very important competence for teachers in order to get to know the new medias. It is important to "have the courage" to "explore and conquer" the products – the technical development of multimedia is so fast that if the teachers do not use this strategy when working with multimedia they will be left behind very soon.

Search-tools

The products characterised as Scenario No. 2 all allows for searching for information. Search-tools (often denoted *search engines*) exists in a huge variety of forms, like:

- The Pinpointer of Microsoft Encarta. (Possibility for relatively advanced search-strategies)
- The Country Index in Dorling Kindersley Eyewitness World Atlas.
- The search engine in Altavista http://www.altavista.com (powerful phrase-search with very advanced search-strategies).
- The search engine in Yahoo http://www.yahoo.com (both topic search and phrase-search).

The words of the bible "Search and thou shall find" (Matheus 7:7) can here be use to guide teachers in a slightly extended version: "Search, and thou shall find – if you know how to use your search-tool". The task when searching information is to find exactly what you are looking for, and not all sorts of other irrelevant materials.

All of the teachers in the usability-lab were able to search for single words [(1):1.31.01, (2):1.20.17], but none of the teacher used advanced search-strategies which is a must if you don't want to drown in irrelevant information.

One huge problem is that the various search-engines work in a number of rather different ways. The search-abilities have to do with gaining the competence to be able to use *any* search engine.

Navigation

In the short history of multimedia, some general thumb-rules about navigation have become defacto-standards. These can be seen both in multimedia-products navigation-bars and in web-browsers. These include for instance a:

- Home-button, that always takes the user to the main screen.
- Forward-button, that takes the user to the next screen or topic.
- Back-button, that takes the user to the previous screen or topic.

And in some, but not all products:

- Help-function
- Map-function that shows some kind of graphical representation of where the user is in the hyperspace.
- "Local" home-button that takes the user back to previous sub-main screen

Such functions ensure that the user doesn't gets lost in the material, as it happened for one of the teachers in the usability-lab [(3):1.41.58].

Another general principle of navigation is the use of hyperlinks [(1):1.45.45, (2):23.34.08], both found in products like Encarta internally on the CD-ROM, as well as externally to web-sites on the net. This integration between internal and external link opens for a large potential, but also contains some risks for non-hyperliterate teachers, as we saw in the studies in the usability-lab when working with Encarta [(2):23.40.41]. The big question for the teachers, when it comes to these kinds of integrated products, is where am I now? Am I surfing in Encarta's "safe space" (where I know who the sender of the materials is), or am I in the "unsafe" Internet, where I can't be sure of who the sender of the materials is? [(3):1.57.27]. It's really a question of knowing where you are in hyperspace – e.g. in order to be critical about the material, you find. This ability of knowing where you are in hyperspace one could call "sense of multimedia-locality".

TECHNICAL COMPETENCES NEEDED, SCENARIO NO. 2

Our analyse of the products and the analyse of the studies in the usability-lab together form a coherent picture of the technical teacher competences needed for working with Scenario No. 2: The teachers need the competences in the field of:

ICT literacy

- To work with a graphical, windows-based user-interface (e.g. closing windows, maximise/minimise, scrolling)
- To know how to work with pull down menues
- To use the "Clipboard-function" in order to cut, copy and paste between applications.
- To be able to handle minor errors with the computers – e.g. breakdowns where you have to reboot.

Information technology literacy:

- "Media-literacy" – to be able to decode "the signs" used in the multimedia-product
- To have a general understanding of search-principles, in order to be able to use different search functions of multimedia-products.
- Knowledge about how the World Wide Web can be used in combination with locally stored tools and materials.
- To use a web-browser
- To know about common principles of navigation, for example hypertext.

- To possess what could be characterised as a "sense of multimedia-locality".

The set-up in the usability-lab stress the need for competences in the field of "decoding the media-message" in general and the need for competences in the field of developing a sense of multimedia-locality. These two competences are very easy to oversee if you only base your list over needed competences on an analysis of multimedia-products.

