United Nations
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UNESCO Institute
for Information Technologies
in Education

Multimedia in Education

Curriculum

Bent B. Andresen
and Katja van den Brink

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by Bent B. Andresen and Katja van den Brink

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Foreword

Dear Colleagues,

You are holding in your hands a new edition of the book prepared by the international experts – Mr Bent B. Andresen (Danish University of Education, Denmark) and Ms Katja van den Brink (University of Landau, Germany) – that was initially issued in 2001 by UNESCO IITE. Since that time, a large variety of innovations and developments have appeared in the field of ICT in education, especially with regard to multimedia application. As the first edition of the book attracted huge attention of the international education community, UNESCO IITE has decided to commission it as an updated curriculum, considering the experience of the authors accumulated since then, and taking into account new achievements in the area of multimedia incorporation into regular educational practice.

Effective teaching and learning is impossible nowadays without the use of various techniques based on modern ICTs and innovations of the so-called 'digital' pedagogy. Within a high-tech information-educational environment, multimedia is one of the powerful tools that assists teachers to enhance their professional capacity and helps students to achieve their educational goals. Moreover, modern multimedia in combination with social media and open educational resources contribute to reaching one of the UNESCO main goals in education – to make quality education more accessible for all.

In this book you will find a well-structured and systematic explanation of several pedagogical scenarios for the use of multimedia in education, including the description of the different aspects of performance and portfolio assessment, the role of multimedia end users, multimedia production process, practical use of multimedia in teaching and learning. This is of high importance, as the integration of ICTs with pedagogy is a key component of the concept of 'new pedagogy' that meets the demands of the Global inclusive knowledge society.

I hope that this publication will be very helpful for teachers and teaching staff, education administrators and policy-makers, researchers and students, as well as for everyone interested in the state-of-the-art multimedia application at different levels and sectors of education.

Dendev Badarch

UNESCO IITE Director a.i.

General Information

Introductory notes on course and curriculum

In 2000, UNESCO IITE asked Dr. Bent B. Andresen from the Department of Education at Aarhus University in Denmark to co-ordinate the preparation of materials for a specialized course module on multimedia in education. In particular, Bent B. Andresen was asked to coordinate the preparation of proposals for an introductory note, a curriculum and a supplementary set of materials for an UNESCO IITE specialized course module. He did this work together with Katja van den Brink, a France-based psychologist.

In addition, Bent B. Andresen was asked to select a group of international experts to work on the development of materials for the UNESCO specialized course module *Multimedia in Education*.

Target audience

The UNESCO course module *Multimedia in Education* was developed within the framework of elaboration of *The IITE Educational Program on ICTs in Education*. According to the classification of UNESCO IITE Educational program, the target audience includes:

1. Heads of pre- and in-service teacher training and vocational development institutions, trainers of trainers for ICTs in education, instructional guidance and support specialists;
2. Teachers, ICT school coordinators and other educational personnel.

Level of preliminary knowledge by participants

- Teacher education;
- ICT literacy;
- Basic knowledge about the function and application of ICTs into educational settings.

Aims and outcomes of course module

The aims of the module Multimedia in Education are that the target groups develop a deep knowledge and high competencies regarding:

- Why, where and how multimedia can be used in school educational settings;
- Pedagogical scenarios concerning the mainstream and future use of educational multimedia;
- Important learning and teaching aspects, in particular, teachers' roles, students' learning strategies, social/collaborative learning, ICT literacy, metacognition, and motivation;
- Present educational goals and how educational multimedia can support these goals;

- Critical and reflective selection and the use of educational multimedia according to mainstream scenarios for multimedia in education;
- Evaluation methods related to the educational use of multimedia.

In particular, the module is aimed at boosting educators' motivation and skills in applying multimedia into educational settings and adapting the content of the course into current educational practices.

In this context, knowledge implies theoretical and practical knowledge concerning the content to be learnt. Competencies refer to the ability to transfer and adapt the material of the module into a real classroom situation. After this module, the trainee is expected to be able to use and apply the acquired knowledge and competencies in his or her school situation.

Content of course module

As stated in the title, the content of the course module is focused on the use of multimedia in education. In particular, it describes the role of teachers and students, and the potential impetus of multimedia on students' learning, motivation, cooperation, etc.

Currently, students are encouraged to use a growing number of multimedia products in a number of different ways. The application of interactive multimedia into educational systems takes place all over the world, although the range and speed of implementation varies from country to country. In educational settings, multimedia products and online services serve as a means of communication and expressive tool in various pedagogical scenarios.

The notion of *pedagogical scenario* designates a postulated sequence of imagined events of a learning situation. Each event is characterized by specific roles of teachers, students and educational multimedia products. Some products and materials are designed to control the process of presentation and students are assigned a somewhat passive role as receivers of information. Other products and materials are interactive in the sense that students are assigned an active role, where they can select topics and jump between them.

The different ways in which students deal with multimedia are categorized – according to a scenario model – into four pedagogical scenarios (Andresen, 1999):

1. The use of multimedia linear educational sources;
2. The use of multimedia hypertext-based materials;
3. The use of multimedia supervising products;
4. The use of multimedia productive tools and ingredients.

Scenarios 1–3 relate to students as to *end user*s of messages from educational multimedia, whereas Scenario 4 regards students as *producers* of small-scale multimedia products.

The use of linear multimedia in Scenario 1 regards the reception of the content of linear multimedia products. Students perform different tasks in a sequence. Initially, they can pick the episodes they want. However, once potentially useful sources have been determined, students have very limited control over the narration.

The use of hypertext-based educational materials in Scenario 2 encompasses the reception of the content of non-sequential multimedia products. Non-sequential narratives include hypertext-based, interactive materials and they are often used as information providers. No guidance is offered through different sections, thus making the student act as an explorer.

The use of multimedia tutoring products in Scenario 3 regards the reception of the content of multimedia products aimed at teaching. These products display various guidelines for students and help them break down and structure different tasks. This type of products typically has a tutoring strategy. Firstly, they are based on knowledge about a subject matter and about instruction, often presented in drill-and-practice sessions. Secondly, they apply a critiquing strategy, e.g. provide feedback tailored to the particular needs of each student helping her/him confirm hypotheses and refine proposals.

The use of multimedia productive tools in Scenario 4 covers students as authors and producers. This scenario regards the production of multimedia presentations by means of proper multimedia elements to be used by students in order to create and edit multimedia products in the classroom, and by means of proper tools to handle elements of texts, graphics, sounds, etc. Here, students take on the role of producer.

The four scenarios cover widely used multimedia genres in educational settings that differ with respect to the role of students and teachers, as well as to the function of multimedia products and online services. Many mainstream approaches are similar to one of the scenarios or consist of a mixture of these. It does not mean, however, that the common multimedia pedagogical practices are considered limited to these four approaches.

The intention is to describe some typical pedagogical scenarios and not to present an exhaustive list of scenarios. More specialized scenarios can, of course, also be found.

Those taking a course on multimedia in education are expected to develop knowledge and skills in the following areas:

- The scenario model concerning the use of multimedia in education and important learning and teaching aspects of learning with educational multimedia;
- Critical and reflective selection of educational multimedia according to educational objectives of the use of multimedia (What knowledge and competencies do students need to develop and how can educational multimedia support these goals?);
- The application of educational multimedia according to Scenarios 1, 2, 3 and 4 and mixtures of those into schools/educational settings;
- Proper methods of evaluation of the knowledge and competencies acquired.

From the point of view of school organization, the integration of multimedia in the process of teaching and learning demands reflexive, pragmatic and experiential approaches, which place teachers, ICT school coordinators and other educational personnel at the centre of innovation. With the help of multimedia, the teacher shifts from being a transmitter of information and the single source of knowledge to one among many sources of knowledge and a facilitator of the learning processes.

Brief descriptions of instructional methods

The course can be given in two ways. The form can be either conventional classroom education or e-learning (i.e. open and distance learning via the Internet).

Conventional provision is the most common offering of in-service teacher education. This form requires the participant to travel to an institution for the purpose of in-service education. In most cases, it is characterized by oral presentations given by instructors, in-class discussions, guided studies of tutorials, as well as by practice in labs. Often, it includes periods with studies in libraries or media resource centers.

It is recommended to use typical tools, such as projectors and computers when, for example, demonstrating on-screen slides or images. Furthermore, the computer is necessary as a learning and teaching tool that helps to construct new knowledge.

In this context, e-learning is characterized by the separation of the teacher and the participant. The interpersonal face-to-face communication of the conventional education is replaced by a mode of communication and guidance mediated by the Internet. In many countries, this form of in-service education is considered complementary to the conventional one. Evaluations are positive if both the forms are connected to each other. Many school leaders, coordinators and teachers prefer to work on their own and in teams in part of the course (Andresen, 2000).

It is planned to provide separate guidelines on both the conventional provision and the e-learning approach for instructors of the course *Multimedia in Education*, as well as for its participants (student guide).

The instructional method of the presented curriculum is based on a common approach for e-learning and conventional classroom learning. The basic instructional approach is a learner-centered approach, i.e. self-regulated and collaborative learning guided and supported by a trainer. The integration of the use of multimedia in teaching-learning experiences demands very reflexive, pragmatic and experiential approaches, which place the course participant at the centre of the learning process. This means that participants have to find their own individual access to information for constructing their knowledge. Therefore, they need a vast pool of appropriate individualized strategies, which will enable them to be active and critical learners.

Structural organization of sessions

The units will be instructed differently according to the learning objectives and learners' previous knowledge. The individual sessions are divided into three phases: the construction of declarative knowledge (knowing that), the construction of procedural knowledge (knowing how), the construction of structural knowledge (knowing why) and reflection on the received information, acquired knowledge and skills, whereby the order of these three phases is not important. This means that there will be situations in which it makes sense to reflect first on the topic, or just to try a certain multimedia application or tool.

Furthermore, there is a broad collection of digital multimedia (see Appendix 1), which can be used to foster learning and teaching with multimedia. This provides an insight on how multimedia can be used in the classroom.

The particular instruction method recommended will be described in connection with each of the specialized module units.

From the beginning, participants can be informed that the course is open, i.e. that it is up to them to choose and engage in the proposed course activities.

Brief description of main phases of units

The individual units/sessions are divided into three phases: the construction of declarative knowledge (knowing that), the construction of procedural knowledge (knowing how), and the construction of structural knowledge (knowing why) and the received information, acquired knowledge and skills.

The order of the phases differs. In some cases, it makes sense to reflect on the topic in the beginning. In other cases, it is recommended just to try a certain multimedia application or tool. Therefore, the units of the course module will be taught differently according to the learning goals and previous knowledge of participants. The recommended pedagogical approach will be described in connection with each of the specialized module units.

Recommendations for organization

The course should be taught to groups of no more than 20 students.

Every student should have access to a computer during the course. Since the course also deals with web-based multimedia materials, access to the Internet is required.

A list of recommended equipment can be seen in Appendix 2, and a list of recommended software – in Appendix 3.

For certain activities, students will need to work in groups of three.

Total time requirements

In practice, the amount of time needed will be depending on participants' previous experience with ICT in educational environments.

Multimedia collection

As mentioned above, there is a broad collection of multimedia (see Appendix 1) that can be used to foster learning and teaching with multimedia, as well as to get a broader view on how multimedia can be used in the classroom.

Curriculum – learning units

Unit 1. Introduction workshop: using multimedia in schools

The overview introductory workshop provides participants with a first insight on the state of the art of the topic *Multimedia in Education.* The workshop looks at teaching and

learning with educational multimedia from a teaching and learning perspective as well as from a practical point of view.

Unit 2. Performance and portfolio assessment

In Unit 2, participants of the course assess their own knowledge and abilities. Positioning the topic 'Assessment/Evaluation' at the second part of the module is due to pedagogical reasons. From the very beginning, students should learn to reflect on their own activities and knowledge.

Participants of the course are expected to work out a performance assessment (Collins, 1992) in the form of a portfolio approach. The production of their own file with the help of multimedia tools during the course can feed several needs of the curriculum – to help participants develop their self-assessment and external evaluation skills as well as various competencies.

Unit 3. Using multimedia according to Scenarios 1/2/3 – learner as end user of multimedia

The application of multimedia into education means many things to many people. However, the use of educational multimedia can be classified according to some mainstream scenarios. As mentioned in the previous section, the scenario model includes four pedagogical scenarios and covers the most common use of multimedia applications (Andresen, 1999).

This unit deals with the reception of linear-narrative elements (Scenario 1), of non-sequential elements (Scenario 2) and of elements aimed at teaching (Scenario 3) of educational multimedia.

The concept of the scenario model will be worked out practically in pairs/group work at the computer.

Unit 4. Multimedia use according to Scenario 4 – learner as producer of multimedia

Exploring this scenario, participants are supposed to produce their own multimedia presentation using proper tools to handle texts, graphics, video, sound, etc.

A multimedia portfolio evaluation will be integrated into multimedia production.

Unit 5. Critical and reflective use and selection of educational multimedia

In this unit, pedagogical reflections on the use of educational multimedia will be considered as well as the critical selection of multimedia applications.

Unit 6. Learning with educational multimedia

This unit deals with theories of learning. In particular, such aspects as learning conceptions, learning strategies and self-directed learning, metacognition, social/collaborative learning, ICT literacy, and motivation will be deepened and practiced.

Order of units and sessions

It is recommended to start with the workshop. During the workshop, participants of the course will be introduced to the main topics of the course module.

Thereafter, it depends on the course provider/instructor how to organize the structure of the course. The order provided in the description of the section 'Course Module' may be appropriate in many situations.

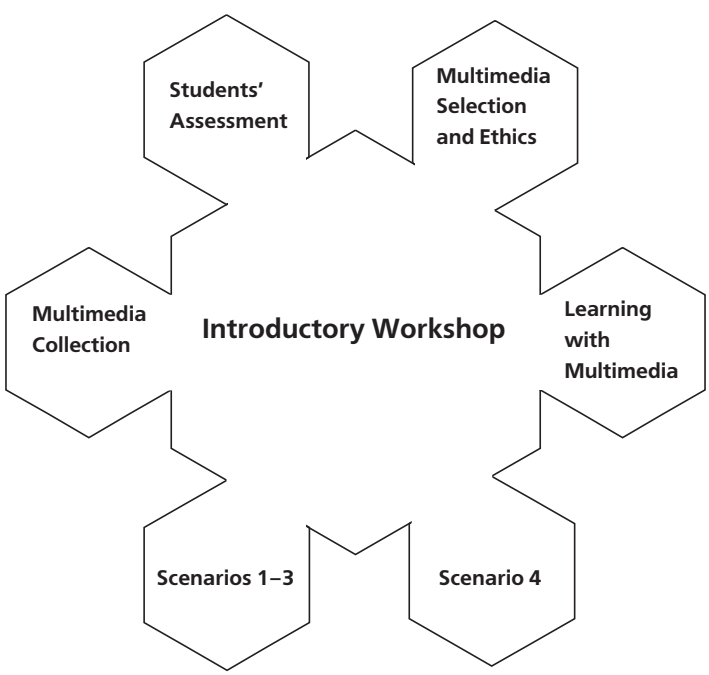
Participants are expected to deal with the order of sessions according to their individual needs.

Since Unit 6 regards the rationale behind the use of multimedia in education, it is possible to change the order of the units and provide it immediately after the introductory workshop.

It is suggested to follow the so-called *market metaphor* (Figure 1), which means that the trainer can choose the order of topics according to his or her own needs. The starting point is the workshop. After completing the workshop, the trainer, however, might prefer to start with theories on learning or he or she might like to start by selecting the practical parts of the curriculum. The assessment of course participants can be placed directly after the workshop, if the trainer is interested in the portfolio approach and if he or she wants to engage participants into their own assessment.

Moreover, there are many opportunities to structure the content of the curriculum. For instance, teaching Unit 4 (Scenario 4) might alternate with teaching Unit 6 (Learning with Multimedia) due to the fact that Unit 6 deals with certain learning theories and learning aspects, which are important to understanding and applying Unit 4 in a pedagogical way.

Figure 1: Organization of the course module *Multimedia in Education*



Overall teaching guide

Pedagogical approach for all units

The integration of ICT and multimedia in schools can change the existing learning principles tremendously. The organization of schools can become innovative in the sense that it will adopt reflexive, pragmatic and experiential approaches, which place the individual learner closer to the centre of the learning processes. The use of multimedia often means that there are more student-centered work and flexible schedules. The teacher's role often changes from being an authority, or the primary source of knowledge, to being also a facilitator or conductor of the learning process. Students have to find their own individual access to the fast changing world and therefore they need a huge pool of appropriate individualized strategies, which will foster their active and critical learning. The ability to share knowledge collaboratively with others in a world where most products are the result of teamwork, having the appropriate strategies and knowing why and how to apply them will be among the most important qualifications within lifelong learning.

As mentioned above, the individual units/sessions are divided in three phases: the construction of declarative knowledge (knowing that), the construction of procedural knowledge (knowing how) and the construction of structural knowledge (knowing why) and reflection on the given or found information, the acquired knowledge and skills. The order of the three phases is not considered important. Sometimes it makes sense just to reflect on the topic at the beginning or to try a certain multimedia application or tool without focusing on it in depth.

What is learned may not be what the teacher intends to be learned (Candy, 1999; Driver and Oldham, 1986 – cited according to Biggs and Moore, 1993). The major determinants of learning are internal to the learner:

1) What is learned depends on what is already known. Most important determinant of learning is existing knowledge; the students construct with the bricks and blueprints they already have. New knowledge obviously affects the outcome, but not as powerfully or directly as we assume.

2) Learning is an ongoing process; it is continuous and active. The learner will have relevant experiences prior to and following formal instruction. It is better if formal instruction tries to encourage and make those links explicit rather than ignore them.

3) Learners have responsibility for their learning. In line with a constructivist view of learning, one must allow learners to develop self-direction and not force 'correct' constructions onto them.

4) Constructed meanings share common characteristics. Through language and shared social experiences people's constructions allow communication and acknowledgement of mutual validity.

The collection of multimedia (see Appendix 1) gives further information on how to work with multimedia in the classroom.

Teachers' ICT competencies

Applying ICT into the classroom, teachers need different types of competencies:

- General pedagogical competencies;
- ICT literacy;
- ICT pedagogical competence.

General pedagogical competencies: The student-centered approach plays an important role.

ICT literacy: To teach a foreign language, the teacher needs to be fluent with respect to that language. For example, the teacher of English has to be fluent in English. In the same way, the teacher needs to be fluent in ICT. For example, he/she needs to know where and how to find materials on the web, how to use it for different subjects for teaching and learning purposes, how to present educational content by means of multimedia, and how to use multimedia products and online services in education.

These competencies include a general understanding of central functions, uses, and methods in general computer use.

Such competences are also needed for being able to discuss multimedia issues in schools.

ICT pedagogical competence: Teaching with multimedia calls for competencies according to the use of the scenarios (see Scenario Model Unit 1-4). The user of multimedia (as an end user and as a producer) needs knowledge and experience with multimedia.

The module *Multimedia in Education* will enable pre- and in-service teachers to construct knowledge in accordance with the latest multimedia competencies. Therefore, ICT literacy is a prerequisite to join the module. However, competencies in all the four dimensions will be constructed during the course of the module.

Role of teachers

As mentioned above, teachers get new competencies and new roles in a multimedia-learning environment. Besides having a broad knowledge base, teachers have to offer pedagogical guidance and supervision by inspiring, motivating and guiding students in their search for knowledge and stimulate their continuous process of asking questions. Having the competence to support students in constructing learning strategies, meta-learning strategies and strategies for developing information-handling skills is important (McFarlane, 1997, cited in Witfelt, 2000). According to Harasim et al. (1997, cited in Witfelt, 2000), the teacher's activities in the classroom when guiding the learning processes seem to be:

- Plan and follow conversations;
- Offer guidance;
- Play a facilitative, observant background role;
- Monitor and encourage participation;
- Form groups;
- Assign roles and responsibilities;
- Moderate and facilitate group processes;
- Co-ordinate interaction, set up guidelines and expectations;
- Pace interaction;
- Organize interaction by relating inputs;
- Stimulate meta-communication.