PRODUCTS IN SCENARIO NO. 4

The scenario 4 is characterised by *construction*. The students construct multimedia themselves via different standard-applications, dedicated applications or multimedia authoring packages.

In general, there are 2 major categories of Scenario No. 4-tools.

- Applications for producing multimedia that are to be used/displayed locally on the students machine
- Applications for producing multimedia that are to be distributed, typically on the Internet.

The borders between these 2 categories are not well defined. An example of this is Microsoft PowerPoint, originally category 1, but now also with functionality to produce a slideshow as HTML to be used on the Internet.

Although the borders are fluid, the two categories of Scenario No. 4 can be a guideline for a teacher in choosing the right tools.

About the conceptual differences between traditional multimedia-authoring systems, like Medi8or, Director etc. and web-authoring systems like FrontPage Express, Composer etc. in a pedagogical context, two points should be noted:

- The web-paradigm offers less build-in features when it comes to animations and fancy layout than for instance Medi8or. Therefore, the students don't so easily get to pay all their attention on the layout and diverse irrelevant, fancy features, but pay more attention on the contents, when working with the web-authoring-packages.
- The motivation of producing a multimedia-presentation that is only available to a small number of users compared to a presentation that automatically is available to the whole web-community is in the latter case much higher. Many students find the web much more inspiring than traditional multimedia-authoring packages.

In the usability set-ups teachers have been working with Scenario No. 4, category 2, because working with the World Wide Web and producing web sites is very popular and because excellent applications, like Netscape Composer 4.6, can be obtained for free.

HTML-tools like Composer are really a kind of workbench, where different chunks of ready-made media (digital video, digital sound, text, graphics etc.) can be assembled to a web site. We will therefore in the following – after a description of Netscape Composer – describe some of the tools a teacher has to know.

Netscape Composer 4.6

Netscape Composer, a part of the Netscape Communicator package, is a web-authoring tool. It is free to download from the web from http://www.netscape.com. Web authoring tool means an environment, where you in wysiwyg[4] can type in text, place graphics etc. and save it all in HTML-format, ready to be published on a web server. These HTML-pages (or web-pages) can then be seen by the members of the web-community in a web-browser.

There are 2 basic ways to use Composer

- Pages can be build up from the ground in Composer. All texts are written directly in Composer
- Composer is used to collect ready made material, made in other dedicated applications, like Word, PaintShop Pro etc.

The user-interface of Composer is very similar to the ones known from word-processors, like Microsoft Word, with menu-bars, toolbars and a working area, where the text is typed in.

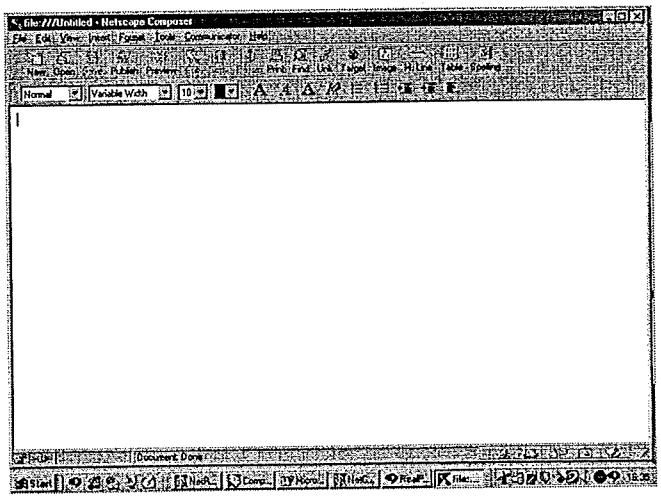

Figure 8. Netscape Composer

[4] What You See Is What You Get. The layout that you create on screen is exactly the layout that you get. No coding is needed.