The idea of facilitating the student's learning processes demands a mutual responsibility for learning. Thus, the responsibility belongs to both, the student and the teacher.

Another very important aspect is the support of meta-learning processes – students need to reflect on their own learning processes to get ahead with their development of effective learning and working strategies (van den Brink et al., 2000).

Some typical roles of the teacher using multimedia in the classroom are (Witfelt, 2000):

The role of an *initiator* who can kick-start the learning process of the whole class at once. To make the students start their learning activities by just giving them the necessary technical support can be challenging.

The role of a *critical friend* who provokes the students to seek beyond the easy solutions. It is easy to browse the web or to navigate multimedia encyclopedias and collect a lot of data, but the teacher's role here is to inspire the student to sort the data and only present the one that can be used to reach the goal.

The role of a *process-adviser* who gives hints on how to work and study. When the students take the responsibility for their own learning, they are in need of supervision. In this case, the teacher assumes the role of an expert and must be able to act as a student advisor.

The role of an *expert* who is well-versed in specific subject matters and provides hints according to the topic of the subject's content.

The role of an *inspirer* who supports when spirits get low. Many teamwork processes and problem-based projects have an almost built-in frustration phase. Teachers should be aware of this and be able to inspire their students to get over the 'dead' periods.

The role of a *moderator* of group discussions. If discussions or arguments turn to be non-solvable, the teacher should act as a moderator. This does not necessary mean to overrule classroom discussions and force a solution, but to listen to the arguments and point at possible ways to get on with the work, satisfying as many points of view as possible.

Many other roles could be mentioned depending on the national level of team learning and other topics, such as:

The role of an organizer who manages learning tasks so that each student feels supported by the fact that the working proposals are adjusted to his/her possibilities;

The role of a creator who creates a student-centered and co-operative environment /atmosphere, which makes it possible for classmates as well as for teachers to be sources of stimulation and help.

The materials in Appendix 1 include more supportive guidelines and ideas regarding teaching and learning with multimedia.

Evaluation of course module *Multimedia in Education*

It is planned to implement and evaluate the course module *Multimedia in Education*. The results will be published on the Internet and in a book format.

Unit 1: Introductory workshop on multimedia in education

Abstract

The introductory workshop provides participants with a first insight into the state of the art of the topic *Multimedia in Education*. The workshop considers studying with educational multimedia from teaching and learning perspectives as well as from a practical point of view.

Introduction

The introductory workshop refers to questions such as why, where and how to use multimedia in educational settings.

First, four different pedagogical scenarios will be presented. Then some decisive aspects of learning will be considered. Furthermore, the main goals of education and the implications for students' learning will be considered. Finally, concrete questions on the use of educational multimedia will be addressed.

In Unit 1, participants of the course are expected to get an overview and first insights into and experiences with multimedia in education.

Goals	**Topics**
Declarative knowledge (knowing that – facts, theories, connections between theories)	Overview of the course *Multimedia in Education*: The use of multimedia in schools: • Scenario model • Concept of learning with multimedia • General goals of education • Different kinds of knowledge • Characteristics of multimedia • Building up connections between presented theoretical approaches to learning and motivation
Procedural knowledge (knowing how)	• Practical use of multimedia • Strategies and competencies in dealing with multimedia hardware and software • Metacognition in learning, reflections on one's own learning and teaching processes • Use of learning and teaching methods
Strategic knowledge (knowing why)	• Development of learning strategies on use of multimedia • Learning to learn within groups and collaboratively

Session description

Session 1: Introduction on the use of multimedia via the scenario model – definitions and aspects of learning with multimedia – definitions of multimedia and interactivity.

Session 2: Multimedia in education – present goals of education – different forms of knowledge – why learning with multimedia?

Session 1

How to use educational multimedia?

The first session will give a preliminary answer to the question many teachers, coordinators and teacher trainers may pose regarding educational multimedia: *How to use these products to foster students' learning and motivation?*

Participants are invited to construct knowledge and attitudes concerning the use of multimedia to foster learning and increase motivation among students. The main topics are: introduction to the use of multimedia in four scenarios, definitions and aspects of learning with multimedia, definitions of multimedia and interactivity.

Participants get a first insight into the use of educational multimedia. They are introduced to the scenario model, the common use of multimedia, and experiences with the various scenarios.

Two common questions regarding educational multimedia will also be addressed: *What is multimedia* and *why use multimedia?*

Certain familiarity with some multimedia products or online services, which are suitable for particular fields of teaching, is presupposed. Otherwise, it is recommended to begin with demonstrations and activities in the computer lab in order to help participants to become aware of these learning opportunities.

The choice of activities and the selection of examples of multimedia products can be done in accordance with the curricula and the objectives of a particular educational system to which participants are affiliated.

In some cases, the course instructor may prefer to begin with the second question: Why use multimedia in education? If this is the case, it is recommended to begin the course with presenting the second session of Unit 1. Furthermore, the trainer can introduce some of the themes of Unit 6 before moving on with the topics of this unit.

Pedagogical scenario model for using multimedia in education

The scenario model proposed by Andresen (1999) classifies the use of multimedia in education according to the roles of teachers, students and applications. The concept of scenario designates a postulated sequence of imagined events aimed at learning (Andresen, 1999, p. 10).

The scenario model identifies and describes four scenarios, which cover the most common use of multimedia applications in education. They are:

Scenario 1 – The use of linear applications: Some multimedia applications have a linear structure in their presentation of content, which leads students through the content in sequences. This form is similar to traditional narratives presented in films. Students can control such applications only in the sense that they can select what they want to learn (i.e. a digital encyclopedia where they can find video, sound or animation clips, etc.).

Some applications provide linear tours (similar to books, but with opportunities to simulate a real assignment situation, etc.). Once users have located the source, they have, however, very limited control during the narration. Often, they can navigate forwards or backwards, but they cannot alter the content.

Use: Scenario 1 applications and elements often make sense when there is very limited previous knowledge concerning a certain topic/subject. See Unit 3.

Scenario 2 – The use of non-sequential applications: Hypertext-based applications with more interactive opportunities mostly used as information providers (encyclopedias, handbooks, etc.). The students can search for information according to their tasks and problems. For example:

Where is Greenland? What kind of weather do they have up there? Which ethnic groups live in this area? …

Compared to ordinary books, this approach to the presentation of content allows for the integration of different types of media such as text, speech, music, animations, simulations of complex relations, numbers, video clips, etc.

Often, the interface has search engine functionalities with some buttons and options that students must decide upon when using this or that multimedia product.

Use: Scenario 2 provides students mainly with information. In addition, the use of this scenario helps the student to become a self-regulated learner who can tap into a huge pool of strategies. While the student is searching for information and reflecting upon his or her actions, the teacher is considered to be responsible to enhance strategy knowledge and support. See Unit 3.

Scenario 3 – Guided discovery: This type of applications guides the student through the content by breaking down different tasks and helping to structure a task sequence. Its narrative style can be located between Scenarios 1 and 2. Often, the content provides motivational elements such as games, competitions or explorations (i.e. educational content in an adventure game environment). Such applications contain on-demand support modules.

There are two different kinds of applications: a tutoring strategy, which provides information on a particular subject as well as on nuances of instruction, and a critiquing strategy, which responds immediately if the student did something incorrectly (spell checking, number checking, etc.). Examples for these types of applications are adventure games in history and biology, drill-and-practice applications in math and languages.

Use: Scenario 3 is recommended when students are supposed to practice their knowledge. Furthermore, this scenario supports critical thinking and problem solving because many of these applications demand complex solutions within motivational games. The teacher can provide support in suggesting appropriate strategies, collaborative work, etc. See Unit 4.

Scenario 4 – Production of multimedia: In Scenario 4, the student is the producer or author of a multimedia application (and not the end user like in Scenarios 1-3). The student uses multimedia tools mainly for the purpose of knowledge construction and representation or as a communication tool for expressing ideas and sharing resources. For instance, the student can use a certain multimedia tool for producing a site homepage or a game. These

tools provide material for text-based elements, numbers, graphics, images, sound, video, animation, etc.

Use: Scenario 4 is recommended when students are supposed to construct, present and structure their knowledge according to critical, creative and complex thinking, reasoning and problem solving. Not only can teachers support them by providing help in using specific tools but also by shaping their thoughts, ideas, etc. See Unit 4.

Please see the table below with a short summary of the scenario descriptions, their advantages and disadvantages, and their common base.

Scenario	Description	Advantages	Disadvantages
Scenario 1	**Reception of linear multimedia presentation of content** Use: presentation of complex functions, connectedness of aspects or procedures No or little previous knowledge	**Structured presentation of topic with beginning and ending** Learners experience less distraction Little ICT literacy is needed	**Structured presentation of topic with beginning and ending** Very limited control over navigation Content cannot be altered No feedback
Scenario 2	**Reception of content of non-sequential multimedia application such as hypertext/media application** Use: as information provider	**High control over navigation** High interactivity Very flexible and individual use of contents Access to knowledge bases outside 'classroom'	**Risk of being 'lost in hyperspace' due to no guidance** Information management strategies are needed for effective use Content cannot be altered No feedback
Scenario 3	**Reception of content of multimedia applications aimed at teaching** Use often closely related to curriculum: Practicing knowledge Supporting critical thinking by offering tricky problems to solve Introduction to topic to be learned	**Content is structured like in textbook** Students learn according to their own pace and learning needs Navigation guide is provided throughout application Learners get feedback Motivation factors such as games Content is structured into learning tasks	**Content is structured like in textbook** Moderate control over navigation Application is built on only one specific learning theory Background – often computer-based training (CBT) Content cannot be altered

Scenario	Description	Advantages	Disadvantages
Scenario 4	**Production of students' own multimedia presentations by means of proper tools to handle texts, graphics, video, sounds, etc.** Use: multimedia as thinking, communication and presentation tool	**Presentation of one's own concepts – actively engaged in learning by developing and not just reproducing material** Concrete (and multiple) representations of abstract ideas Conceptualization of thinking Support of thinking and problem-solving Support of collaborative learning High motivation due to ownership of product Construction of knowledge	**Higher learners' ICT literacy is needed** Production tools needed Hardware and software requirements Time consuming
All scenarios	**Many different types of content is provided (1–3) or possible to produce (4)** New roles for teachers and learners: both groups are actively involved Teachers support and guide students' learning processes and are not anymore the sole information provider	**Learners use application according to their own pace and educational needs – support of self–directed learning** Students can be supported individually by teacher	**Content and technical limitations of presentations, applications and tools**

Session 2

Multimedia in education

The main topics of the session are: multimedia in education, present goals of education, different forms of knowledge, why learning with multimedia?

In particular, the session intends to answer an important question common among teachers and teacher trainers: Why is it worth using educational multimedia and where can it be used?

What is multimedia?

The concept of multimedia is defined in many ways. Most of the definitions agree on the characteristic that multimedia contains texts, graphics, animations, video and sound in an integrated way and the content can be structured and presented differently. One of the most crucial characteristics is the interactivity of multimedia products used in Scenarios 2–4. Rhodes and Azbell (1985, cited in Schulmeister, 1997) distinguish three forms of interactivity:

- *Reactive interaction*: Learners give responses to a presented stimulus. The order of tasks is strongly determined and the individual influence on the program is small (Scenario 1).
- *Proactive interaction*: Learners control the program. They make decisions on the order of tasks or where to navigate within the application (Scenario 2).
- *Mutual interaction:* Learners and program are able to adapt to each other (some Scenarios 2 and 3).

These forms differ in terms of user control. At the reactive level, the producer/designer has total control over the content, its presentation, sequences, and practical assignments. At the pro-active and mutual levels, there is more flexibility for the user.

According to Reimann (1997), interactivity contains a broad range of possibilities for influencing the process of learning and the content of studies:

- *Manipulating objects* on the screen by mouse activities;
- *Linear navigating*: moving forward/backward on the screen;
- *Hierarchic navigating*: the possibility of selecting sites/content by using special menus;
- *Interactive help functionality*. This kind of help, which can be available through special menu buttons, is most effective when adapted to the topical presentation of information;
- *Feedback*: The program answers by giving an assessment on the quality of user activities. These answers are visible on the screen. The further course program may be dependent on this assessment, i.e. adaptability is established;
- *Communicative interaction:* The possibility of interaction with other persons, i.e. other users or 'friends' in social networks. Since, 'social networks consist of people who are connected by a shared object' (Zengestrom, 2005), networks can foster learning about these objects.

- *Constructive interaction*: The program provides an opportunity for constructing or configuring objects on the screen. For example, users have a possibility to actively create their own nodes and link models, i.e. they can add new nodes and new links between already existing nodes and in this way develop their own hypertext structure;
- *Reflective interactions*: The program stores the learner's individual activities for further analysis (e.g. a navigation path within a hypermedia lesson). Furthermore, the program can provide the learner with an 'expert path' or a 'guided tour';
- *Simulative interactivity*: Objects on the screen are linked together and exchange information in such a way that a particular configuration of objects produces 'behavior' of these objects (simulations of machines, simulations of social interactions, etc.);
- *Non-immersed contextual interactivity*: The learner is involved in an activity that implies a pedagogical purpose. Many edutainment applications (software which combines education and entertainment) and adventure games use this kind of interactivity (Scenario 3);
- *Immersed contextual interactivity*: This is virtual reality. Within virtual reality the user dives into a simulated three-dimensional world.

Why use multimedia in education?

Using multimedia for knowledge construction

Multimedia can be viewed as a learning tool and a means of communication. Within learning situations, multimedia products and online services can be used creatively and reflectively.

Furthermore, multimedia can be used to foster learning subject matters and cross-curricular topics. General goals of education frame the use of multimedia in education. The following goals of education can be considered as important:

Construction of meaningful and understood knowledge: This means the development of a well-structured, disciplinary, interdisciplinary and daily-life-oriented system of flexible and usable competencies, abilities, skills and content knowledge.

C*onstruction of applicable knowledge*: How to transfer meaningful and understood knowledge into applicable knowledge?

Construction of knowledge about learning. This important competence enables students to be experts of their own learning processes. Consequently, reflection and metacognition of learning processes support the construction of meaningful and understood knowledge as well as applicable knowledge.

The concept of *learning to learn* means to find out and to apply specific successful ways and strategies in every subject. One aim is to increase the student's knowledge about the idea of learning in itself and about his or her own memory. The student can reflect and use metacognitions by asking the following questions: How can I control my own learning processes? How do I plan my learning? How do I divide a certain task into units? How can I observe myself when learning? How do I check and evaluate my learning

results? What is learning in my opinion? What is the purpose of my learning? Why does learning (with multimedia) make sense?

Although the concept of *knowledge* has developed since the ancient times, we still do not fully understand the ways in which knowledge is acquired and applied by individuals. Concepts like *learning*, *competencies* and *human potential* represent different attempts to describe or explain the processes where individuals become subjects with a substantial body of knowledge. These concepts vary according to their underlying epistemological and ontological assumptions. To use the language of information technology, the different approaches are not compatible.

Learning

Many definitions of learning take into account the realization of these learning opportunities and the development process of understanding, capacity, disposition, etc.

According to Alan H. Schoenfeld (1999), 'one has learned when one has developed *new understanding* or *capacity.*' Some aspects are decisive for this development of new understanding and/or capacity. According to current learning theories, some important *learner* aspects are:

- Capacities and abilities (physiological and intellectual prerequisites, previous knowledge concerning the topic, etc.);
- Interests, learning strategies, metacognitions, conceptions of learning, motivation, emotions, attitudes concerning the content to be learned, social competencies, etc.

Most concepts of learning agree that two factors are essential to learning:

- Social contacts and relationships to people (family members, classmates, teachers, friends), i.e. communities of practice, communities of communication and cooperation;
- Learning objects, i.e. learning materials (books, videos, tapes, and multimedia products), physical objects and artifacts, and virtual learning spaces.

Also the *environment* in which learning takes place influences learning. This includes the structure, conditions and access to the environment itself (society, libraries, media resource centers, computer labs, nature, cities or countryside, etc.).

In this sense, multimedia applications can be used as one out of many learning environments that are suited to be used in different learning situations, where learners are mulling over the subject matter and engaging in a dialog with peers and teachers concerning their learning experiences.

Learning goals

In order to handle this complex situation, in which learning takes place, it is recommended to have explicit *learning goals*.

Teachers and learners typically define these objectives within the frame of the curriculum.

They can be specified as a combination of the declarative knowledge (knowing that), skills (knowing how), and ability of learners to use knowledge, skills and personal, social and/or methodological abilities.

The learning units do not state the domain specific knowledge of multimedia applications, i.e. the explicit knowledge represented in these applications. Since this content can refer to many different subject matters at many levels, the units only contain examples of the explicit knowledge that are stored, processed, and presented by means of educational multimedia.

It is recommended that instructors of particular courses provide proper examples of multimedia products that can foster learning in the teaching fields of participants.

It has been known for many years that educational multimedia – under certain conditions – can be used as effective learning objects (see for overview Hasebrook, 1997; Schulmeister, 1997). Learning with multimedia can foster different aspects of learning:

Firstly, it can foster cognitive aspects of learning such as information processing and understanding (Jonassen, 1996, Mayer and Sims, 1994).

Secondly, it can increase motivational aspects of learning (see Chapter 6).

Thirdly, it can increase collaborative or social-cognitive aspects of learning (see Chapter 6).

Fourthly, educational multimedia has the potential of fostering learners' deep approach to learning and consequently deep learning (Hambleton et al., 1998; Lamon et al., 1993; Ramsden, 1992).

Multimedia products and online services provide many opportunities for these different aspects of effective learning. The potentials are, among others, to:

- Use several perception channels during the learning processes and hereby anchor information processing with several senses;
- Simulate complicated real experiments;
- Visualize abstract contents;
- Present processes in a dynamic manner in order to stimulate learners' cognitive structures and interpretations by embedding the content in the broad context of environment, society, history and by relating to the interpretation made by the learner;
- Foster collaborative learning through online discussions in blogs, web groups, etc. (see Chapter 6).

Some advantages of multimedia in education

Multimedia is very helpful and fruitful in education due to its characteristics of interactivity, flexibility, and the integration of different media that can support learning, take into account individual differences among learners and increase their motivation.

The provision of interaction is the biggest advantage of the digital media in comparison with other media. It refers to the process of providing information and response. Interactivity allows control over the presented content to a certain extent: learners can change parameters, observe their results or respond to choice options. They can also control the speed of applications and the amount of repetition to meet their individual needs.

Furthermore, the ability to provide feedback tailored to the needs of students distinguishes the interactive multimedia from any other media without a human presence.

However, many aspects need to be taken into account when using multimedia in education. Even though multimedia is offered worldwide, access to learning materials and computing equipment differs from country to country.

The use of multimedia by students needs to be supported by very skilled teachers. They must guide students through the learning process and provide them with appropriate and effective learning strategies.

Like the use of textbooks, the use of educational multimedia fosters teaching strategies, where the teacher's role is not just that of information provider but the one of guide, supporter and facilitator.

Multimedia offers a variety of media usually combined in a meaningful manner. This gives an opportunity to use the computer for the presentation of ideas in different ways, including by means of:

- Images, including scanned photographs, drawings, maps and slides;
- Sounds, e.g. recordings of voice, noise and music;
- Video, including complex procedures and 'talking heads';
- Animation and simulations;
- Discussions among learners (social networks, online discussions, blogs, etc.).

Often, presentations supported by attractive images or animations are visually more appealing than static texts, and they can support the appearance of emotions to complement the information presented.

Multimedia can appeal to many types of learning preferences – some students profit more from learning by reading, some by hearing and some by watching, etc.

In addition, the use of multimedia allows for different ways of working – students can decide on their own how to explore the materials as well as how to use interactive and collaborative tools.

Moreover, students can adjust their own learning processes according to their abilities and preferences. They can work according to their interests, repeat material as much as they want reducing embarrassment concerning their learning outcomes.

The use of multimedia can thus be tailored to the students' differences in interests, social and cultural backgrounds, learning preferences and rates, etc.