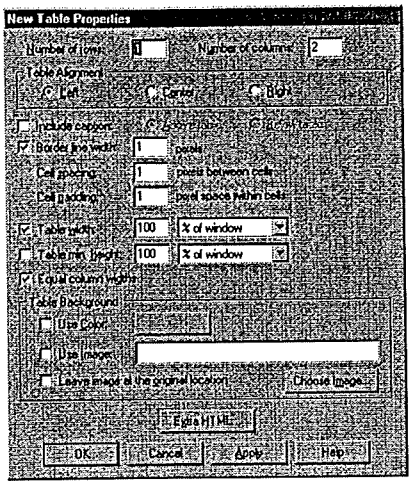

Figure 9. Working with tables

Fonts and typefaces

Fonts and typefaces is a bit difficult in homepage-production. The browsers use the fonts, which are installed on the machine, not the fonts that you as designer choose to use[5]. This means that you must only use standard fonts and typefaces. These are Times New Roman and Arial. You can of course choose to use Futura Black, Old Western and Zapf Dingbats, but when a user that hasn't got these fonts installed browses your page, the fonts are substituted with others, mostly Courier or some other typewriter-font – and the result looks awful and to you unpredictable. The homepage designer must understand fonts. If special effects are to be used, when it comes to font, it is recommended to write the text in a drawing program and export it as graphics and import it into the homepage.

An another important aspect, when it comes to text, is the use of styles. In most word processors, there are a number of styles and you can define others. Never do this, when it comes to homepages, and never import a document made in a wordprocessor with special styles. These will not be seen by the users who browses you page. You cannot predict what the styles will be substituted with.

Instead, use the standard styles provided in the HTML-standard, H1, H2, H3...comment etc. They may be dull, but they work and, you can always predict how the surfers will see your pages and they are well suited for screen reading.

Therefore, when working with fonts it's important to remember that HTML "wysiwyg" is not quite reliable [(5): 2.18.13] – you have to check the page from time to time in a browser, while working. Composer has a button that easily opens the page in a browser [(4):0.25.18].

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[5] HTML is a rapidly developing standard and today you have the possibility to embed fonts, but this is not yet state of the art, so we will leave this topic here.

Graphics

The Internet and especially the World Wide Web is a very visual media. A homepage without graphics isn't really a homepage. Pictures, photo-graphics can easily be inserted in Composer via pushing a button in the toolbar. Afterward a dialogue is shown:

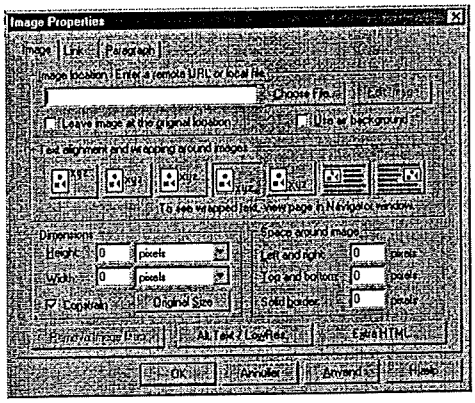

Figure 10. Image Properties

In the dialogue you have to specify which picture, you want to use and where to find it. When you place graphics on a HTML-page, you don't integrate it in the file, but show it as a link to the picture on disc. This is different from many word processors, where pictures are integrated in the text. It is important to realise this difference, when the files are to be uploaded to a server.

Links

One of the very basic functions of the web is links. A link is a highlighted piece of text or graphics, you can click on to load another web page or go to another position in the same page. Links are inserted into the document by clicking the chain-icon in the toolbar.

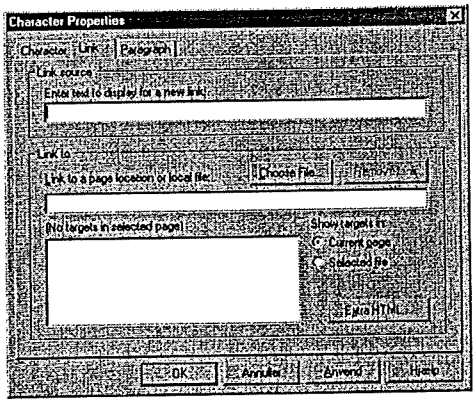

Figure 11. The Link-dialogue.

In the dialogue, you type in the URL of the new page. If it is a page on the same web site you can pick the file by clicking the button "Choose file".

You can also choose to link to another position on the same page, if you have inserted an anchor. There is a button in Composer for inserting anchors.

Upload to server

When the homepage (or the whole web site) is finished, it has to be uploaded to a web server in order for it to be accessible from the World Wide Web. This process can be done directly from Composer via the Internet. You also need to have upload-privileges to a web server.

Competences needed to use Composer

For using Composer to produce relatively simple homepages, it is necessary to know about

- Writing texts in Composer
- Inserting pictures
- Making links
- Making headlines
- Importing materials from other applications (e.g. cut and paste)
- Saving a homepage locally
- Uploading a page to a web server.
- How to make tables to place elements precisely

Working with digitised images

Teachers need to have a basic understanding of how to work with graphics in electronic format. Graphics are a very basic part of the concept of multimedia. Many teachers have experience with working with traditional graphics and combining them with other media-types, typically text. The focus when working with graphics in compulsory school must be on the conversion process from traditional to electronic media, for instance to take digital pictures of the students works of art, so they can be incorporated in multimedia productions.

For these purposes teachers need to know about digital cameras, scanners and some basic understanding of ways to store graphics digitally.

The scanner is a device, attached to a computer. The scanner works very much like the photocopy-machine, well known by many teachers. Place the object (the paper), under the cover, start some scanner-application on the computer[6]. In the application, push the scan-button, choose a resolution and picture-format, a filename and after a moment, the contents on the scanner can be seen on screen (and is saved on disc). The difficult part is to determine resolution and the format of the output-file. The number of formats for files is legio, but

[6] There exists a huge variety of possible applications to control a scanner, e.g. Paint Shop Pro, Omnipage Pro, CorelScan etc. Often the suppliers of the scanner also supply some software for scanning. The applications are very similar.

teachers need only to understand a couple of the most important ones and some characteristics of them. Choosing the right format is a question about for which purpose the results should be used. If the pictures are to be used on print, for instance, pictures are to be taken by the students and printed poster-size on a colour-printer, as high a resolution as possible, and a format of the file (like TIFF) will be appropriate. If the pictures are to be viewed on screen, for instance in a multimedia-presentation or on a homepage, the size of the pictures must not exceed 10k. The eye cannot grasp very high-resolution pictures on a screen, so there is a point in using interlaced GIF in low resolution. On the World Wide Web, all these details are well documented.

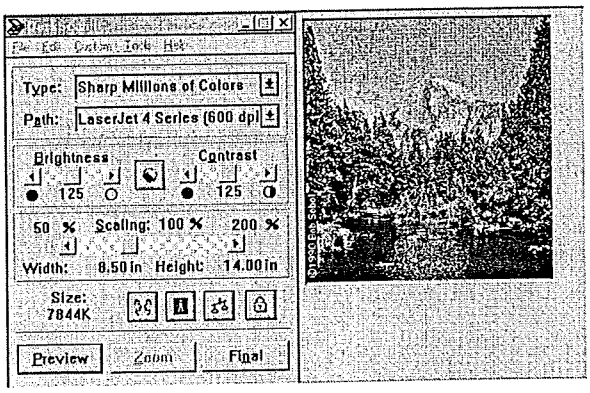

Figure 12. The application "Desk Scan" is used to control a scanner.

From the screen and a file on disc there is still a way to go. Usually there is only one scanner in each computer lab. From here the picture must be transported via network, Internet, discs or other portable media to the workstation, where it is going to be used. Teachers (and students) must know how to copy files to portable or network media to do this.

Digital cameras have the same advantages as scanners except that those cameras can be taken along, for documentation purposes. Digital cameras cannot be used for optical character recognition (OCR[7]) like scanners. Teachers must understand this basic difference and know when to choose a camera or when to use a scanner.

Most digital cameras have the possibility of taking pictures in high resolution, medium- or low resolution, depending on the purpose. If high resolution is used, only a few pictures can be stored. Today digital cameras work much like auto-focus traditional cameras. Some needs to be connected to a computer via a cable and pictures are then transferred to some graphics software, where pictures are shown like thumbnails. In other cases, pictures are stored on mini-disc or discs.