Individual learning can promote active, self-directed learning. In addition, multimedia applications can be used to facilitate group work. Small groups of students can work through multimedia applications together – in order to learn from each other as well as to improve their dialogue skills. The interactive opportunities of multimedia lead to high flexibility, which can be very helpful for students with special needs:

- *Dyslectic students* can use synthetic speech in order to become familiar with the content of digital texts.
- *Autistic children* show an increase of phonologic awareness and word reading by using multimedia (Heimann et al. 1995).

- *Students with severe speech and physical impairments* gain from learning with multimedia, because the computer is flexible enough to meet individual needs – they can repeat as often they want, can hear it loud, etc. (Steelman, 1993).
- *For deaf students,* the visual presentation of content improves their motivation to learn (Voltena et al., 1995).

The computer can noticeably improve student access to information. Such delivery platforms as the World Wide Web provide 24-hour access to information.

Moreover, it is relatively easy to update web-based educational materials, i.e. to change design, content, instruction methods, etc.

Some disadvantages of multimedia in education

Self-regulated learning: Some learners are not able to handle the freedom provided by hypertext-based multimedia.

Distraction: Often, confused presentations of the material can cause distraction due to conflicting messages. Non-linear structured multimedia allows the user to follow the supplied links, which can distract from the topic to be learned. The massive amount of information provided by multimedia applications may distract our attention during learning.

The human short-term memory is limited; usually it can hold around 7 pieces of information. When several media presented at the same time, the learner can only concentrate on some of them and ignore others. This could result in ignoring important information. Human beings cannot use all channels available simultaneously, and this can prevent us from realizing the full potential of multimedia.

Low interactivity: Even though the interactivity between the learner and multimedia applications is increasing, it is still considered restricted compared to the elaborated human-human interactivity.

No selective feedback: Feedback is generally very limited within computer-assisted learning packages. Generally, computers can't substitute for person-to-person teaching, only enhance it. Often, the feedback provided is limited to right/wrong, and it does not support in learning strategies or further content explanations. Multimedia applications cannot identify individual needs or problems of the learner, so they cannot respond like people.

Simulations are often not enough: It may be important for students to have true hands-on experience. For example, for studying insects in biology it is necessary to go out in nature, to see insects living in their natural environments.

Lack of skills – pupils and teachers: Students, particularly mature-age students, may not be ICT literate. Also teachers may lack some personal skills, which are needed to teach effectively with multimedia.

Difficult to do: Creating audio, video and graphical materials can be more challenging than creating ordinary texts.

Time consuming: Using multimedia can be time consuming. Especially the production of multimedia takes much time.

Access: Not all students have appropriate access to proper hardware and the Internet. This may limit the scope of teaching.

Social in/exclusion: Not all members of a society can be involved in the use of multimedia technology due to lack of access to the Internet or lack of hardware to make full use of the educational material on the web.

Equipment problems: Hardware and software needs to be configured in a way that their usage is as simple as straight forwarded as possible.

Bandwidth issue: Limited bandwidth means slow performance for sound, graphics and video, interrupting streaming and causing long waits for download that can affect the ease of learning.

Multimedia is portable: Paper-based notes can be read everywhere, on the bus, at the beach, etc., but web-based materials or multimedia materials require specific hardware devices.

Computer screens aren't paper: The content on screens may not be as easy to read as the content on paper. If there are large chunks of information that need to be read from top to bottom, it is probably best to view such a document on paper. Books and journal articles may still be better to read in paper. End users often prefer to use technology to search for information, but when it comes to reading, they tend to read from print-outs.

In summary, multimedia products can be used to represent and process various types of knowledge. They can be used as means of representation and communication of knowledge. The use of these products can foster students' construction of their own knowledge. They can construct knowledge and develop skills related to various subjects by accessing or producing digital representations of knowledge. In particular, they can develop literacy and other core competencies. For example, they can develop motivation for learning activities, communication abilities, social competencies as well as learning competencies, values and ethics.

Pedagogical approach

The trainer of the module is supposed to develop these sessions in a very student-centered and teacher-guided approach. A three-step approach to experience Scenarios 1-4 can be suggested:

- Phase 1: Open exploration.
- Phase 2: Think of tasks that students could perform around such a resource.
- Phase 3: Solve the tasks you would provide to students yourself. What is needed is an overarching goal that makes it reasonable to use the resource instead of just experiencing it.

Participants of the course already have a body of (intuitive) knowledge concerning learning, important learning aspects, present goals of education, etc. – especially according to their own experiences. The workshop's goal can be both:

- To construct a common understanding within a group of participants on what is learning and which aspects are important when learning with educational multimedia (by class discussion, group work, class brainstorming, etc.).
- To construct knowledge on different opportunities and perspectives in the use of educational multimedia.

The teacher/educator can collect participants' different approaches and perspectives and construct a common model based on these different constructions. This model can then form the basis of the course for the training module.

One way of activating students could be to ask them: What is learning for you? Give me a definition. What do you think are important aspects for learning? What do you think it means to learn and teach with multimedia? Why is it useful?

The trainer might search for other definitions, examples and perspectives of learning and learning with educational multimedia and of present goals of education, and offer these to students in the end. Also, invite them to discuss the definitions and finally agree on a definition that they will work with throughout the module.

Furthermore, papers on relevant topics concerning political/ethical questions can be handed to students.

Content to be learned	**Proposals for didactical method**
The use of multimedia in school. Scenario model. Definition on learning. Goals of education. Forms of knowledge. Characteristics of multimedia. Building up connections between individual theoretical approaches	Student-centered teacher guided approach; use and ask for their previous knowledge; develop models together with students; reflection exercises; Use Collection of Multimedia (see Appendix 1)
The use of multimedia application (Scenario 2); competencies in dealing with hardware and software	Collaborative work – students could work in pairs or small groups according to a specific task (to search for something)
Reflection on one's own learning processes	Homework/group discussion
Metacognition in learning. Development of learning strategies within the use of multimedia; learning to learn within a group and collaboratively	Modeling
Experiencing and reflecting on non-hierarchical use of learning and teaching methods	Modeling/reflection by using self-reports on experiences, group discussions

Unit 2: Performance and portfolio assessment

Abstract

Unit 2 deals with participants' assessment of their own knowledge and capacities. Positioning the topic of education assessment at the second part of the module is due to pedagogical reasons: Participants will learn from the beginning to reflect on their own activities and knowledge.

They are expected to work out a performance assessment (Collins, 1992) based on a portfolio approach. The production of their own portfolio – during the course also produced with the help of multimedia tools can feed several needs of the curriculum – self-evaluation and external evaluation and the development of various competencies.

Introduction

Unit 2 covers new approaches to assessment and evaluation.

The demands on participants of the course for Unit 2 are:

Educational goals	Topics
Construction of declarative knowledge (knowing that – facts, theories, connections amongst theories)	Presentation of alternative assessment methods (performance and portfolio assessment)
Construction of procedural knowledge (knowing how)	The use of assessment methods /portfolio/ multimedia portfolio (Scenario 4) Competencies in dealing with hard- and software; network use, etc., non-hierarchical use of learning and teaching methods
Construction of strategic knowledge (knowing how to apply)	Metacognitions in learning, reflections on participants' own learning processes; working in groups, supporting each other; non-hierarchical use of learning and teaching methods

Session description

Session 1: Portfolio assessment: portfolio – advantages and disadvantages of portfolio assessment – design of portfolio assessment – analyzing and reporting data of portfolio assessment

Session 2: Designing a portfolio assessment for the course

Session 1: The general use of qualitative assessment (portfolio assessment)

Portfolio assessment

The use of multimedia in education does not have to be accompanied by innovations in the methods of assessment and evaluation such as portfolio assessment presented in this unit. Portfolio assessment can be supplied with computer-based tests. Course participants can systematically collect their assignments, written reports, drawings, calculations and multimedia products, hand in hand with the feedback they receive from their teachers, other participants and from their own notes (diaries or logs) regarding their learning activities. These methods are based on the so-called portfolio model.

This chapter deals with such types of assessment, which ask for course participants' construction, demonstration and documentation of their deep understanding of subject matters and their actual ability to solve complex problems, and to work in groups or teams.

Assessment requires making a judgment. For example, judgments of course participants could address some of these questions:

- Have I reached the goal? Are the results satisfactory?
- How do I use certain applications? Do I possess the skills needed for this specific application?
- How can I make sure that the task or project has been completed?
- How do I know whether I learned sufficiently well? How do I evaluate not just the outcome but also the stages of the learning process? How do I evaluate the strategies I have used and my approach to tasks?

The portfolio assessment approach makes educational assessment an integral part of the learning processes (Collins, 1992). Educational portfolios provide information about learners' considerations, interests, motivation, abilities, knowledge, skills, and progress.

What is a portfolio?

Portfolio is a collection of objects assembled for a specific purpose – for instance a file of drafts, sketches, and completed projects. The idea is that course participants provide materials from various sources, through multiple methods, and over multiple points in time (Shaklee, Barbour, Ambrose and Hansford, 1997, cited in Sewell et al. 1998).

The content of portfolios can include materials such as drawings, photos, writing or other work samples, and copies of standardized tests. Furthermore, materials can include information from people who communicate or cooperate (on- or off-line) with course participants during their learning activities.

Portfolio assessment provides a practical strategy for collecting and organizing such data systematically. The production of one's own folder – for example, produced with the help of various software tools or ready-to-use online tools – can feed several needs of the curriculum: self-evaluation and external evaluation, the development of different competencies such as ICT literacy and media competencies; deep learning approach, etc.

Portfolios are structured in folders which represent some evidence concerning the construction of three forms of knowledge by course participants:

1. *Domain specific knowledge* (declarative knowledge – to know what – facts, numbers, concepts, etc. and conditional knowledge – to know the relations of the concepts);
2. *Procedural knowledge* (specific skills – to know how – to indicate how well the learner can make the *domain knowledge* work);
3. *Self-management and metacognitive skills* (strategic knowledge – to know about one's own learning and competencies).

Since motivation is an important target of assessment, the content of folders might also contain some evidence concerning the motivational orientation and efforts of course participants.

Advantages and disadvantages of portfolio assessment

Many teachers, head masters and coordinators of schools appreciate the portfolio model of evaluation because of:

1. Its contribution to the student's development of reflexive skills and learning skills (Elmin, 2000);
2. The provision of feedback, which is considered one of the most effective processes in education (Hattie, 2009).

In order to foster such development, the criteria for appraising portfolio products must be set by teachers and presented to course participants in advance of their portfolio preparation.

Some teachers prefer the portfolio model because of its strong character of documentation of learning and change. Portfolio assessment provides means of conducting assessments throughout the lifecycle of learning activities because of its multiple points in time. This formative assessment, where planned activities can be refined or redefined accordingly to meet the demands of the course, helps to maintain focus on the outcomes of learning activities. Furthermore, it ensures that the implementation is in line with the goals established.

According to Sewell et al. (1998) portfolio assessment can be used:

- To provide insight into learning processes and related changes. Because portfolio assessment emphasizes the *process* of change or growth at multiple points in time, it may be easier to see patterns within the learning behavior.
- As a tool to foster communication and accountability to teachers and course participants. Therefore, a portfolio can reveal the attitudes and learning motives of course participants regarding more complex, and important aspects of the curriculum.

Portfolio assessment is not useful for:

- Ranking learners in a quantitative or standardized way (although teachers may be able to make subjective judgments of relative merit).
- Comparing learners to standardized norms.

Sewell et al. (1998) describe advantages and disadvantages to be considered when implementing portfolio assessment.

Advantages

- It allows the evaluator to see the student as an individual; everybody is unique with his or her own characteristics, needs and strengths.
- It provides a basis for future analysis and planning. By viewing the pattern of individual learners, one can identify areas of strengths and weaknesses and barriers to success.
- It serves as a concrete vehicle for communication, providing ongoing communication or exchanges of information among those involved.
- It promotes a shift in ownership; learners can take an active role in examining their actual level and at which level they want to perform.
- Portfolio assessment offers the possibility of addressing limitations of traditional assessment. It offers the possibility of assessing more complex and important aspects of an area or topic to be addressed.
- It covers a broad scope of knowledge and information, from many different sources.
- Portfolio assessments are flexible and open evaluation instruments.

Disadvantages

- It may be seen as less reliable or fair than more quantitative evaluations such as test scores.
- It can be very time consuming for teachers to organize and evaluate the contents, especially if portfolios have to be done in addition to traditional testing and grading.
- Having to develop your own individualized criteria can be difficult or unfamiliar at first.
- If goals and criteria are not clear, the portfolio can be just a collection of miscellaneous artifacts that do not show the patterns of learners' growth or achievement.
- Like any other form of qualitative data, the data from portfolio assessments can be difficult to analyze or aggregate to show change.

Design of portfolio assessment

According to Barton and Collins (1997), the three main factors that guide the design of a portfolio are: purpose, assessment criteria and evidence.

1) Purpose

At the beginning the aims of the portfolio need to be established. Operational criteria as guidelines will be defined to help participants collect their data. For example, is the goal to use the portfolio as data to inform the trainer and/or the course participants about their competencies? Is the goal to report progress? Or is it to identify special needs? Or is it to report many different aspects together?

2) Assessment Criteria

According to the purpose or aim of the portfolio, decisions are made about criteria, standards, and strategies necessary to meet the aim. Criteria items can be selected together with all participants: teachers and course participants.

3) Evidence

Many questions arise when it comes to the evidence of the portfolio: What sources of evidence should be used? How many items for the portfolio should be collected? How can one interpret the evidence of what has been collected? Which type of information weighs more than others? Under what conditions? According to Barton and Collins (1997), evidence can include different types of information:

- *Artifacts and productions* (items produced in the course of classroom activities – i.e. multimedia production, documentation, reflection diary);
- *Reproductions* (documentation of activities outside the classroom);
- *Attestations and feedback* (statements and observations by others about the learner);
- *Presentations and show cases* (items prepared specially for the portfolio, such as the learner's reflections on his or her learning or choices).

Most portfolio assessments are both process and product portfolios (Cole, Ryan, and Kick, 1995).

For designing a portfolio assessment, Sewell et al. (1998) propose a two-step procedure:

Step 1 is the development of a *process portfolio*, which documents growth over time toward a specific aim. The documentation includes statements of final aims, criteria and future plans. The portfolio should also give space for baseline information or items describing the learner's performance or mastery level at the beginning of the course.

Other items or information are 'works in progress' selected at many interim points to demonstrate steps toward mastery.

At this stage, the portfolio serves as a formative evaluation tool.

Step 2 is the development of a *product portfolio* (a 'best pieces portfolio'), which presents examples of the learner's best efforts. These examples lead to the 'final evidence', which demonstrates attainment (or non-attainment) of the final goal. These portfolios encourage deep reflections about the change or the learning processes. The learners, either individually or in groups, are involved in selecting the content, discussing the criteria for their selections, judging criteria and the 'evidence' that the established criteria might meet (Winograd and Jones, 1992).

The portfolio assessment may foster a sense of ownership among participants of the course. It helps to present or communicate the accomplishments of each individual participant. At this stage, the portfolio is an example of summative evaluation.

According to Barton and Collins (1997), certain characteristics when using any type of portfolio for assessment are:

Multi-sourced: Multiple data sources include *statements and observations* of learners, teachers or parents, etc. and *artifacts/products* (anything from test scores to photos, drawings, text documents, numbers, animations, multimedia presentations, home pages, video and sound tapes).

Authentic: The items/information selected or produced for evidence should be related to curriculum activities, as well as the aims and criteria.

Dynamic: The data or evidence is collected at many points in time. Rather than including just the best work pieces, the portfolio should also include examples of different stages of mastery. This allows for a reflection and a rich understanding of the process of learning.

Explicit: Course participants should know in advance what is expected of them, so they can take responsibility for creating their own portfolios.

Integrated: Learners should be asked to reflect and demonstrate how they can apply their competencies or knowledge to real-life situations.

Based on ownership: The portfolio assessment process demands participants to engage in reflection and self-evaluation as they select evidence to include and set or modify their goals. They are not just evaluated or graded by others.

Multi-purposed: A well-designed portfolio assessment process evaluates the effectiveness of teachers' intervention at the same time as it evaluates the growth of individuals. It also serves as a (collaborative) communication tool when shared with class members – so learners can also learn from each other. Furthermore, it can be passed to other teachers as the student moves from one level or grade or course to another.

Analyzing and reporting data

According to the purpose of the portfolio and the types of data collected, the methods of data analysis will vary (Patton, 1990; cited in Sewell et al., 1998). If goals and criteria have been clearly defined, the *evidence* in the portfolio makes it relatively easy to demonstrate that the individual has moved from a baseline level of performance to the achievement of particular goals (Sewell et al. 1998). Often, the obvious subjectivity of judgments of portfolio assessments is seen as problematic (Bateson, 1994, cited in Sewell et al., 1998). According to Barton and Collins (1997), teachers can rate independently the same portfolio to see if they agree on scoring. This serves as a simple check on reliability and can be easily reported.

Pedagogical approach

Introduce content to participants by following the methods used in Unit 1. Connect participants' knowledge; build on their previous knowledge from Unit 1 and other resources. Allow time for reflection, ask questions similar to: Why use portfolio assessment? When is it useful to implement the portfolio model in a school assessment? Use collaborative forms of learning – perhaps, students can conduct search in small groups (2-4 participants) for more information in the Internet according to the topic 'Assessment'. Reflection.

Content to be learned	Proposals for didactical method
Portfolio assessment – its advantages, disadvantages; portfolio as formative and summative assessment; design of portfolio and its main characteristics to consider, analyzing and reporting data	Use methods from Unit 1 Distribute material/references according to the topic (before the session as homework for reflection) Ask questions, collect ideas, refer to Unit 1 Course participants develop ideas/models in groups Use the multimedia collection (see Appendix 1)
Reflection: content/own learning processes/ didactics for use in school	Homework/portfolio assessment/group discussion

Session 2: Designing a portfolio assessment for the course

Portfolio assessment in the course module *Multimedia in Education*

The goal of the session is to help students develop the structure of their individual portfolios.

The following box provides an example of portfolio development in the course module *Multimedia in Education* (the structure is according to Lissmann, 2000). The portfolio guidelines address participants directly, therefore 'you' refers to the course participants.

To all course participants of the module Multimedia in Education

Aim of portfolio

The aim of the portfolio covers two aspects: the documentation of your own learning processes and the presentation of the whole course content reflected and constructed into knowledge on your own. This means that the contents of the portfolio should document the development of your content knowledge, your methodological skills (when solving tasks) and your attitudes. The portfolio serves as an evaluation tool for the trainer as well as for you as a reflective self-evaluation and learning tool. Choose on your own, which parts of the portfolio the trainer will evaluate. Include your best practice work.

Furthermore, the portfolio presents you as a learner to other course participants, so that they can learn from you and exchange their opinions and perspectives with you (and vice versa).

Structure of portfolio

Give a contents structure of the (electronic) portfolio. You might use an index, a guided tour, or a hypertext structure. Mention all the materials you included.

Contents of portfolio

The contents of the portfolio are determined to a certain extent: the portfolio should mirror your ability to deal with the content of the curriculum. This means, there are some mandatory contents of the curriculum:

Materials on the contents of the multimedia in education workshop (Unit 1: scenario model, introduction into learning theories, etc.)

Your evaluation of your own work (reflection on the portfolio approach: What is a portfolio? What are the prerequisites of a portfolio assessment? What different types of portfolio exist? What is to consider when producing a portfolio?)

Working with the Scenarios 1-4 (Why, where and how do you want to implement these scenarios? If the answer is yes, what are the main characteristics of the educational setting?)

Furthermore, the following aspects need to be considered:

- Critical selection of multimedia for educational use;
- Ethical points when using multimedia in education;
- Theories on learning and teaching with multimedia.

Materials can be different types of information – produced by typing, scanning, sound production, animations, etc.:

Artifacts and productions (items produced in the normal course of classroom activities, e.g. multimedia pieces, documents, reflective diaries);

Reproductions (documentation of activities outside the classroom);

Attestations and feedback (statements and observations by others about the learner);

Presentations and showcases (items prepared specially for the portfolio, such as the learner's reflections on his/her learning or choices).

Additionally, you might need to discuss more (or less) criteria for including into the portfolio. Discuss within your group of course participants: Which aspects of the course are important for you? What are your aims of the course?

Structure the contents according to your own needs and points of views. You might include a team portfolio into your personal portfolio. This means that if you work in teams, don't hesitate to include the outcome of team working processes into your portfolio. Mention the teamwork and reflect upon it.

Evaluation based on portfolio

Evaluation based on your portfolio aims at the criteria you worked out together with your trainer and the group you have worked in. The trainer suggests some evaluation criteria, which will be discussed and maybe changed within the team.

Possible criteria could be:

Development of your own abilities, knowledge and skills (registered in a diary, which includes dimensions such as reflections on the workday, work outcomes, knowledge representation on learning and teaching with multimedia, e.g. by reading and analyzing articles on certain topics, etc.)

Quality of presented materials (variation, tools used, the analytic structure, the aesthetic structure, consideration of learning theories when developing the materials, etc.)

Evidence of the selection of materials (Why did you select this work as your best practice?)

Pedagogical approach

Prepare carefully your specific goals according to the content. Course participants are expected to have certain knowledge and skills after finishing the course *Multimedia in Education*. The portfolio in itself provides many opportunities to meet this final goal. Discuss the content of the last session together with the course participants. Let the course participants reflect on what they want to assess: knowledge, reflection, change, learning processes, etc. What kind of sources do you integrate in the portfolio? Don't forget, this is a multimedia course. See some recommendations in the table below.

Build on their previous knowledge gained during the course. Allow time for reflection:

Content to be learned	**Didactical method**
How to design a portfolio for the course Multimedia in Education	Use methods from Unit 1 Define purpose, assessment criteria and evidence of the portfolio Use a 'reflective diary' (can be done as a word file). The portfolio can serve as a reflective tool. The portfolio is portable and therefore always usable (in class, at home, etc.) In combination with Scenarios 1, 2, 3 and 4. Report about the use of Scenarios 1-3 and Scenario 4 will be part of the portfolio itself (see Scenario 4 Unit)
Reflection: content/own learning processes/ didactics for use in school	Homework/portfolio assessment/group or class discussion
Experiencing and reflecting on non-hierarchical use of learning and teaching methods	Modeling/reflecting by using self-reports on experiences, group discussions

Unit 3:
Scenarios 1, 2 and 3 – learner as end user of multimedia

Abstract

The application of multimedia into education means many things to many people. The use of educational multimedia, however, can be classified according to some mainstream scenarios. As mentioned in the previous section, the scenario model encompasses four pedagogical scenarios regarding the mainstream use of multimedia applications (Andresen, 1999).

This unit deals with the reception of linear-narrative materials (Scenario 1), of non-sequential elements (Scenario 2) and of elements of educational multimedia aimed at teaching (Scenario 3).

The concept of the scenario model will be worked out practically in pairs, i.e. based on collaborative work at the computer.

Introduction

Unit 3 gives a broad insight into the scenario model, where the learner is the end user of a multimedia application.

After this unit, participants of the course should be able to plan the use of multimedia in their own teaching according to the following three scenarios:

Scenario	Example of multimedia applications
1. The use of linear educational multimedia	Applications providing one or more narratives to the student
2. The use of non-linear multimedia	Hypertext-based sources and websites, in which the student can navigate and search for information
3. The use of supervising multimedia	Applications that allow for some kind of feedback to the answers and problem solving strategies of the student

The demands to course participants for Unit 3 are:

Educational goals	**Topics**
Construction of declarative knowledge (knowing that – facts, theories, connections amongst theories)	Deepening their knowledge on how, why and where to implement Scenarios 1–3
Construction of procedural knowledge (knowing how)	The use of multimedia according to Scenarios 1–3. Competencies in dealing with the use of hardware, software and networks
Construction of strategic knowledge (knowing how to apply)	Metacognitions in learning, reflections on one's own learning processes. Working in groups, supporting each other. Non-hierarchical use of learning and teaching methods

Session description

Course participants will acquire knowledge on the use of educational multimedia according to Scenarios 1, 2 and 3, and at the same time they will become active end users of educational multimedia. Hence, they will develop the capacity to handle these pedagogical scenarios. This means that participants can learn how, and with which learning goals they can use multimedia.

Session 1: Scenario 1

Session 2: Scenario 2

Session 3: Scenario 3

The active use of educational multimedia according to Scenario 1 – Linear applications

Scenario 1: Linear applications

Some audio-visual and multimedia materials (or elements of such materials) have a linear structure. During the presentation of content the learner is lead through the material in sequences. Some products provide linear tours through the whole application. Compared to hardcopy books, these applications allow for a more advanced integration of different types of media, such as text materials, speech, music, animations, and simulations of complex relations, numbers and video clips. In other words, the content is multimodal.

Multimodality is the use of several semiotic resources, i.e. text, images, video, speech, and music – separately and together. There has been a distinct preference for monomodality, i.e. writing without illustrations on graphically uniform pages (of print) or painting on canvas using the same medium (oil). Today, the medium of the screen, however, has become dominant (Kress, 2003). In the age of digitization, the different semiotic resources have technically become the same at some level of representation (Kress and van Leeuwen, 2001). In consequence, educational content can be represented verbally, visually and orally, and accessed through one interface.

What to expect when using Scenario 1 applications or elements?

Linear narratives – and Scenario 1 – are especially recommended when learners do not have any or have very little previous knowledge and want to get an overview of a specific domain. These kinds of narratives are appropriate when learners obtain some background knowledge about a topic. The use of multimedia according to Scenario 1 provides students with an already structured information entity; the linear format has a beginning and an end like the chapters of a textbook, and this structure supports preliminary knowledge construction in a particular domain.

According to cognitive science research (e.g. Kintsch and Greene, 1978), texts that are unfamiliarly structured make excessive demands on the learner's cognitive processes. On the other hand, memory and comprehension are used most effectively when texts are clearly structured and navigable. Students already have schemata derived from exposure to conventional narratives and are constantly adjusting their understanding in accordance with these, making the construction of 'story' a central cognitive goal.

A teaching example for the use of Scenario 1 – linear representation of content in a school context:

A biology teacher wants to introduce her class to the concept of *evolution*. First, she asks the pupils what they already know about the topic or what their thoughts on the topic are.

After having a discussion, a brainstorming session and after collecting some questions from the pupils, the teacher wants to set up 'common knowledge' by showing a multimedia presentation regarding the topic. In this way, the pupils gain a first insight into the term 'evolution'. The interactive aspect is very limited. Then, the pupils can use the application on their own – individually or in small groups or pairs – repeating the presentation, stopping it when needed, going forward or backward.

After the pupils' exploration of the multimedia material, the teacher encourages the pupils to discuss the topic again, to speak about their own ideas (what is evolution for them), whether they agree with the content of the multimedia material, etc.

At the next lesson, the teacher provides the pupils with some subtopics. Now, with certain knowledge, they are able to ask questions and extend these questions to problems for investigation. They can use multimedia within Scenarios 2–4.

An example of Scenario 1 can be seen at the homepage on mummies: 'Unwrapped – The Mysterious World of Mummies' (http://videos.howstuffworks.com/history/mummy-videos-playlist.htm#video-30595). This site is hosted by an Egyptologist who has been in charge of the video on mummies. The site introduces the user to Egyptian mummies. It offers a Scenario 1 environment with animation, sound, text, video, etc.

Scenario 1 application can be used effectively in both ways: individually and collaboratively (see Unit 6).

Pedagogical approach

Build on the previous knowledge from the sessions from Unit 1 (scenario model) and Unit 6. Select one of the sites from the multimedia collection (Appendix 1) or research the Internet for an example suitable for Scenario 1. For instance, you can find many examples in encyclopedias on the Internet (e.g. Wikipedia in various languages and Encyclopaedia Britannica in English). There, course participants can search for appropriate Scenario 1 elements by using Scenario 2.

Give your course participants different tasks: Let them develop a learning environment. For example, let them apply Scenario 1 on a topic, with which they are already familiar, as well as on a topic with which they are not at all familiar. Use it individually for each participant (hence, an encyclopedia will serve many). Support your participants according to their individual needs – give examples to the whole group if you meet the same problem more than once. Especially provide support for using and constructing strategies.

Give them time for reflection – ask questions and let them develop their own questions.

Content to be learned	Proposed didactical method
The use of Scenario 1: why, how and where to use linear applications	Use methods from Unit 1
The practical use of Scenario 1	Experiencing and experimenting with Scenario 1
Reflection: content/own learning processes/ didactics for use in schools	Homework/portfolio assessment/group or class discussions

Session 2: Scenario 2

Scenario 2: The use of non–sequential applications

Multimodal materials with interactive opportunities are often used as information providers, i.e. as encyclopedias, atlases, handbooks, etc. Learners can search for information according to their tasks and problems. For example, they can research the Internet in order to get answers to the following questions: Where is St. Petersburg? What kind of weather do they have in this city? How many people live in the city?

A teaching example for the course module

A trainer of the course Multimedia in Education invites participants to work on a small project to find some facts about their own country. They should gather images illustrating various geographical conditions and public cultures of the country. The participants are asked to work in teams on this topic. The trainer guides individual teams according to their individual needs and supports them by providing effective searching strategies for the task. If the teacher realizes that many teams are facing similar problems, he/she stops the whole process and asks for attention from all the course participants. Then, she works together with the whole group to solve the identified common problem. She describes the problem: 'Typing BRASIL as a search term brings too many results. It is too difficult to select the required information from all these sites.' The teacher then asks for possible solutions of the problem. If she does not get any productive answers, she should then give concrete examples on how to proceed.

Often, the interface offers a search engine and some buttons and options. The learner must decide how to use them.

Examples of Scenario 2 – non-linear hyper-structure environments are electronically based newspapers or journals (www.guardian.com) because they offer many links to subject-related topics (science, education, literature, critical public discussions, etc.).

Example for Scenario 2 application

The *CNN Millennium – a CNN Perspectives Series* site[1] provides animated and textual content for Scenario 2. It presents a panorama of the people and events that shaped the world over the last 1,000 years. The site allows the user to choose from ten centuries. In each of these centuries one can choose among certain aspects such as: Timeline (important events); Map/profiles (important persons); Unsolved history (still unsolved mysteries of the century); Having dinner with xx (for example, with a Viking king in the 11th century or with an astronaut in the 20th century); Artifact (a very special invention of this period).

[1] http://edition.cnn.com/SPECIALS/1999/millennium/

The Smithonian's African Voices Exhibit[2]. This site explores objects that attest to African diversity and history. The site contains sections about general history, particular themes and focus galleries. Another section called *Learning Center* that explores the African past on an interactive timeline. This section, among other things, offers a collection of web links and a broad bibliography on such topics as African arts, culture and anthropology, history and religion, but does not provide any feedback driven activities.

Some more examples of sites for Scenario 2 can be found in the multimedia collection (Appendix 1).

What to expect using Scenario 2 applications or elements?

Scenario 2 is often applied in order to foster understanding of complex processes. As mentioned above, searching for information is the main activity in the use of Scenario 2. Due to the hyperlink format, Scenario 2 includes the use of links to many kinds of websites. In particular, it includes the use of digital encyclopedias. These links give the reader control of what is read and in what order. His or her organization of the elements of hypertext may be more personally meaningful than the organization imposed by the authors of the content. This requires that the reader creates his or her own track of reading.

In education, Scenario 2 supports the construction of an individual's knowledge base. Learners can search for information according to their own need for information and with their own pace (see also Unit 4 – Scenario 4, where the functioning and the characteristics of hypertext is explained).

Scenario 2 can be used in different educational situations: Firstly, when learners have some previous knowledge about a certain topic so that they can ask specific questions. Secondly, when learners don't know anything and just want to get the required information on specific facts.

Information management strategies

The effective strategies of Scenario 2 can be seen as information management strategies. This includes searching for and collecting information and the development of deep understanding of certain processes or procedures.

These forms of learning strategies support a collaborative learning style.

Searching for and collecting information

If learners have to collect information for a project, a seminar or a presentation, they are expected to focus mainly on strategies such as:

- Identifying what information is needed;
- Selecting and evaluating the information found;
- Embedding the information in context.

[2] www.mnh.si.edu/africanvoices/

These strategies support analytic thinking and learning as well as creative complex thinking.

These three strategies can be applied for (van den Brink et al., 2000):

- Intense discussions among pupils;
- Exchanging material;
- Interactions with teachers;
- Applying searching strategies;
- Navigating by taking advantage of the hypertext structure (i.e. in a kind of 'drifting navigation' to catch non-predicted information);
- Listening to spoken texts;
- Apprehending information by segmenting it into discrete units;
- Apprehending information by focusing on bits of information;
- Glancing the articles/texts/websites they found;
- Teamwork division;
- Research on the Internet.

At the beginning of sessions with Scenario 2, learners who work in groups can start discussing these questions: What information is needed? How to work together in a group and with other groups?

In one study on Scenario 2 (van den Brink et al., 2000) students used their classroom intensively and exchanged materials, ideas, problem solving strategies, etc. with other classmates. There was a lot of traffic in the classroom and the pupils met each other at the printer. Some pupils printed their files twice to exchange their print-outs with their classmates and posed such questions as: 'Can I see what your group has already found?'; 'Can I make a copy?'

Analyzing the navigation structures

Some pupils discussed the structure of CD-ROMs and found it very interesting: 'So we could get an impression of the internal logic; it was so interesting to see the connectedness between all these different aspects' (interview information); 'And it was a very nice experience for me to see how I could get through the CD-ROM; is it easy to find a way, to click on the topics, to select the topics I am interested in (not just the teacher) – it gives me much more freedom.'

'Yes – I could go where I thought; *this* is important, and this is not. Then, sometimes I found out that I wasn't right but I found it out by myself or together with others in the group and not because the teacher is telling us how it works'.

Searching, selecting and evaluating information

The pupils applied different searching strategies. Most of them used very poorly developed searching strategies – they worked only with the index or they just searched using non-specific keywords. The more pupils searches for information, the more or less intuitively and oriented they became regarding each other's strategies.

Many pupils reported during interviews that they wanted an introduction into search strategies. In particular, they did not know how to use a search engine effectively. Most

often, the pupils just used links to access information. Thus, it is recommended to introduce search strategies and methods to the pupils.

Most pupils selected information by looking at the headlines and the written information. Thereafter, they decided – individually or in groups – whether it suits their needs or not. If it met their requirements, they could print it.

The evaluation of the selected information was also challenging. Some of the pupils commented on this issue:

- 'How to find information depends on the topic. If the topic is difficult, it is also harder to find good information on it.'
- 'We have learned a lot in the last two sessions. After we had the initial information during the last session we could integrate the new information much better. However, the real learning starts after these sessions, when we have to analyze the information.'
- 'Okay, we already knew something about the topic. But we have learnt very much in both sessions – especially background knowledge.'

Deep learning of processes and procedures – using simulations

In classes where subject specific processes should be understood (e.g. blood circulation in the human body) Scenario 2 was used with simulations and animations (i.e. elements of Scenario 1) of complex procedures. Often, the teachers guided the pupils. The teachers acted as role models and introduced the pupils to different learning strategies by showing them how to access the required information. Afterwards, the pupils could explore the content of the program or manipulate the simulation variables, so they could repeat the simulations and discuss the content to be learned, together with the teachers. In this way of applying Scenario 2 further information management strategies were needed:

- Embedding information in a context;
- Giving relevance to information;
- Constructing knowledge from information;
- Linking knowledge and creating knowledge networks;
- Transmitting, transferring and distributing knowledge;
- Exchanging and adding knowledge;
- Applying and transposing knowledge;
- Evaluating knowledge-based actions;
- Developing new knowledge from evaluated actions.

Collaborative learning: Active discussions/debates and problem solving

Using Scenario 2, a group of pupils (www.pedactice.com) addressed questions to their neighbors and debated very actively. They developed different approaches to solving the problem. In particular, they decided which links they should follow, which words they should use for search engines, and whether or not they should use search engines at all, etc. Teachers in classes supported the pupils by encouraging them to reflect on the learning objectives obtained, to anticipate their actions, to foresee their needs, and to make joint decisions.

Reflections on one's own activities: Using Scenario 2, most pupils repeatedly reflected on their activities and strategies for finding information. One of the pupils said to his partners: 'We can't find adequate information when we go further in this direction; we have to find other terms and we have to think about what our topic really is'. Another girl reported: 'Sometimes we stopped and thought about the topic.'

Comprehension, monitoring and checking: Some pupils tried to match new content with the information they had already been familiar, and in case of doubt they turned back and checked it.

(In)effective strategies

In a study of Scenario 2 (van den Brink et al., 2000), some groups of students worked in a way so that everybody was looking for everything – there was an overlap but they were still sure that they were on the right track. Other groups divided their teams into different topic searching groups and worked very efficiently. Two groups divided searching, according to the skills within those groups. Some pupils were very creative in applying searching strategies.

Problems when learning with Scenario 2

Time pressure: When using Scenario 2 and dealing with information resources, many pupils felt time pressure. They wanted to find as much information as possible.

Lack of searching strategies: Many pupils experience difficulties when searching for adequate information. As mentioned above, they may lack effective searching strategies.

For example, a student who worked with the Internet stated: 'One is searching and searching and searching. We need the information but it is very difficult to find the adequate information'.

Special problems with the software/computer: In some examples of Scenario 2, pupils experienced difficulty in accessing the central menu (used as the main 'navigation' reference) from many specific themes, due to the need of going 'backwards' through all the opened levels (they missed a button that permits this). For example, one student stated: 'Someone who wants to leave a theme must go all the way back through the pages... then it takes time... for someone who searches a lot of things, they must come back all the way instead of going directly to the main menu.'

Content problems: In some Scenario 2 environments the pupils experienced problems if they wanted to know more about certain themes, due to a shallow coverage of those within the application. For example, one student stated: 'Sometimes we wanted to know a little more and it was not adequate... it was all too superficial.'

Pedagogical approach

Build on the participants' previous knowledge concerning learning and motivation and on their knowledge from the workshop (Unit 1). Use various recommended sites; where you will find many ideas on how to teach with Scenario 2 applications. Together with other course participants, reflect upon the above examples of the use of multimedia

in schools. Look through the multimedia collection (Appendix 1) and select some of the sites, or search the Internet for similar sites with rich multimedia environments. Give time for both: exploring and experimenting with the sites and reflecting upon the use of certain sites. Provide course participants with an opportunity to discover sites according to their needs, interests and pace.

Course participants could search for information on how teachers in their own country and around the world experience learning and teaching with multimedia in the classroom. Various national and international teacher networks provide information on best practices with ICT and Web 2.0.

To support course participants according to their individual needs, provide them with examples. Support, for example, may be needed when using and constructing search strategies and reflecting upon the importance of such strategies. Give them links to resources that cover the use of effective searching strategies and have guidance on the use the Internet (also as a Scenario 2 application).

The following table gives a short summary of teaching strategies with Scenario 2 applications:

Situations	**Recommended teaching strategies**
Course participants get lost in hyperspace	Prepare course participants for a possibility of getting lost and discuss with them strategies such as 'stick to the topic,' 'find effective search terms,' 'allow yourself to get distracted if it seems constructive for the topic.'
Participants need to develop searching and information management strategies	Introduce course participants to the effective use of search engines – use the previous knowledge of those participants already familiar with how to search effectively. Use the collection of multimedia (see Appendix 1). Watch your group while working with Scenario 2 – give support to the teams that need it – provide hints, ask questions and urge them to develop different search strategies.
Collaborative learning	Encourage course participants to discuss and exchange opinions and perspectives to learn from each other. Suggest course participants to divide their workload into subtasks.
The user is confused by the navigation system; he/she is disoriented and can lose the pathway or can become unable to move from one level/text/assignment to the next one	Support the integration of the information found in the participant's knowledge base, support the construction and reorganization of information in the order preferred by the participant.