[7] OCR is the process of scanning text and converting the picture of the text to raw text that can be processed in a word processor.

The set-up in the Usability-lab, scenario No. 4

Netscape Composer works, in its wysiwyg, free-style editing-form, very much like a word processor, for instance Microsoft Word and the teachers had no big problems working with Composer. To set up a homepage with headlines, text and graphics seemed quite easy for the teachers. A bit more advanced features like making headlines in Microsoft Paint and importing them into the homepage and also working with links gave some of the teachers problems (described later).

World Wide Web

In our usability-lab fundamental differences between working with word processors and applications like HTML-editors as Composer have become very clear.

When working with HTML-editors it is e.g. essential to know about files, handling files and basic naming conventions. Files that are going to be viewed in a browser must have the file-extension *htm* or *html*, which gave the teachers in the lab some problems [(4):0.40.45]. Another technical aspect is that the main HTML-file should be named index.htmX or default.htmX (the X should be exchanged with an 1 or nothing), so the surfers can type http://www.dlh.dk and not have to specify the filename as well, for instance http://www.dlh.dk/-my_start_up_file.html. Even though this is a very technical aspect it shows something about the level of competency, the teachers must have.

It is important to differ between a homepage's name and title. The *title* refers to the name of the page that e.g. will be shown in bookmarks-list, whereas the *filename* is the actual name of the file placed on the server. Composer automatically asks for a title to this page, when saving a new page, but none of the teachers really knew, what this meant [(4):0.25.18, (5):2.09.27].

To know about files and the fundamental difference between typical word processor-documents and homepages is at stake again, when it comes to using pictures, videos and sounds etc. on the homepages. Files are not embedded in the homepage, but all files used on the homepages are inserted on the homepages as references to files. This means that all files used on the page must be uploaded to the web server together with the homepage, in order to be seen.

URL's (Uniform Resource Locators; a unique naming convention for web sites, like http://www.dlh.dk) are important to understand on a basic level. Basic level is here not the *structure* of URL's but more like knowing, when it is necessary to use the prefix http:// or not. When using browsers for surfing, it is not necessary to use the prefix, which the teachers knew, but when coding the links in Composer, you simply have to state the prefix, "http://", "ftp://" or "mailto", in order to determine what kind of link this is [(4):0.40.45, (5):2.09.27].

Layout

The World Wide Web differs from the underlying Internet in the heavy graphical representation. The graphical representation is a very important motivational feature. For the students it is important to be able to produce homepages that are just as fancy as the ones they meet on the net when browsing. Therefore, it is important for the teacher to have basic competences know about visual arts and graphical design on the net.

Graphical components (photos, clipart, graphics, headlines, animated gif-files, chunks of video, MP3-music etc.) have to be produced in dedicated applications, and imported to homepages in Composer. From a design point of view, the big quest is to place the components not just in any order, but exactly where you want them. HTML doesn't facilitate advanced ways to place graphics, but when using tables you can place graphics etc., wherever you like it [(4):0.38.03].

TECHNICAL COMPETENCES NEEDED, SCENARIO NO. 4

The analyse of the products and the analyse of the studies in the usability lab together form a coherent picture of the technical teacher competences needed for working with Scenario No. 4. The teachers need the competences in the field of:

ICT literacy:

- To work with a graphical, windows-based user-interface (e.g. closing windows, maximise/minimise)
- To use the "Clipboard-function" in order to cut, copy and paste between applications.
- To be able to handle minor errors with the computers – e.g. breakdowns where you have to reboot.
- To know how to save the produced file in a proper way

Information technology literacy

- To produce text in a digitised form.
- To produce and manipulate pictures in a digitised form.
- To produce and manipulate video- and sound files (not described in this paper).
- To use a web-browser.
- To produce hypertext (to make links).
- To understand the characteristics of HTML.
- To know how to upload files to a server.