Situations	Recommended teaching strategies
Using the multimedia potential	Encourage course participants to use the potential of the presented multimedia scenario – the graphics, animations, links, sounds, etc.
Analyzing the navigation structure	Ask course participants to analyze the structure of the site and to evaluate it – are there other opportunities to structure the content? What ideas are beyond the structure of the site?
Navigating/surfing through the application	Support course participants by hints such as consider headlines/links/search engines/
Time pressure	Plan the lesson carefully in advance; use many different search strategies to support course participants
Software/hardware problems	See introductory notes
Content problems	Inform course participants that many applications may have limitations in terms of the depth of their content

Content to be learned	Proposed didactical method
Using Scenario 2 theoretically: why, how and where to use linear applications	Use methods from Unit 1
Using Scenario 2 practically	Experiencing and experimenting with Scenario 2 under certain tasks, work collaborative and individually
Reflection: content/own learning processes/ didactics for use in school	Homework/portfolio assessment/group or class discussion

Scenario 3: Guided discovery use of multimedia applications

The type of applications used in Scenario 3 guides learners through the content by breaking down different tasks and helping them to structure a task sequence. Its narrative style can be located between Scenarios 1 and 2. Scenario 3 very often contains elements from Scenarios 1 and 2. Often, the content provides motivational aspects such as competitions and explorations (i.e. educational content in an adventure game environment). Scenario 3 applications often provide feedback, tests and support if required. Tests are mainly constructed in a quantitative way, using multiple-choice construction. In many instances, learners are not allowed to jump from one section to another within a certain fragment.

A teaching example:

A teacher of biology wants to introduce his students to the world of spiders, insects and snails. She opens the lesson by asking the course participants what they know about these species. After the initial exploration phase, the teacher invites the students to explore minibeasts at a site, where children can learn many different things about spiders, insects, snails, etc.[3] The teacher tells the students that the site provides a small test, where one is asked to circle the insects shown.

Additionally, the teacher invites the course participants to go to the city's gardens in the second session of the class to prepare for further work. During this work, the students might find very similar or maybe very different animals than the ones they saw on the website.

The kids work in pairs exploring the environment and producing an Insect Bookshelf. They are inspired by the bookshelves made by other learners, which can be found on the website.

The teacher observes the class and provides support if needed. The class ends by assessing the lesson: Did the students like to work with this type of multimedia? What did they like and what didn't they like?

[3] http://www.teachers.ash.org.au/jmresources/minibeasts/minibeasts.htm

Another Scenario 3 multimedia example:

Scenario 3 example: The Art of Japan[4].

The Art of Japan is a site on the server of ThinkQuest[5], which provides various multimedia sites on different topics. The Art of Japan gives an insight into five different art genres: origami, architecture, gardens, painting and sculpture. The site map provides an overview of the content. In addition to various content pertaining to the mentioned genres, learners can find links, quizzes, puzzles and a bibliography. They can also construct their own Japanese garden. There is also a test, in which the learner can check his or her knowledge of the Japanese art.

Another good example for Scenario 3 is the site on the history of the millennium[6], where one can find questions to test one's knowledge of the era.

What to expect when using applications or elements from Scenario 3?

Scenario 3 is often considered most appropriate for individual learning. An example is the topic of minibeasts. Here, children can systematically construct knowledge on the 'little beasts' (spiders, insects, etc.). Compared to the traditional textbook approach, this interactive site allows for a more flexible use of the learning content.

There is often a guided tour on how to use a specific learning application where the authors of this application recommend what they think might be the best way to use it depending on certain conditions (for instance, if students don't have any prior knowledge on the subject of the application).

Scenario 3 offers many opportunities for various needs of learners. The strategies used in Scenario 3 include computer-based training strategies (CBT), self-regulated learning strategies and also computer supported co-operative learning (CSCL). Multimodal materials tailored to Scenario 3 are meant to support these strategies: they can contain a variety of learning units and course participants can decide on their own which aspects of the topic they would like to study more in-depth, or in which aspects they have already built up a knowledge base.

Based on their assignments or interests, learners can also decide from which units they want to start. Within Scenario 3 learning applications, the learner gets an opportunity to test and evaluate his or her own knowledge. Therefore, one can go first to the testing part and be judged on how much one already knows. However, such tests are often quantitative and do not cover extensively the content to be learnt. For teachers, it might make more sense to add other evaluation methods. There is often an introduction into the application, in which its functions (such as print/export information/index/glossary/search, etc.) and various components (navigation opportunities/content/structure, etc.)

[4] http://library.thinkquest.org/27458/
[5] http://thinkquest.org
[6] http://edition.cnn.com/SPECIALS/1999/millennium/

are explained, and where the learner gets information on how to work with the application. Furthermore, an introduction to the structure and content of the application is often provided.

Scenario 3 learning tools can support many different functions, including:

- An information source (hypertext-structured information);
- A learning program – the application leads the learner according to his/her needs through the subject – one can learn according to the proposed learning routes or opt for a customized approach;
- A deep learning tool – with the help of authentic and situated presentations of the learning content and with different perspectives on it (by videos, graphics, animation, audio, etc.);
- An opportunity to check and evaluate one's own knowledge;
- A reflection tool about the content to be learnt (if the application, for instance, provides a text or graphic program for expressing one's own thoughts).

These aspects strongly support self-regulated learning. However, often the learner needs support to apply these strategies efficiently.

Collaborative use of Scenario 3

A collaborative use can also be recommended if the site is not a basic drill-and-practice application (van den Brink et al., 2000). If the application is rich in information and provides authentic situated presentations and different perspectives on the topic, learners can discuss and exchange their views with each other.

Learning strategies when using Scenario 3

In line with Scenario 3, different learning strategies can be applied in the classroom (van den Brink et al., 2000):

- *Implementation strategies*: Repeating information by rehearsal – surface learning;
- *Organization*: Grouping items on some characteristics – a deep learning strategy;
- *Elaboration:* The construction of a meaningful context – a deep learning strategy.

Simple rehearsal is usually less effective than other strategies that require learners to process the material more actively by organizing related ideas or elaborating new ideas by making connections to their previous knowledge.

Simple rehearsals can be found in Scenario 3, especially in language and spelling programs. These applications foster the user to practice the pronunciation or spelling of the words.

Examples:

In a study, a simple rehearsal was found in the use of *Le francais facile*, a French spelling and word program. The pupils only responded to assignments in the application (www.pedactice.com). The application is focused on fostering the processes of learning the French pronunciation and vocabulary. The students could repeat the words or tasks again and again, and listen to the recorded voices as much as they wanted. Furthermore, they asked for help from their partners: 'Did I pronounce it right?' The most used strategy was repeating the words or phrases that the program had played before.

Elaboration strategies – making meaningful associations requires an extensive knowledge (Chan, Burtis, Scardamaglia and Bereiter, 1992). Elaboration could be found in almost all cases in a study of Scenario 3 applications, particularly in the case where the pupils could develop rules for the German spelling and make connections to their previous knowledge (van den Brink et al., 2000). However, in all cases pupils created the strategies intuitively but not because the programs encouraged them to use certain strategies. Some pupils, who used a German spelling program, reported in the interview that they had developed their own rules: speaking the words, which were presented in the program again and again, listening carefully again and again and dividing the words into parts. They also thought about where the words came from. For example, when they decided on the correct spelling of the word 'Mehrheit' (majority), they had to choose between 'Meerheit' and 'Mehrheit.' 'Meer' means 'sea,' therefore 'Meerheit' can't be right; 'mehr,' on the other hand, means 'more,' hence the correct spelling is 'Mehrheit.' During the next session some pupils who worked in pairs developed more rules – the teacher invited the children to do so and facilitated this process by asking 'Could you do anything else?'

Active discussions/debates – problem solving

The above mentioned study showed that task-oriented debates took place in the case of an adventure practice package. The pupils asked their classmates and considered together with them different approaches for solving the problem. Two girls stated:

'Don't go there with the mouse. You have to go this way – it is there we have to go.'

'Why?'

'Because this way leads us into the spaceship. You can see it on this sign.'

They were successful by confronting each other with new ideas, asking for reasons and discussions. A few minutes later they found out that they'd made a mistake: 'How can we get out of here?' They started discussing the situation and then decided to write something new ('please, write something').

They checked if their classmates had made more progress with the spaceship. They discussed with each other: 'I would like to try this out, because I want to see if it works.'

Exploring ways of problem solving could often be observed, whereas little if any discussions were observed when using computer-based training programs (CBT). The pupils using CBT spoke about the correctness of their answers, but these were very short conversations. Some pupils listened to audio instructions from the programs. They were more or less testing their knowledge according to what they had already learned. If they did not manage to solve the problem they went back to their desks, consulted with textbooks and other materials and practiced more. Their main goal was to solve the tasks successfully. The ones who worked in pairs were debating and trying to achieve the best possible results.

These findings show that the use of assignments, where many different judgments are needed, is the best approach to foster discussions about complex problem solving among pupils. The use of computer-based training programs, on the other hand, is more appropriate when the main task is to test students' knowledge.

Meta-learning

Comprehension, monitoring and checking: Those pupils who worked with a Scenario 3 adventure program (to learn spelling) recognized after getting some feedback from the application that they had problems with their spelling and the correct placing of the comma. Then they practiced more – even if it wasn't required for getting the points for the spaceship. Those pupils, who worked with *Le francais facile* realized that they had problems with the pronunciation. So they repeated listening to the words again and again and asked for help from the pupils and the teacher who did also repeat the words to them.

Feedback checking: Most kids using Scenario 3 checked the feedback function (in some applications, using the feedback function is voluntary). They did it because – as they said in the interviews – they really wanted to know which words they wrote were wrong. Some kids wrote down their mistakes with a pencil and they wanted to practice these words at home.

Performing similar activities: When working with drill-and-practice assignments, most pupils did very similar things – they just did what was demanded from them – they repeated the words and phrases, or spelled them out (van den Brink et al., 2000).

Problem solving: Most of the children who used the adventure game tried more than one possible solution. However, many of them had problems developing more than one or two solutions – the teacher encouraged them to search for further solutions.

Pedagogical approach

The following table gives a brief overview of teaching strategies in the course with possible Scenario 3 applications:

Situations in the classroom	Recommended teaching strategies
Provide course participants with a Scenario 3 application (find it on the Internet according to the culture of participants) – testing knowledge/using feedback/reflect on knowledge	Give participants enough time when using the Scenario 3 guided discovery and invite them to test their own knowledge.
Collaborative learning	Invite course participants to discuss topics within the application – discussion topics can be focused on the application's content, structure, motivational aspects, design, etc. Encourage course participants to support and help each other. Watch your group while working with Scenario 3 – provide support to the teams that experience difficulties – give hints, ask questions, invite them to develop different search strategies.

Situations in the classroom	Recommended teaching strategies
Using the multimedia potential	Invite course participants to use the potential of the presented multimedia scenario – the graphics, animations, links, sounds, etc.
Analyzing the navigation structure	Invite course participants to analyze the structure of the site and to evaluate it – are there other opportunities to structure the content? What ideas are beyond the structure of the site?
Time pressure	Plan the lesson carefully in advance; be able to use many different search strategies in supporting course participants
Software/hardware problems	See introductory notes
All situations	The teacher should be very familiar with the content to support course participants

Building on their previous knowledge from former sessions on Scenario 1 and 2 and the sessions in Unit 6 and from the workshop (Unit 1), chose a website and explore Scenario 3. For example, look through the multimedia collection (Appendix 1).

In general, course participants need time for exploring sites and reflecting upon the use of their content. Provide course participants with an opportunity to learn according to their needs, interests and pace. As in Scenario 2, if you see that several participants come across the same problem, provide them with guidance through examples. Likewise, guide them on the use of appropriate strategies and emphasize their importance.

Content to be learned	Proposed didactical method
Using Scenario 3 theoretically: why, how and where to use linear applications	Use methods from Unit 1
Using Scenario 3 practically	Experiencing and experimenting with Scenario 3
Reflection: content/own learning processes/ didactics for use in school	Homework/portfolio assessment/group or class discussion

Unit 4: Scenario 4 – production of multimedia

Abstract

According to this scenario, the participants are supposed to produce their own multimedia materials by means of proper tools to handle texts, graphics, video, sounds, etc.

A multimedia portfolio evaluation will be integrated into the production of multimedia.

Introduction

Unit 4 gives a broad insight into the use of Scenario 4, in which the learner is the creator and producer of materials integrating text, images, etc. In particular, course participants represent their knowledge in a way that can be stored, processed, and presented. The content of the products is course participants' knowledge represented by means of letters, numbers or icons/images in a linear and/or hypertext structure.

In Unit 4, participants are expected to use multimedia as mind tools for presentation and knowledge communication. Typically, course participants work on a project.

After this unit, participants will be able to sketch a multimedia presentation on a particular topic in the curriculum or on a cross-curricular subject.

Educational goals	**Topics**
Construction of declarative knowledge (knowing that – facts, theories, connections amongst theories)	Deepening the knowledge constructed in former sessions, constructing knowledge on the use of Scenario 4 as a mind tool.
Construction of procedural knowledge (knowing how)	The use of multimedia for producing one's own multimedia material; competencies in dealing with hardware and software. The use of a multimedia portfolio (Scenario 4) and tools. Competencies for dealing with hardware and software, networks, non-hierarchical use of learning and teaching methods.
Construction of strategic knowledge (knowing how to apply)	Metacognitions in learning, reflections on their own learning processes; working in groups, supporting each other; non-hierarchical use of learning and teaching methods.

Session description

Course participants will develop knowledge about the production of educational multimedia according to Scenario 4 and use it as a cognitive tool.

Session 1: Deepening one's knowledge on Scenario 4; why and how to use Scenario 4; beginning of producing: planning the project and beginning to work with a tool.

Session 2: Project work

Session 3: Project work

Session 4: Project work and completion

Session 1: Deepening knowledge on Scenario 4

Using educational multimedia according to scenario 4

According to Scenario 4, the student is the author of a multimedia product (and not the end user like in Scenarios 1–3). The student uses multimedia mainly for knowledge construction and representation or as a communication tool for expressing one's constructed knowledge and sharing resources. One can either use a standard word processor or a dedicated editor. For example, the student can use such tools to produce individual web pages that can be linked together in a hypertext structure. Alternatively, one can use PowerPoint or similar programs to produce linear presentations.

All these tools can be used to process text-based elements, numbers, graphics, images, sounds, moving pictures, animation, etc.

What to expect when using scenario 4 applications or elements?

The use of multimedia in the framework of Scenario 4 means mainly using multimedia as a mind tool. 'Using computers as mind tools requires a change of thinking about how computers should be used in schools' (Jonassen, 1996). The computer is considered a knowledge representation tool, a tool for thinking about the content that is being studied. A primary intellectual reason for using computers as mind tools is that they engage learners in critical, creative and complex thinking skills.

Mind tools as cognitive tools for learning consider the computer as an intellectual partner of the learner to facilitate higher order and deep learning processes (see Unit 6). Derry (1990, cit. in Jonassen, 1996) defines the term *cognitive tools* as mental and computational devices that support, guide and extend the thinking processes of their users: 'Mind tools provide an environment and a vehicle that often require learners to think harder about the subject matter domain being studied than they would have to think without the Mind tool. Learners are creators of knowledge rather than receivers of presentations. So Mind tools are cognitive reflection and amplification tools that help learners construct their own representations of a new content domain or revisit an old one' (Jonassen, 1996, p. 11).

Learning is an active process and deep processing needs active involvement (see Unit 6). The use of Scenario 4, where the learner is the author and creator of multimedia content, involves an active involvement of the learner.

Furthermore, such aspects as motivation, interests and collaboration are also important when using the productive scenario. Research has shown that learners worked harder, were more interested and involved, and collaborated and planned more when they worked within a Scenario 4 environment (Carver et al., 1992, cited in Jonassen 1996).

Moreover, there are also practical reasons for producing multimedia on one's own (Jonassen, 1996; van den Brink et al., 2000):

A shallow pool of software: According to Jonassen (1996), surveys have shown that approximately 85% of the available software was either drill-and-practice or tutorial software that supported rote learning but not a deep approach to learning. The supply

of these software programs does not cover at all the subjects taught in schools. Mind tools can be used across the curriculum.

Costs: Many applications only address a single learning objective, and if schools want to use many such applications, it will be very expensive. However, a further development of the Internet may allow for free or more affordable educational applications.

Efficiency: Due to a greater flexibility across the curriculum, mind tools provide both cost and operating efficiencies.

The use of Scenario 4 applications for developing complex, critical and analytical thinking and collaborative learning

Complex thinking (see Unit 6) might be one of the most important sets of skills pupils are expected to develop in schools. Multimedia can be used as a mind tool for creative, complex and analytical thinking by construction. The construction of hypertext/hypermedia structures focuses on non-sequential, non-linear methods for organizing and displaying content (see the use of Scenario 2). This form of presentation gives the learner much more control over the content, which enables the learner to learn more in a personal way. Moreover, the learner decides individually on how to determine the sequences in which to access information. Here interaction is also the most important attribute.

The open architecture of hyperstructured learning content means that the same set of nodes can be organized in many different ways to reflect different perspectives or conceptions concerning the content.

According to Jonassen (1989), hypertexts are characterized by the following aspects:

- Nodes or chunks of information of varying size;
- Associative links between the nodes that allow travelling from one node to another;
- A network of ideas formed by the link structure;
- An organizational structure, which describes the network of ideas;
- The ability to represent explicitly the structure of information in the structure of hypertext;
- Dynamic control of information by the learner;
- Simultaneous multi-user access to the information.

Problems often occur in using hypertexts when navigating, due to the huge information source the hypertext provides. The user can get lost, can become disoriented, can lose track of the route or can become unable to leave the hypertext to go to another one. When using information from the hyperstructured content, the learner has to integrate this information to construct and reorganize knowledge in his/her own way. Developing hyperstructured content collaboratively or individually, which reflects the learner's understanding and perspectives, could solve this problem. Jonassen (1996) suggests that learners learn more by constructing instructional materials than by studying them.

According to some perspectives on learning (see Unit 6), learners who create multimedia documents can construct knowledge in a deep way.

Nowadays, many teachers encourage and support learners in creating their own multimedia Scenario 4 applications on specific topics.

Multimedia design and development

Thinking skills for producing multimedia

Designing multimedia is a complex process, which demands high-order skills and strategies from the learner. According to Carver et al. (1992, cited in Jonassen, 1996), the following major thinking skills are needed in order to produce multimedia presentations:

- *Project management skills* (time management – time planning – time checking; allocating resources and time; assigning roles to team members);
- *Research skills (*determining the nature of a problem and the organization of research; developing questions concerning a topic and its structure; searching for information within specific sources; developing new information with surveys, interviews, questionnaires and other sources; analyzing and interpreting the information);
- *Organization and representation skills* (deciding how to segment and sequence the information found, deciding about the form of representation – text/graphics/video/animation etc.; deciding how to organize and link the information to be presented);
- *Presentation skills* (mapping the design onto the presentation; implementing the ideas into multimedia; deciding how to attract and maintain the interest of the audience);
- *Reflection skills* (evaluating the application and the processes used to create the application; revising the design by using feedback).

Organizing a process of creating multimedia

There are many software opportunities to build up a multimedia product. For example, a creator or a producer has to decide on the editor she/he wants to use to construct a homepage. There are a number of powerful software packages, which allow for the production of multimedia applications. Some are highly advanced and expensive tools, whereas others are simpler and cheaper or freeware (see Appendix 3). As mentioned above, tools like PowerPoint and word processors can also be used as editors of linear and non-linear presentations.

Most often, these tools are accompanied by online manuals and video tutorials that are easy to use. Of course, there are many other tools and the listed tools should not be seen as a recommendation of particular tools to use.

Designing a multimedia application

Lehrer (1993) developed a framework for building hypermedia applications in the classroom. His framework contains four major processes:

1 – Planning

This process demands from learners to make different decisions on the major goals of the knowledge base, i.e. who is the audience and what should be learnt, what are the topics

and content of the knowledge base, which relationships are there between the topics, how to design the use interface, etc.

2 – Accessing, transforming and translating information into knowledge

This process contains the following activities – searching for and collecting relevant information; selecting and interpreting information sources; developing new interpretations and perspectives; allocating information to nodes and making decisions on representation forms.

3 – Evaluating the knowledge base

During this process, course participants assess the work on different dimensions. They evaluate compromises in what was represented and how; they assess the information coverage and its organization; they must test the browser and application with users and also consider content feedback integration.

4 – Revising the knowledge base

At this stage, course participants have to consider all feedback and revise their application accordingly – correct content errors, reorganize and restructure the content.

The application of Scenario 4 is strongly recommended because of the advantages of working cooperatively and the facilitation of knowledge construction (see Unit 6 and multimedia collection).

A teaching example for Scenario 4:

The trainer of the course module invites course participants to discuss the most important steps for designing a homepage on 'learning and teaching with multimedia' for a national teacher education event. Course participants collect their ideas and present their results on the whiteboard. The teacher finds statements, which fit into Lehrer's framework categories: project planning/accessing – transforming – and translating information into knowledge/evaluating knowledge/revising knowledge. The teacher asks participants, which kind of skills are needed to meet the demands of these processes. The participants find similar answers, which can be summarized under project management skills, research skills, and organization and representation skills. The trainer summarizes and reflects on the results found by participants.

The next step is to make a decision on whether course participants will work individually, in pairs or in teams. The trainer asks participants about their opinion on working collaboratively and individually. Then, the group decides how to work (who with whom, etc.). Afterwards, the work begins.

Phase 1: Planning

The teams start to plan their work. They discuss the possible content of the site, the way they will address the audience, the way they will get the information needed, the way they will use the tools, and the way responsibilities will be distributed within the teams.

One group decides to work on the topic *Learning and teaching with Scenario 2* (non-linear representation of content). Therefore, they decide to undertake several steps in terms of planning. They want to present a hypertext-based site, which includes different types of media: a text about the content, a speech from one of the course participants about how she learned and experienced Scenario 2. Then, they decide to produce and integrate a digital video, where course participants learn with Scenario 2 and one participant will take over the position of the trainer.

That sums up the initial stage. The resources of this team include web-pages and encyclopedias as well as books and personal experiences on learning within the course. They also plan to use hardware and software. They will need a tape recorder, a video camera, a multimedia tool, and a scanner.

The trainer observes the planning phase and asks questions on the organization of the planned activities. In addition, the trainer guides and supports the teams.

Phase 2: Accessing, transforming and translating information into knowledge

The next step is to search for information needed to construct and present their topic on *Scenario 2 learning and teaching*. The team has to identify, select and interpret information sources (see also Scenario 2 strategies) and to develop individual perspectives on this information and to organize it accordingly. After a discussion, a decision should be made on the presentation structure/ format of the topic: the navigation, the structure of hypermedia, etc.

In this phase, the trainer provides support (as in phase 1).The trainer puts a lot of emphasis on the development of individual perspectives and on the presentation and organization of different points of view and ideas.

Phase 3: Evaluating the knowledge base

Participants work independently on the selected information, on the presentation of the topic, its structure and organization. Furthermore, they test the browser to see if all the links and nodes work as expected. Then, they have to make a revised plan for the final draft.

The trainer strongly encourages reflection on the selected topics.

Phase 4: Revising the knowledge base

Participants have to consider all the feedback they have and then decide, what they will change and what they will skip, and what will be new, etc. (correcting content errors, reorganizing and restructuring the content). During these processes, the trainer's tasks are coaching, supporting, and guiding his course participants in order to help them meet their needs According to Lehrer (1993), the trainer can ask questions similar to:

- How are you going to organize your presentation and why?
- How are you going to decide on what to include and what to leave out?

- Can you draw a flow chart of your program? Does it seem logical?
- Which content do you want to include and what does it represent?
- Which are the most important themes when describing your content? How did you determine that they were the most important?

For many examples go to ThinkQuest[7], which is a non-profit organization offering programs designed to advance education through the use of technology. Pupils and/or teachers have designed most applications. There is a ThinkQuest Internet Challenge contest where applications receive prizes.

Disadvantages of Scenario 4

The use of Scenario 4 might be time-consuming and there are some hardware and software requirements for multimedia construction – devices such as scanners, audio/image recording devices, speakers, head sets, and video cameras.

[7] http://www.thinkquest.org

Sessions 2–4: Production of multimedia

Pedagogical approach

Participants can create their own homepage for the courses they attended. This homepage can cover different aspects of the course. For instance, it can have topics such as *Using Multimedia in School* and *Portfolios*. Thus, participants can work individually within their portfolio where they can present multimedia projects, i.e. they can present their own interests, or people and organizations they know in a short movie. Moreover, through team work participants can better understand advantages and disadvantages of collaboration (see Unit 6).

Prerequisites for creating one's own multimedia application include:

- Being able to use computers as daily work devices;
- Being able to search for information (Scenario 2);
- Starting and shutting down the computer;
- Starting applications;
- Logging on;
- Organizing files, copying, pasting, deleting files and elements of files;
- Searching for files;
- Installing and running CD-ROMs;
- Word processing;
- Writing documents, changing their font and size and saving documents;
- Designing text by using pictures, illustrations, lines and tables;
- Using templates, columns, headers and footers;
- Working with spreadsheets;
- Making calculations;
- Creating diagrams and integrating then into word documents;
- Knowing the basics of the Internet (URL, link, node, portal, domain, etc.);
- Going to homepages by typing addresses and following links;
- Using search engines;
- Downloading shareware and plug-ins;
- Sending and receiving e-mails.

Extended ICT competencies are needed for advanced applications. These competencies will be developed during the sessions:

- Creating multimedia;
- Editing and adding digital images – scanning, using digital camera and image editing software;
- Editing and adding sounds digitally – recording and manipulating sounds;
- Editing and adding videos digitally – recording and manipulating movies.

Identify and use participants' prior knowledge from previous sessions. Pitch and discuss ideas for a possible project. Plan the project carefully according to the listed characteristics. Start the project in groups and give participants enough space, so that they can also work on their own, developing their own portfolio (see Unit 2). Use the multimedia collection (Appendix 1). Give time for reflection.

Situations in the classroom	Recommended teaching strategies
Provide course participants with different tools to produce their own multimedia and give them a plan for the next Scenario 4 sessions	Give participants enough time when using Scenario 4 – plan time according to participants' previous knowledge and needs.
Collaborative learning	Invite course participants to share knowledge, help each other, and discuss the topics they want to select. Watch your groups while working with Scenario 4 – give support to the teams that need it– give them hints and ask questions, encourage them to develop different strategies.
Using the multimedia potential	Invite course participants to use the potential of the tools to produce multimedia – they are invited to produce different kinds of media – graphics, animations, links, sounds, etc.
Creating the navigation structure	Support course participants when creating the structure of the site – are there other opportunities to structure the content? What ideas are beyond the structure of the site?
Time pressure	Plan the lesson carefully in advance; support course participants and support the development of a collaborative learning culture.
Software/hardware problems	See introductory notes.
All situations	The teacher should be very familiar with the content and production tools to support participants.

Content to be learned	Didactic method
Scenario 4 application as a mind-tool (why and how to use) Use it for motivation, collaboration Implement required thinking skills by reflecting on what is going on in the teams Techniques for producing multimedia Applying multimedia production tools	Use methods from the previous unit. Jointly with course participants define the project Use Scenario 4 to help course participants produce their own portfolios.
Reflection: content/one's own learning processes/didactics for use in schools	Homework/portfolio assessment/group or class discussions

Unit 5: Critical and reflective use of educational multimedia

Abstract

In this unit, pedagogical reflections on the use of multimedia material will be considered as well as the critical selection of multimedia applications.

Introduction

Unit 5 deals with reflections on the effective and critical use of multimedia materials.

The following requirements to course participants for Unit 5 deal with pedagogical and ethical reflections on the use of multimedia in education.

Educational goals	**Topics**
Declarative knowledge (knowing that – facts, theories, connections amongst theories)	Selection criteria for using multimedia, multimedia law and copyright, sociological perspectives of social in/exclusion when using multimedia in education; cultural and gender differences.
Procedural knowledge (knowing how)	The use of multimedia products, competencies in dealing with hardware and software, metacognitions in learning, reflections on one's own learning processes, non-hierarchical use of learning and teaching methods.
Strategic knowledge (knowing why)	Development of learning strategies within the use of educational multimedia, learning to learn within a group and collaboratively; Construction of useful characteristics for selecting multimedia products for educational purposes; Construction of attitudes and perspectives on the ethical aspects of the use of educational multimedia; The use of multimedia (Internet research), Scenario 4 competencies for reflecting on a topic, competencies in dealing with hardware and software, metacognitions in learning, reflections on learning processes, discussions in groups, non-hierarchical use of learning and teaching methods.

Session description

The content of this chapter deals with the critical and reflective use of multimedia. In particular, it deals with the efforts of teachers to identify proper multimedia materials or online services according to the overall objectives of the learning activities.

Session 1: Criteria for the selection of multimedia and the planning of learning activities in the classroom.

Session 2: Discussions on the validity and reliability of online information, ethical aspects such as social in/exclusion and copyright law.

Session 1: Selection criteria for the application of multimedia into the classroom

Criteria for the selection of multimedia and the planning of the learning activities in the classroom

Using educational multimedia in the classroom effectively and meaningfully demands a careful selection of materials. Multimedia products and online services should be selected according to the overall objectives of learning activities, learners' prior knowledge and experiences, curriculum, etc.

The following selection criteria refer to multimedia-based learning materials from the end user's/learner's perspective, i.e. Scenarios 1 – 3. According to the learning principles that this course module is based on, the following selected evaluation criteria support the principles that learning involves knowledge construction where new knowledge is built upon existing knowledge and within meaningful contexts. According to different sources (MENON[8]; Binh Pham, 1998[9], van den Brink and Slack, 2000, Duarte, 2000), selection criteria for Scenarios 1–3 are:

Appropriateness of the target group: Is there a clear definition of the target group? Is the presentation of the content to be learned appropriate with respect to graphics, sounds, identification figures, etc.?

Gender issues: How to observe and overcome gender differences when learners receive and produce multimodal content?

Pedagogical content: Are the learning objectives defined? Are the knowledge content and its organization appropriate for achieving the specified objectives? Are they pitched at the right complexity level for the users that the system attempts to reach? Do the tasks that are designed to convey this knowledge stimulate and enhance users' capacity for learning? How much content does the application contain? Is there a guide through the application? Does it give useful and correct information on the content to be learned? Does it ask questions or allow learners to interact actively with the application – for more than just navigation purposes? Does it fit the (national) curriculum? Which learning approach does the application use? Does it support a deep approach to learning? Does the material provide selective feedback? How can it be used collaboratively?

Flexibility and Navigation: How easy can users obtain knowledge or perform tasks by following the links provided by the system? Does the information content provided in each node and its associated nodes facilitate relational understanding of concepts? How do such links and navigation methods provide more effective ways to disseminate knowledge than traditional media? Do they stimulate creative ideas and collaboration? How is the content structured? Is it possible for learners to choose their own path through the material or to return to previously viewed work without returning to the start? Is it

[8] www.menon.org

[9] http://cleo.murdoch.edu.au/ajet/ajet14/pham.html provides a broad approach to the evaluation of educational multimedia

possible to modify the content of the application? Is it possible to use the application for different attainment levels? Is there an interactive assessment with selective feedback?

User- friendliness: Is the application easy to use and to install from the web or a CD-ROM and to remove? Does the application provide guidance to its use? Is it easy to survey? How easy is it for users to learn the ways of operating the system and remembering them? How well can users manage the application through its interface?

Technical quality: Slow, badly designed or unreliable systems will quickly lose support of their users. Technical evaluation covers interaction, speed, capacity, reliability and extensibility. How responsive is the system? Is it fast enough to provide real-time response, and if not, is there any message to inform users on what is going on? How reliable is the system when used continuously by different types of users? Does it provide new functionalities or innovative ways to perform a specific task? Are these capabilities implemented in such a way that they can be easily scaled? How good is the quality of such multimedia elements as graphics, animations, videos, sounds, etc.? Are the symbols used easy to see and understand? Is the presented format (Web, CD-ROM, etc.) easy to use? Is the target platform used in the classroom (e.g. a Windows version)? How is the hardware configured?

Value for money: The value for money criterion can be considered through the evaluation of all the listed criteria.

Scenario planning related to the production of multimedia content

How can educators observe and overcome gender differences when learners design and implement multimodal content? And how to foster collaborative learning when creating multimedia products?

Gender issues

The impact of gender is related to individuals' preferred and habitual approach to multimodal information. As opposed to sex differences, gender refers to learned roles. In most learning communities, boys and girls, men and women have somewhat different roles. This social construction of gender changes over time. In addition, it varies within a culture.

It is, however, possible to present a general picture. When computers were rather new for the public, studies of Turkle (1984 and 1987) indicated that men and women differed significantly in terms of attitudes towards this technology. Turkle recognized a spectrum of user behaviors and attitudes.

At one side of the spectrum, we find a user profile whose cognitive strategies are relatively unstructured and attitudes towards the computer are rather positive. Typically, these 'jack-of-all-trades' are curious and enjoy experimenting with the technology. In particular, they take pleasure from mastering it.

At the other end of the spectrum, there is a user profile called 'builders.' Normally, 'builders' view technologies only as means of communication and problem solving. Most often, they don't care to acquire more knowledge about information technologies than

necessary. Their use of technologies, however, is better planned and organized than in the case of 'jack-of-all-trades.'

Among 'jack-of-all-trades', research finds more young people than elderly people, and more men than women. With regards to gender differences, there is thus a predominance of female 'builders.'

These findings can be generalized to attitudes towards the mastery of current technology, software development and multimedia design. More males than females find the workings of the technology itself as fascinating as their use of the technology (Moghaddam, 2010).

In addition, more male than female students prefer career opportunities as developers of digital content. Evidently, further education related to ICT is a male-dominated field.

These findings, however, do not fully explain the gender differences related to the use of multimedia content in educational settings.

Volman et al. (2005) found differences in the preferences of multimedia applications. Boys preferred games, in which they can beat somebody, programs with lots of choice and 'trying out something first and then an explanation,' while many girls preferred the opposite – having something explained to them rather than working it out by themselves. Furthermore, girls preferred working collaboratively when working with the Image program; when working with 'Global Teenager,' a program that asks questions about certain topics, girls try harder to find answers than boys, who give up more easily. Nevertheless, according to the research, in primary school, gender differences seem to be quite small (Volman et al., 2005). According to the study of Volman et al., gender differences appear much stronger in secondary education: girls used computers less at home than boys, but they e-mailed more.

Boys and girls, men and women use information technology for leaning and as a way to connect with people in their social networks. Some males might be more interested than females in these tasks. On the other hand, more males than females seem to experience reading and writing difficulties, i.e. they do not possess age appropriate reading and writing skills. This lack of literacy often results in lower rates of reading and writing preferences. The gender differences in the perception of multimedia in educational settings are thus related to literacy factors as well as to preferred and habitual approaches to multimedia products.

Another factor to be considered is the impact of personality and attitudes towards innovations including attitudes towards technologies in general. Findings from studies of innovations show that some people act as early adaptors of new technologies, whereas others are considered laggards (Rogers, 2003). Moreover, first innovators have more favorable attitudes towards risk (Gatignon and Robertson, 1991).

Since genders differ significantly in terms of attitude toward risk (Brunner and Bennett, 1998), risk-averse behavior is likely to result in lower rates of motivation when learners are asked to produce complex media products including hypertext, video and audio captions or animations.

Historically, the user interface has improved a lot. Therefore, the impact of risk related differences may be smaller or not significant when learners are assigned the role of end users of multimedia.

Cooperative learning

Computer supported collaborative work has been recommended for many years due to the fact that co-workers inspire and learn from each other (see Chapter 6). Within the scope of a method advancing framework, cooperative learning structures have been developed systematically (Kagan, 1994). Educators can apply the structures for many aims and tasks, including tasks in which learners produce multimodal content.

Common methods of cooperative learning are Jigsaw, Think-Pair-Share, Three-Step Interview, Round Robin Brainstorming, Three-Minute Review, Numbered-Heads-Together, Team-Pair-Solo, Circle-the-Sage, Partners (Kagan, 1994). For example,[10] with the Jigsaw method it is necessary to form groups of four students, and every group member is obliged to learn individually a certain material and then to teach this content to his or her group members. Then, students working on the same sub-material get together and decide what is important. They also decide how to deliver this information to the other students in their groups. These expert students then go back to their groups and students teach each other. The teacher provides help to the expert groups and supports the teaching processes. Tests or assessments follow the process in order to evaluate the learned content.

The cooperative structure may, among other things, foster acquisition of new concepts and increase self-esteem. Since learners communicate with each other in various phases of their design and production processes, new concepts may become part of their active language. Similarly, they may deepen their knowledge about these concepts when they provide critique of the products of other learners, and when they evaluate these products generally (see also Unit 6 on collaborative learning).

[10] More examples are available at http://edtech.kennesaw.edu/intech/cooperativelearning.htm

Session 2: Discussions on ethical aspects such as social in/exclusion and copyright law

Validity and reliability of online information, ethical aspects and copyright law

Validity and reliability

Due to Web 2.0, increasingly more people provide information to others. Basically, Web 2.0 is a many-to-many communication. This trend represents a change compared to the traditional mass communications where a smaller number of publishers disseminate content to their audiences. Information provided in this traditional way is usually edited, i.e. selected and processed according to certain criteria.

There is, however, no systematic quality assurance. Potential receivers of Web 2.0 information should be critical in order to identify incorrect data and attempts at manipulation. A critical approach to Web 2.0 sources is necessary due to the fact that information presented at such sources is often produced, edited and published by one and the same person, and therefore often not checked for factual errors.

Dealing with so cloud computing resources, a user can never be sure about the identity of another user, whether it is an individual or an organization. To protect themselves, many users prefer not to provide personal data to the users they don't trust. Consequently, such sources of information as blogs, wikis, discussion forums, etc. cannot be taken for what they claim to be even when their content seems authentic.

It is often recommended to compare several sources of information on a particular subject and to search for information on specific authors/publishers. For example, information provided by academic sources can be peer reviewed unlike information provided by individuals.

In general, public institutions and private companies are aware of their image. Their branding is increasingly more often tailored for Web 2.0. In particular, social networks are used to foster customer loyalty and boost demand for products and services.

Ethical aspects: social inclusion and exclusion

When using multimedia in education it is necessary to consider such important ethical aspects as social in/exclusion and the development of respect towards copyright. Thus, teachers need to be well informed to discuss these aspects with their students in order to develop ethical rules referring to the use of multimedia in education.

- What is the potential role of the Internet with regards to information access?
- How can ICTs bring change to disadvantaged communities?
- What is the role of the Internet for social inclusion/exclusion?
- How to decrease social exclusion with the use of multimedia?
- How to support ICTs and information literacy for disabled people?

For an international survey, see Sally Jane Norman's *Culture and the New Media Technologies*, a paper presented at the Intergovernmental Conference on Cultural Policies for Development[11].

Copyright

Using multimedia, learners need to know their rights and responsibilities. According to some authors, learners should not use technologies until they have demonstrated that they know and can apply ethical standards and school policies on the use of multimedia. Teachers applying multimedia in school – in all scenarios – act as models for learners' behavior (Roland, 1996[12]). Teachers have an important role in transmitting the underlying values. In today's schools, new technologies are often misused, and teachers tend to opt for the unauthorized copying of computer software. It is important that all users of software are informed about what they can and cannot do under copyright laws and software license agreements. There are national copyright laws and international treaty provisions. Often, software licenses allow the purchaser to make one copy for archival reasons, i.e. for back-up purposes.

Teachers have a moral responsibility to inform their students about ethical issues such as the correct use of software according to copyright law.

The following papers provide further opportunities to discuss approaches to ethical aspects within the classroom.

Ethics and Computers: Implications for Teaching Art[13] by Craig Roland. Besides copyright law, questions of privacy, intellectual property, individual and institutional rights are discussed.

Developing an Ethical Compass for Worlds of Learning[14] by Doug Johnson. This paper offers teaching strategies for ethical approaches within primary and secondary school. Questions of privacy, intellectual property, and the appropriate use of multimedia in education are discussed.

Plagiarism

Plagiarism is a serious problem in schools. Due to easy and fast access to information, students seem to be tempted to copy and paste. However, this problem can be avoided not only through the enforcement of strict guidelines on attribution but also through the explanation of the tasks students must perform. If assignments are formulated in a very specific way – with reference to specific examples – students are forced to connect the examples with the knowledge they have.