The set-up in the usability-lab stress the need for competences in the field of producing digitised material – or at least it is necessary for the teacher to know how to manipulate and use already produced material. This competence involves some knowledge about the format of files etc.

In addition, the set-up in the usability-lab stresses the need for competences in the field of basic HTML-coding skills. Even if the most common HTML-editors are very "wysiwyg-alike" there are some basic things about HTML the teacher must know in order to solve the most common problems when producing web-sites.

CONCLUSION

In this paper some of the basic technical competences a teacher must possess to use multimedia effectively in class in compulsory school have been identified. It has been shown that a teacher must possess competences in the following fields:

General ICT literacy

- Most of the multimedia products are designed to be used on a platform where graphical, windows-based user-interfaces are used. Therefore it is necessary to know something about how to use a graphical, windows-based user-interface – how to handle your files, how to handle system-breakdowns etc.

Information technology literacy

- The teacher must have the ability to understand and use the different symbols presented in multimedia-products.
- The World Wide Web is integrated with more and more CD-ROM titles and to fully exploit the World Wide Web, it is necessary to possess a sense of multimedia-locality.
- Searching is essential to most multimedia products and especially on the web. Knowing the most basic techniques when using a search-engine is essential to find exactly that piece of information on the CD-ROM or on the web that is needed.
- When working with multimedia it is very often necessary to know how to use or produce digitised material, in order to convert between digital and traditional, analogue material. If the students are working with multimedia as described in the Scenario No. 2 maybe they find a photo on a CD-ROM they want to use in their essay. And if they are producing their own multimedia-product (Scenario No. 4) it is a core-activity to produce and handle digitised material.

The long-term-effect of competences

One of the interesting questions when discussing the need for teachers' technical competences is how application-specific these technical competences have to be? And when dealing with education of new teachers and for the in-service training of teachers in the field of multimedia – how application-specific does the training of teachers' technical competences need to be?

Leon Sulkers experiences – as described in "Competences, teacher competences and multimedia teacher competences – a study of literature" (Witfelt, 1999) – shows that focusing on general strategies for handling computers instead of focusing on the specific software when working with upgrading teachers technical competences could be a wise strategy.

Transferring this idea to the field of multimedia we suggest to use the scenario-model as described in Bent B. Andresen (Andresen (1), 1999) as a frame for defining in which areas a teacher should possess general technical competences. And then in the training of these competences we suggest – with Leon Sulker in mind – to focus on developing general strategies for each scenario. Talking about Scenario No. 2 and 4 these strategies can be based on our findings described in this report.

These general strategies will provide the teacher with a "technical toolbox" in the field of multimedia so he or she will be well prepared for the real challenge – using the multimedia in a pedagogical context in compulsory school.

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APPENDIXES

Appendixes 1 and 2 are the written instructions to the teachers in the Usability-lab.

APPENDIX 1

Scenario No. 2

Multimedia and the new competences of Teachers

Your task in the Usability-lab is to prepare and plan 4 lessons for some students at the age of 14. In these lessons the students are going to make a project using multimedia. Your task as a teacher is to prepare the first part of this project-work, where the students are going to gather information about the topics of the project-work.

To get the information needed the students have access to the World Wide Web and they can use the following multimedia-products:

- Microsoft: "Encarta Encyclopaedia '99"
- Dorling Kindersley Multimedia: "Eyewitness World Atlas"

You can choose between the following two topics for the project-work

- "London"
- "Native Americans"

APPENDIX 2

Scenario No. 4

Multimedia and the new competences of Teachers

Your task in the Usability-lab is to prepare and plan 4 lessons for some students at age 14 who are going to make a web site about London. The students have already been working with London for some time and they have produced some text and pictures ready for the web site. Nevertheless, not all of the material is digitised now, so a scanner and a word processor will be available for the students.

To make the web site the students have access to World Wide Web and they can use the following products:

- Netscape Composer v. 4.6
- Microsoft Word 97
- World Wide Web via a browser as Explorer 4.x or Netscape 4.x
- "Paint" (a simple graphic illustration program).