[11] www.unesco-sweden.org/Conference/Papers/paper9.htm
[12] http://grove.ufl.edu/~rolandc/ethics~paper.html
[13] http://plaza.ufl.edu/rolandc/archives/computer_ethics/ethics~paper.html
[14] www.infotoday.com/MMSchools/nov98/johnson.htm

Pedagogical approach

Selecting criteria for evaluation: Let participants develop their own criteria for selecting multimedia for educational reasons. Then, provide examples of criteria others have developed to evaluate multimedia. Moreover, discuss different approaches and relate them to the cultural environment of the course participants.

Furthermore, discuss the *ethical aspects* with the participants. Provide them with material (videos, papers, etc.) according to their national and cultural background. Use the material provided in Appendix 1 as examples. Give time for reflection.

Content to be learned	**Proposed didactical method**
Criteria for the selection of multimedia Ethical questions concerning the use of multimedia – cultural aspects – social in/exclusion Copyright law	Use methods from former units – discussions, portfolio reflections Use different perspectives on the different topics Give time for discussions
Reflection: content/own learning processes/ didactics for use in schools	Homework/portfolio assessment/group or class discussion

Unit 6: Learning with educational multimedia

Abstract

This Unit deals with theories on learning. In particular, such aspects as learning conceptions, learning strategies and self-directed learning, metacognition, social/collaborative learning, ICT literacy, and motivation will be deepened and experienced.

Introduction

Unit 6 covers research findings concerning learning with educational multimedia, theories on learning, on motivation, as well as on social interaction.

This unit can be placed at the end of the curriculum in order to deepen knowledge on the process of learning when learning with multimedia. Since it presents important themes on learning with multimedia, the Unit can also be placed at the beginning of the course, i.e. after the introductory note and the overview of the curriculum as well as during Units 1–5 if only one or two topics of Unit 6 are chosen.

Educational goals	**Topics**
Construction of declarative knowledge (knowing that – facts, theories, connections amongst theories)	Theories on learning and communication and on learning with educational multimedia, prerequisites and conditions for these types of learning and empirical results
Construction of procedural knowledge (knowing how)	Applying Scenario 4; using digital portfolios for learning; competencies in dealing with hardware and software, metacognitions in learning, reflections on one's own learning processes
Construction of strategic knowledge (knowing how to apply)	Development of learning strategies within the use of multimedia: Learning strategies – implementing strategies, information management strategies, active discussions, problem solving, self-regulated learning, metacognitions in learning (in theory – Unit 6, in practice – all units); learning to learn within a group and collaboratively

Session description

The scientific state-of-the-art theories about learning and the construction of knowledge do not provide a consistent theory for all important aspects of learning. However, they provide a set of theories helping us to better understand human learning.

Unit 6 covers the following themes:

Session A: Approaches to learning and conceptions of learning

Session B: Previous knowledge and learning

Session C: Intrinsic and extrinsic motivation and multimedia

Session D: Learning strategies and metacognition with multimedia

Session E: Computer supported problem solving with hypermedia games

Session F: Social interaction

The sessions in this unit are divided into topics. Session D has a broad body of information and can be split into two sessions.

Approaches to learning and conceptions of learning (Session A)

Conceptions of learning

The research on personal conceptions of what learning is has found that these assumptions can be qualitative or quantitative (Marton and Säljö, 1994). People are asked the question 'What do you mean by learning?' The analyses produced a hierarchy of categories ranging from very simple (learning is a matter of acquiring pieces of information from others) to most sophisticated perspectives on learning: learning is reasoning and understanding, involves personal engagement with the task, learning can be experienced over time as changing as a person; learning is seen as transforming the incoming information by relating it to already existing knowledge; knowledge always changes.

The following sections outline empirical research findings on quantitative and qualitative conceptions:

Quantitative conceptions

a) Increasing one's knowledge (*what*: learning new things – content is unspecified; bits of information; *how*: absorbing, storing; process is unspecified, except increasing or absorbing);

b) Memorizing and reproducing (*what*: facts – isolated but specified items of knowledge; *how*: rote learning; getting it right; repetition, memorizing);

c) Applying (*what*: facts and procedures – similar to memorizing and reproducing, but facts are broader and include procedural knowledge of rules and algorithms; *how*: make use of it in one way – the facts have to be adjusted to the applied context).

These three conceptions are concerned with isolated items and learned by restricted or lower order strategies such as rote learning or memorizing. Applying these conceptions is at the level of simple math problems – applying the same algorithm to solve a standard type of task.

Quantitative conceptions are widespread – many people holding this conception think that a good learner knows more than others. Nowadays, popular television quizzes are similar to *Who Wants to Become a Millionaire?* (where participants have to answer questions such as 'In which year was UNESCO founded?' or 'Who won the gold medal in XY at the 2008 Olympic games?'). They mirror this quantitative conception of learning, where rapid retrieval of unrelated pieces of knowledge – speed and accuracy of memory – is questioned.

Qualitative conceptions

Within this perspective, learning is seen, from a qualitative point of view as a change in one's individual perspective on the world. This means – similar to the constructivist perspective – that learning implies a reinterpretation of knowledge and therefore a reconstruction of the self (e.g. Marton and Booth, 1997).

Qualitative conceptions are the following ones:

d) Learning is understanding the meaning of content (*what*: ideas – what do words and sentences stand for – what does the author want to say; *how*: grasping, understanding, relating new knowledge to previous knowledge, discussing, finding analogies, etc.)

e) Seeing or understanding something in a different, new way (*what*: a view of things, concepts or principles in a qualitative different way – the world is perceived differently; *how*: studying things in a way that they become a pattern, that they are related with each other in a new way).

f) Changing as a person (*what*: the meaning of experience, a philosophy of life; *how*: by deep involvement in learning).

The quantitative and qualitative levels of conceptions of learning feed each other. It is assumed that the quantitative levels are in many cases a prerequisite for the qualitative ones. Most educational systems call for a realization of stage F for pupils at school, independent and self-regulated learners.

According to Biggs and Moore (1993), one of the results of metalearning ('the process by which learners become aware of and increasingly in control of habits of perception, inquiry, learning, and growth that they have internalized' – defined by Maudsley in1979) is that learners derive their individual ways of coping with problems or the challenge of learning. According to an investigation done by Tayler (1984, cited in Biggs and Moore, 1993), pupils make a personal study contract with themselves: 'This is what I want. In order to obtain it, I have to do this or that. If I don't do it, I would break my contract and lose.' This contract can be divided in two important pieces – the will and the skill (Pintrich and DeGroot, 1990):

1) Will: What do I want out of this? Why am I learning this – what are my motives?

2) Skill: What can I do to get there? How do I do that, what are the strategies for achieving what I want?

Approaches to learning

According to Biggs and Moore (1993), different learning motives tend to determine the applied strategies – learning motive and strategies together forming an approach to learning (Biggs, 1985; Marton and Säljö, 1976a, 1976b). The concept of approaches to learning (deep/surface/achieving or performance approach) was developed and investigated within an academic environment (school, university, professional courses). It describes typical ways of pupils' metacognitions within these school/university environments.

Marton and Säljö (1976a, 1976b), Biggs (1987a) and Entwistle and Ramsdon (1983) subsequently developed the concept 'approaches to learning.' In questionnaires and surveys in several countries in all types and levels of schooling, three approaches to learning were consistently found: the surface, the deep and the achieving approaches to learning. The conceptualization of approaches to learning deals with significant learning aspects of learning strategies and different forms of motivation. These approaches describe the strategies used by learners in relation to their learning motivation respectively their inten-

tion to learn. Intrinsic motivation finds its complement in the deep approach, extrinsic motivation relates to demands from outside the student's person. For social motivation, no clear strategies could be found.

The surface approach

Within the surface approach, the main motive is instrumental; the main goal is embedded in pragmatism: to gain qualifications at a minimum allowable standard, to cope with course requirements as a balance between working too hard and failing. Typical strategies here are usually based on rote learning with the intention to reproduce bare essentials. Without an attempt to find understanding, the student has to rely on memorization as a strategy for 'learning' the material. The student does not see a bigger picture – he/she doesn't understand the learning content's implications and connections. As an outcome, the student can only recall isolated factual fragments of the learning material. According to Brophy (1986), the use of metacognitions is less than in other approaches – the student wants to get the task out of the way. Further extrinsic motivations (pleasing parents and teachers) can be of importance.

The deep approach to learning

Within the deep approach to learning, the motive is intrinsic. The learner enjoys and continues learning without expecting a reward (Hidi, 1990; Schiefele, 1991). The learner's curiosity and interest are only satisfied when the content to be learned is felt as understood. This kind of motivation corresponds to the felt need of solving a problem experienced in everyday problem solving in personally important contexts. Deep learning involves a personal commitment to the current learning process which means that strategies are used to enable the learner to relate the content to be learned to personally meaningful contexts or to his/her existing prior knowledge on a specific topic. The learner wants to understand what is to be learned through interrelating ideas and reading widely.

Within the deep approach, the learner is totally involved in the content of the task. According to Biggs and Moore (1993), learners with a deep approach to learning in a certain domain:

- possess a great deal of relevant content knowledge;
- operate at a high, or abstract, level of conceptualization;
- reflect on what is to be done, using optimal strategies for handling the task (metacognition);
- enjoy the process;
- are prepared to invest time and effort.

The achieving approach

Within the achieving approach, the motive is focused on the product and/or the ego involvement that comes from reaching high grades and winning prizes. Adequate strategies have to maximize chances of joining the ranks of the best students, so the learner has to be involved optimally in the task (like learners employing deep strategies), but this involvement is the means and not the aim (Biggs and Moore, 1993). 'The achieving strategy concentrates on cost-effective use of time and effort, a rather cold-blooded

calculation, involving organizational behaviors that characterize the model student, such as keeping clear notes, planning optimal use of time and all those planning and organizational activities referred to as 'study skills'. … Like the deep approach, then, the achieving approach involves a high degree of metalearning, relating both to context (awareness of self, task and context, with deliberate planning of time and resource allocation) and to content (optimal task engagement). While deep and surface are mutually exclusive at any given moment, an achieving approach may be linked to either: one can rote-learn in an organized or an unorganized way, or seek meaning in an organized or unorganized way. Surface achieving is the approach adopted by learners who want to obtain high grades and think that the way to do so is by using the surface strategy. … Deep-achieving, a planned and cost-effective search for meaning, is however characteristic of many of the better learners.' (Biggs and Moore, 1993, p. 314). Learners, who adopt a strategic approach, are alert to cues about marking schemes.

The deep-achieving approach

Research shows (van den Brink, 2006) that highly motivated students primarily employ strategies that help them establish connections between new and old information, generate high quality inferences and exhibit integrated problem solving plans. They relate the learning material to personally meaningful experiences and contexts. They try to be critical and construct their own opinions of what is learned. Furthermore, these students also employ such strategies as writing short notes, summaries, making overviews, tables, sketches and lists. To a lower extent, memorizing, evaluation and metacognition were also used within this type of learning (research question VI). An extrinsic motivation and the lack of concentration seem to be opposed to this form of learning.

Approaches to learning with multimedia

In spite of the potential of multimedia in fostering deep and deep-achieving approaches to learning, research has found contradictory evidence (Laurillard, 1993; Webb et al., 1994). Many applications do not integrate meaningful information processing (Jonassen, 1993 cit. Gunn, 1995). Hart stated (1987, cit. Ramsden, 1992) that multimedia users could become rich in information but poor in knowledge. Furthermore, even well-structured products would sometimes be used (by certain learners and in certain moments) on the basis of a surface approach to learning (Webb et al., 1994 and Newman et al., 1998). In this respect, the context in which learning takes place (i.e. users' skills and learning environment*)* is a key variable.

Different types of conceptions of learning with multimedia become apparent (van den Brink et al., 2000): conceptions of learning with multimedia range from a quantitative view of learning to a qualitative one. This implies that pupils' conceptions of learning with multimedia seem to be based in general conceptions of learning. Some pupils can see multimedia as a way of acquiring more knowledge. This seems to be a quantitative conception of learning (i.e. acquiring information). Multimedia can be represented as a way of improving learning effectiveness (e.g. by enhancing motivation) probably because it promotes a greater involvement in the learning situation. The fact that pupils can represent multimedia as a way of speeding the learning process and reducing information overload can imply that this kind of learning could be also seen as a resource for surface

learning. In the same study, teachers also expressed conceptions of learning with multimedia ranging from a quantitative view to a qualitative one that replicates research on teachers' conceptions of learning in general (Prosser et al., 1994, cit. Entwistle, 1997b).

Pedagogical approach

Conceptions and approaches to learning is an excellent topic for discussions. Course participants might discuss their own approaches to learning and conceptions of learning in a reflective and critical way. Furthermore, the educational system and institutions provide certain specific conceptions of learning. What conclusions for further work in schools do course participants find? How can they use multimedia for changing approaches and conceptions to foster deep-achieving learning?

For representing a qualitative conception of learning, course participants can develop prior (or parallel) qualitative conceptions through group discussions and confrontation with their own knowledge. Therefore, the introduction of multimedia into education alone is not sufficient to improve the quality of learning. Learning with multimedia can be organized in order to support its development from a quantitative conception of learning to a qualitative one.

The fact that course participants can see learning with multimedia as a self-regulatory process suggests that this type of learning can be introduced to autonomous learning and constitute a way to stimulate self-regulation.

Emphasizing that teachers can see multimedia as a resource to implement a type of learning previously defined (e.g. quantitative) suggests that they might need to develop a qualitative conception of learning in order to use multimedia as a resource for learning as a qualitative process.

Teachers can be aware of the conception of learning implicitly in the applications produced.

Content to be learned	**Proposals for pedagogical methods**
Learning theories: quantitative and qualitative conceptions of learning; deep/surface/achievement approaches to learning. Conceptions and approaches to learning with multimedia in school	See Unit 1, material and references. Use one of the questionnaires (Biggs, 1996) for identifying teachers' and course participants' approaches and conceptions to learning. Use Scenario 3 and introduce course participants to different conceptions of learning within the applications. Use Scenario 4 and introduce deep approach (organizing content in hypertext structure according to own constructions) and surface strategies (copy and paste, often without thinking).
Reflection: content/own learning processes/didactics for use in schools	Give homework/support portfolio assessment/ group or class discussion/ hints to references about the topic. Explain your didactics.

Previous knowledge and expert knowledge (Session B)

Several studies have shown that previous knowledge is one of the best predictors for high cognitive performance – a better predictor than general intellectual aptitude in adults as well as in children (Weinert, 1996; Heller, 1997; Ceci and Liker, 1986; Thompson and Zaboanga, 2004). In general, previous knowledge means one person's declarative knowledge (to know that) and procedural knowledge (to know how) within a specific domain (Renkl, 1996). According to Renkl (1996), many studies confirm that learning difficulties in children and adults are very often caused by missing or false previous knowledge (Renkl, 1996; Dochy et al., 1999). Previous knowledge is always the starting point for an extended knowledge base or expert knowledge. How do human beings acquire the many procedures required to construct an extensive knowledge base? It involves learning over a long period of time and this learning never stops because the construction of extended knowledge is based on modifying and reconstructing the previous knowledge with every learning process.

Neuroscientific perspective

An increase in performance is especially based on an increase in knowledge and on a more effective use of strategies. As children grow older, they are more likely to use strategies more effectively. For instance, in memory performance: older children's memory recall is more clustered – similar pieces of information are grouped together. One interpretation of this is that older children use strategies more intentionally. Furthermore, they might have a more extended knowledge about specific domains.

When the knowledge base increases and the connectedness amongst different knowledge domains becomes stronger, knowledge is more accessible for the learner (Rabinowiz and McAuley, 1990).

The relation between knowledge and the ability to use strategies effectively can be very close. Knowledge can replace the use of strategies – for instance, children sometimes use strategies because they do not have a sufficient knowledge base in several fields (Siegler and Shrager, 1984). Otherwise, knowledge can enable the use of strategies, because without an appropriate previous knowledge it is very difficult to carry out certain strategies (for instance, to understand the content of an Italian text certain previous knowledge is necessary).

The interactivity in multimedia software is not an advantage in all learning situations for constructing a broad knowledge base. According to Viau and Larivee (1993) and Shaw (1992), the learner's control of instruction is most effective when the learner has some expertise in the domain. Learners with little previous knowledge in the subject area are often unable to discriminate between critical and tangential information. The power of choice, which is given to them at a high level of interactivity, grants them with more responsibility and thus could generate cognitive overload. This could lead to a poor performance (Jonassen and Grabinger, 1990). Therefore, learning strategy training seems to be very useful.

Pedagogical approach

Support course participants to activate their previous knowledge by proposing strategies, which relate their previous knowledge to information encountered or expected in the

learning material. Provide summaries of what was learned before and try to relate the educational multimedia applications to issues already known to course participants.

Use educational multimedia, which provide the learner with different navigation possibilities. Learners with a relatively limited previous knowledge need far more instructions. The offer of a guided tour supports learners with a limited knowledge base within the specific domain (Scenario 3). Besides this, an open navigation path (Scenario 2) will be provided for the learners who have more knowledge within the domain or for the learners who don't need the guided tour anymore – therefore, they can choose individually their own learning path according to their learning prerequisites.

Furthermore, cognitive tools (Scenario 4) as a tool for expressing, constructing and representing the learner's knowledge structure can support connections among several knowledge domains within one's own knowledge base. Moreover, according to the characteristics of educational multimedia, these applications can provide flexible presentation of information. Educational multimedia can provide several demand levels of the content to be learned depending on the learner's level of previous knowledge. If multimedia software establishes different levels of information, weak learners will not suffer from lagging behind and bright learners will not suffer from boredom. Furthermore, educational multimedia could also provide children with an opportunity of using different learning strategies according to the special tasks and demands, and explain how these strategies can be applied in a manner that is appropriate to the target group. In addition, further encouragement for using strategies and construction of their own strategies could enhance children's performance.

Content to be learned	**Proposals for didactical methods**
Learning theories: previous knowledge, expert knowledge, development of knowledge base, use of strategies, interactivity in multimedia and previous knowledge	See Unit 1, material and references. Homework before the session: let course participants make summaries on their knowledge on previous sessions about learning. Use Scenario 2 or 3 and – for most course participants – use an unfamiliar topic (physics/mathematics) – guided tours, use multimedia with different levels of difficulty. Use Scenario 2: every student chooses a very familiar topic according to his/her interests OR Use Scenario 4 and guide students with limited previous knowledge.
Reflection: content/own learning processes/ pedagogical approach for use in school	Give homework/support portfolio assessment/group or class discussion/ hints to references according to the topic. Explain your pedagogical approach.

Information technology fluency as a previous knowledge requirement for course module (Session B)

The concept of literacy includes a complex set of abilities allowing someone to understand and use the dominant symbol systems of a culture (Andresen, 1999, p. 20). Nowadays, the concept of literacy is expanding to include the digital symbols in addition to other symbol systems (Andresen, 1999). '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. ICT literacy covers the ability to access, analyze, produce and evaluate information through a variety of these media. Included in ICT 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' (Andresen 1999, p. 21).

According to Abbott (2001), 'notions of literacy have been changed and developed as a result of ICT, and literacy is central to most definitions of education' (p. 11). And '… by the end of the twentieth century it was no longer possible to view literacy as based on the word or even on the word-based text. Literacy today is essentially multimedia, composed of an amalgam of words, pictures, sounds and the moving image' (p. 9).

Learners using multimedia have to construct knowledge about technologies. People who use technology fluently do not run for help immediately when something does not work optimally. Tapscott (1998) writes about the benefits of 'growing up digital.' Similarly, Papert (1996, cited in Andresen, 1999) demands an IT fluency, which means that teachers and learners should be able to use technology like a foreign language – fluently.

Pedagogical approach

Course participants and teachers need to know how to use their knowledge effectively and to decide what strategies they use when working with multimedia. Therefore, teachers need many new competencies in order to monitor the progress of learning in this new situation – they must obtain their own IT fluency. Based on an individual analysis the learner can develop his or her own effective learning strategies in the fields/domains in which he or she has deficiencies. They can revise and/or re-evaluate the strategies they have already applied. This provides them with an opportunity of self-evaluation as well as self-monitoring that motivates them to learn. In groups, they can discover their strong and weak points and help each other.

Content to be learned	**Proposals for didactical methods**
Learning theories: ICT literacy	See Unit 1, material and references
Reflection: content/own learning processes/ didactics for use in schools – how to teach strategies	Give homework/support portfolio assessment/group or class discussion/ hints to references according to the topic. Explain your pedagogical approach.

Motivation (Session C)

Motivation plays an important role within the learning process and its existence is essential in order to succeed in learning. Motivation is determined by a mix of learners' beliefs and perceptions regarding their learning processes, teachers' behavior, educational demands, design of the learning material and classroom practices.

Multimedia products prove a useful tool in this area, as these products can give immediate and focused feedback (Sherman and Kurshan, 2005). In addition, many studies have shown that working with multimedia at school increases students' motivation. Moreover, multimedia products can challenge learners and evoke their curiosity and mental images and models. Therefore, motivation is often high in learning activities with multimedia. Nevertheless, multimedia is not a panacea and as every learning tool it won't reach all students at the same time.

Pintrich (2003), who proposed a 'motivational science,' posed seven general questions in order to better understand motivation in learning: What do students want? What motivates students in classrooms? How do students get what they want? Do students know what they want or what motivates them? How does motivation lead to cognition and cognition to motivation? How does motivation change and develop? What is the role of context and culture? These questions might be interesting to ask in every classroom. Until now, research on motivation is still at the beginning. This session presents some crucial findings.

Learners' role – Teachers' role

Research shows that in general pupils seem to appreciate and to be very motivated when working with educational multimedia. Even when pupils evaluated some multimedia software as quite bad, they liked working on the programs. According to many pupils, learning with multimedia applications means learning on one's own, with far more freedom to decide what to do (compared with traditional lessons) and being able to learn at one's own pace.

Pupils in many studies report that the role of the teacher is changing when using educational multimedia in classrooms: pupils appreciated working with teachers who can help them individually, support them in their learning and working strategies. Pupils perceived that the learning situation with computers differed from the traditional one: the relationship between pupils and teachers is less hierarchical and much more relaxed and the centre of activities is on their own learning (van den Brink et al., 2000). Working with multimedia, pupils often show extrinsic as well as intrinsic motivation. Extrinsic motivation is due to their need to know the content to be learnt for exams or presentations; intrinsic motivation is due to their joy when working on multimedia applications – often, students want to continue working without a break or to take the program home in order to continue learning. Many pupils report better concentration and attention in multimedia classes than in classes without educational multimedia. Some pupils reported to be motivated to start with other related topics, which are not needed for school but which they found very interesting (van den Brink et al. 2000).

Although the surveyed teachers established different teaching styles, all of them adopted the facilitator/helper/guide role. Two teaching styles could be identified. When the pupils

had to work on their own, the teachers had a tendency to intervene as little as possible. When the pupils had to get involved themselves actively in reflexive and/or critical processes, the teachers had a tendency to intervene by provoking, questioning the pupils' decisions, suggesting alternative ways, etc. The teachers never repressed inter-group interactions. This type of fluid and direct relationship reminds of the situation – or does not differ much from – when teachers work on projects which require an active and collaborative involvement of pupils.

The results of this European project showed that the pupils put a lot of emphasis on three aspects: the active learning, the multimedia elements of the software, and the teacher's behavior in class. Furthermore, the pupils have plenty of fun when working collaboratively in pairs or in small groups, especially with the combination of these two factors – a good educational multimedia program and a teacher, who is present in the background for giving support when needed – seems to be very motivating. Teamwork also motivates the pupils but it depends on the software program and the tasks to be performed. If the software allows for a critical dialogue with the content, then collaborative work is very welcome. In cases where only repetitions are demanded the pupils prefer to work on their own (van den Brink et al., 2000).

Motivation

Intrinsic motivation: The focus is on feelings of satisfaction and fulfillment and not from external rewards. These positive feelings increase individual engagement into the learning process.

Rewards can undermine performance, when initial interest in the rewarded activity is high and when the reward to performance is so obvious that it seems to be a bribe (Lepper and Hodell, 1989). When the initial interest is not so high, a reward might increase the interest and affect the performance of the task (Bandura and Schunk, 1981).

According to Robinson teachers should give pupils a chance to correct mistakes and they should emphasize that making mistakes is an important part of learning, that teachers support pupils in trying new things and that they support a hard working learning environment. Using educational multimedia applications, which do not give negative feedback on failure, but give an opportunity to correct mistakes several times, requests the use of different learning strategies.

Considering the deep-achieving approach to learning (van den Brink, 2006), students employing this approach in certain learning situations want to reach determined goals related to tasks and are strongly intrinsically motivated: they enjoy learning, are interested in and fascinated by the learning material, and they want to understand it.

MULTIMEDIA

Goal setting

The process of goal setting demands establishing goals and modifying them if required. Specific and proximal goals tend to be more motivating and lead to more success within the learning process than general goals. According to Schunk (1990), this is due to the fact that specific goals are easier to gauge by learners. In Scenario 2, the risk of 'getting lost

in cyberspace' is quite high, especially for inexperienced users. Specific goals can limit this 'danger' and increase chances of success.

Pupils' self-efficacy: the challenge of using multimedia

Pupils with high self-efficacy believe that they are able to reach a desired goal or attain a certain level of performance. Self-efficacy is domain-specific and very stable over the years (Bandura, 1977). High self-efficacy is influenced by former success in the domain, social models, opinions of others and feedback. Self-efficacy also depends on the individual's level of demand on his or her own performance. Challenging but not too difficult tasks support self-efficacy. Many multimedia applications offer continuous help, selective feedback, and different levels of task difficulty or different levels of navigation.

The classroom situation, in which educational multimedia applications are used, provides opportunities for self-regulation and autonomous activities, for high learner control with the programs and others, and multi-perspective presentations of content corresponding to the programs. Teachers can support pupils in this situation by counseling on the use of adequate strategies, and by showing them the possibility of more than one perspective, etc. The use of educational multimedia applications that provide characters with which pupils can identify themselves – of the same sex, age, race and religion – can be supportive. The content should be based on life themes, which are important to learners and depict intense action and feeling (Anderson, Shirey, Wilson and Fielding, 1987). The design should be user-friendly, well-structured and appropriate to the target group.

Furthermore, the use of productive tools (Scenario 4), where learners actively create a platform for knowledge representation or communication, improves learners' motivation if the teacher provides appropriate and continuous support to them (van den Brink et al., 2000).

Pedagogical approach

Facilitate the use of interactivity within the multimedia application – provide different strategies for using it. Use applications, which provide different levels and forms of interactivity for different needs of different learners (with different prerequisites, such as speed, previous knowledge, interests, etc.).

Provide course participants with specific and proximal goals; respectively, let them develop their own specific and proximal goals while working with educational multimedia (when using Scenarios 1, 2 or 4). Introduce them to multimedia, which provide specific and proximal task goals within the application (Scenario 3).

Provide course participants with tasks, which are challenging but not so difficult that progress is impossible as this is important for high self-efficacy. After successful performance, course participants experience greater confidence. This increases self-efficacy. For example, in the case of learning with multimedia this means that course participants should have an opportunity of working with multimedia applications, which are neither too difficult nor too easy for them. Getting familiar with educational applications (how they work, what can be done with them, etc.) often takes time. The course trainer should

be well prepared for working with a specific application. He or she should know the most important features (Scenario 1, 2, 3) or productive opportunities (Scenario 4) of the application to prevent course participants from getting bored when using the application for the first time. Use educational multimedia applications, which increase self-efficacy by offering different levels of difficulty within the tasks or opportunities. An increase in interest towards the content can be established by a varied design of the learning environment within the program.

Use changes in knowledge for motivation: Ask course participants questions on topics to gauge their previous knowledge (photosynthesis, political geography in Africa, Asia or Europe, etc.). Let them discuss their individual knowledge bases according to the topic. Reach agreement on definitions, formulations, and facts. Use the Internet and other media and support individual interests according to the tasks by discussing students' responsibility for certain parts of the task (one student searches for methods, another for history numbers, yet another one is responsible for the presentation of results, etc.). At the end of the session, let them assess their knowledge change.

Encourage course participants to ask for help and support each other within the learning situation.

Depending on the ego-involvement of some course participants, ask them to develop assessment measurements for their own performance assessment (connect to previous knowledge from Unit 2). Introduce a multimedia application (Scenario 3), which gives them positive feedback or alternatively, use one with negative feedback to show the impact on their motivation. Afterwards, collect results and give time for reflecting on the learning process. Ask about their motivation.

Content to be learned	**Proposed didactical methods**
Learning theories: activation/interactivity; learners' control; motivation for learning, motivation and multimedia, intrinsic motivation	See Unit 1. Introduce different scenarios of multimedia to course participants and let them experience different levels of interactivity. Be sure to provide help in difficult situations.
Goal setting	Support course participants' goal setting: provide course participants with specific and proximal goals and respectively let them develop their own specific and proximal goals while working with educational multimedia (when using Scenario 1, 2 or 4). Course participants should understand the difference between specific and general goal setting. Introduce them to multimedia, which provides specific and proximal task goals within the application (Scenario 3).
Learners' self-efficacy	Challenging but not too difficult tasks, integrate Scenarios 1–4.

Content to be learned	Proposed didactical methods
Course participants' perceptions or theories of intelligence	Make sure that course participants understand the work; pay attention to whether pupils make progress or not, give them a chance to correct mistakes (making mistakes is an important part of learning). Support pupils in trying new things in a safe environment. Encourage them to use different learning strategies appropriate to the tasks.
Ego involvement	Assessment opportunities; show positive vs. negative feedback in Scenario 3 applications.
Teachers' role/course participants' role	Task: familiar topic (biology, geography etc.) – check and compare knowledge bases – get new information by using multimedia (Scenario 2), present your guide/facilitator's role and transform it into a topic to discuss – what should the teacher know? Knowledge and strategies to get most recent and up-to-date information.
Reflection: content/own learning processes/ didactics for use in schools	Give homework/support portfolio assessment/group discussion/ hints to references according to the topic. Explain your didactics.

Learning strategies with multimedia (Session D)

Most theories on learning agree on the assumption that knowledge is actively built up by the learner, that knowledge does not exist independently from the learner, and that knowledge is generated dynamically and not stored in a fixed way. Therefore, knowledge cannot be transmitted to other subjects without building up their own constructions (Weinert, 1996; Papert, 1992). According to these assumptions, representations of the constructions are in a permanent renewal process concerning the interpretation of presentations of cognition and there are no static symbols. Many new learning theories accept basic assumptions about learning such as: learning is a constructive and active process, and it is situated and has to be embedded in a relevant context (Weinert, 1996). Stebler and Reusser (1994; cited in Schulmeister, 1997) argue that effective knowledge construction occurs in an active confrontation with the learning content (active), within a certain context (situated), together with others (cultural/social/interactive). Within this process new information will be linked with existing one and structures will be built up in a new qualitative way. Learning is very effective if the learner works in a goal-directed way referred to as the learning goal (goal-directed), and also if he or she monitors and regulates competently his/her activities by his/herself (metacognitive and self-regulated).

According to Biggs (1996), the most desirable outcome of learning is a metacognitive understanding of the subject. This means, that the student is able to transfer the content to be learned, to reflect on one's own (learning) activities, to evaluate decisions already made, to formulate an individual theory about the subject and to generate new approaches to the subject. Can we support pupils to learn in this way with the help of multimedia?

Multimedia as an intellectual tool

Education implies the empowerment of the learners with the intellectual tools of their culture. In many cultures, multimedia can be seen as an important intellectual tool. According to Vygotsky (1978), tools can support learning at different levels. Multimedia as a tool – and the use of Scenario 4 seems to be especially powerful in this sense – is mainly used for:

- Communicating ideas and information representation;
- Handling information;
- Modeling;
- Measurement and control.

These four aspects should support a certain level of concept understanding as well as genuine creative productions. Using multimedia as a powerful cultural tool the learner has the opportunity to look into a certain subject and gain new insights.

1) *Communicating ideas and information representation* (Scenario 4). For communicating information, it is necessary to develop, organize, structure, and store ideas in visual and oral forms by desktop publishing.

2) *Handling information*. Multimedia provides many possibilities for handling information. Information handling software can search, sort and represent information in graphs and charts, and it can deal with a broad range of media including pictures and sounds. On the elementary level, databases in the manner of a card-index archive can

be used. However, this requires the learner to adapt his/her thinking to the structure of the database and this is not always easy as it takes many different cognitive strategies. More supportive to learning are data structures such as 'decision tree' software applications, which help the learner to sort or classify objects in relation to questions with YES/NO answers.

3) *Modeling*. Multimedia-based modeling provides support in learning to handle abstract concepts, especially subject matters such as physics, mathematics and biology – all science subjects can use multimedia modeling very effectively. At the elementary level, spreadsheets are a useful tool, which presents rows and columns in the form of a table. The software calculates and recalculates data automatically and therefore, the learner can concentrate on the presented scientific concepts and does not waste time on calculating. 'Spreadsheets enable learners to operate high level of abstraction in setting up the model and understanding the way in which a table with changing numbers represents a system in the natural world' (Davis et al., 1997, p. 19). Simulations and, more specifically, modeling tools, are generated by spreadsheets. Here, the learner can interact with the model by controlling factors, which will have an impact on the program. One limiting aspect is the fact that simulations can only represent a rule-governed system and are not able to handle unpredictable factors. However, the modeling demands the learner's critical confrontation within one's own limits. Then, the simulation might stimulate the understanding of the presented model and this decreases the possibility of misunderstanding. Modeling provides many possibilities for 'What if?' questions such as 'What if gravity was zero?'

Cognitive tools are a special form of modeling. The term 'cognitive tools' is used when the software application provides an opportunity for constructing knowledge by the user through direct manipulation. Jonassen (1992) defines cognitive tools as mind tools or problem exploration tools. According to him, the true potential of hypertext structures may lie in its capacity as a study aid or a cognitive learning tool. 'A cognitive learning tool is any activity (that may or may not be supported by computers) that fosters or facilitates a deeper or more meaningful level of information processing in learners... the act of creating the systems engages the learner in a level of analysis and depth of learning that is not elicited by other instructional or learning strategies. Having learners create their own hypertexts, especially if they develop hypergraphs, hypermaps, may provide learners with the most powerful learning aid yet provided. Research has shown that learning effects are greater for persons involved in developing materials than for those merely using the system. So, hypertext may well function best as a study aid that provides multi-dimensional note taking. The hypertext will not teach the learner. The learner will learn by creating hypertext.' (Beeman et al., 1987, p. 37, cit. in Jonassen, 1992). The user is able to create his/her own nodes and links among them. He/she can explore the topic to be structured, structure and restructure it and link the sub-structures together, etc. See also the site http://ictmindtools.net, which introduces many online applications, supporting higher-order thinking strategies and creativity for children and adults.

Applications, which provide the user with the possibility to create or construct objects by using graphic programs or linking nodes together, are not only objects but also cognitive concepts or models, which are dependent on the learners' current knowledge base. An example is the program KNOT-Mac (Knowledge Network Organizing Tool for Macintosh).

4) *Measurement and control.* Multimedia can be used for demonstrating complicated processes such as the human circulatory system or the weather system (cloud development). Furthermore, the learner can use the software to take many more accurate measurements and explore creatively a phenomenon and consider additional factors than would otherwise have been possible. With the help of IT-enhanced interactive features, the learner is able to control the pace and the content of what will be seen on the screen. The learner can understand complex interrelationships. He or she can control the learning process.

Creative and critical thinking by using multimedia productivity tools

Critical thinking is a very useful skill in order to understand deeply the content to be learned. Critical thinking is essential to higher-order thinking procedures. Jonassen (1996) presents an integrative model of complex thinking in which critical thinking plays an important part and is related to other thinking skills – content/basic thinking and creative thinking. These three thinking skills are highly interactive with each other.

Content/basic thinking deals with the skills, attitudes and dispositions required to learn and to recall accepted information such as academic content, general knowledge, etc.

Critical thinking means the dynamic reorganization of knowledge in meaningful and usable ways and it contains three general skills such as evaluating, analyzing and connecting the information found.

C*reative thinking* demands going beyond accepted knowledge to generate new knowledge, which is highly connected to critical thinking. However, unlike critical thinking that requires analyzing skills, creative thinking calls for personal and subjective skills. The main aspects of creative skills are synthesizing, imagining and elaborating. Of course, the results of this thinking will be evaluated by critical thinking.

To succeed within the use of Scenario 4 applications, complex thinking skills are needed (see Unit 4 for detailed information on the use of Scenario 4).

Pedagogical approach

Content to be learned	Proposals for didactical methods
Learning theories: multimedia as a cultural tool and being productive	See Unit 1, material and references. Teaching the strategies.
Communicating ideas and information representation Handling information Modeling Measurement and control	Apply different tools of Scenario 4. Course participants can choose one game and work on it in a metacognitive way.
Reflection: content/own learning processes/ didactics for use in schools – how-to-teach strategies	Give homework/support portfolio assessment/group discussion/ hints to references according to the topic. Explain your didactics.

Active learning and interactivity in multimedia: high vs. low learner control (Session D)

Active learning is one of the most crucial requirements of current learning theories. Active learning means to be engaged actively within the learning processes as an active agent and not just as a passive learner digesting what teachers or teaching tools, i.e. multimedia applications, provide. Over three decades, the teaching and learning processes in schools have changed: learners gain more and more control over their own learning processes and activities; teachers turn into facilitators of learning, leaving their role of the only knowledgeable ones, behind (Merill, 1980).

Multimedia in classroom situations provides learners and course trainers with a learning environment within which the learners are allowed to learn actively. Many studies have suggested that high learner control over the learning process within multimedia applications is associated with qualitatively better learning. This allows the student to study course material at a speed that suits his/her needs which helps to improve their knowledge retention. According to Gagné (1985), the learner's control of the pace of instruction provides the learner with the opportunity to encode information. When the learners control the content and the order in which the content is presented, motivation and learning are increasing. According to Keller (1983), the learning process becomes more relevant to the learner, if he can control the learning process. Moreover, the learner can choose the portion of the content's material allowing the learner to freely select material at will. Laurillard (1984) found that the learner's control of instruction within multimedia applications allows to follow a logical route through the instructional material that is meaningful to the student. The alternative – the instructor's logical route – is less meaningful to the student and therefore less motivational. See also the international project *Hole in the Wall*, which was started in a slum of Delhi, where a couple of computers were installed in order to provide the opportunity for the local children to acquire basic computer skills. The children had a very high level of control over the computers. The project has been imported to other developing countries (www.hole-in-the-wall.com).

Multimedia as a productive tool (Scenario 4) could provide learners with high learning instruction control during the learning process. The research data from Biggs (1979) suggests that intrinsically oriented learners need to feel a sense of control over the learning process – they prefer to control their own learning contingencies. He found that these learners perform better when empowered to control their own learning processes.

Entwistle, Hanley and Hounsell (1979) investigated the relationship between the learners' motivation orientation and learning strategies. They found that extrinsically oriented learners tend to use 'game playing strategies,' where the goal is reaching a high grade. Intrinsically motivated learners used more global strategies, trying to understand the problem; they wanted to construct a meaning of the problem. According to Pintrich and Schrauben (1992), more intrinsically motivated learners are more cognitively engaged in learning and use metacognitive learning strategies. They concluded that the (intrinsic/extrinsic) goal orientation of learners influences the self-direction of thought and behavior and thereby the learners' academic performance.

Most teachers are familiar with some of the pitfalls of high learner control. The learners need to be able to develop competent strategies, individually and in groups. As described in the previous chapter, the learners may work best cooperatively (see Chapter 5).

Pedagogical approach

Introduce course participants to the concept of active learning. Encourage discussions in the group about the advantages and disadvantages of active learning (see also advantages and disadvantages of multimedia in education in Unit 1).

Ask participants about their attitudes towards active learning within interactive learning environments.

Learning strategies and metacognition (Session D)

Besides being highly motivated and having an extended knowledge base, learning requires a big pool of learning strategies and metacognition and the ability to use them.

Course trainers/tutors as operators/facilitators of the learning process can provide learners with a pool of possible learning strategies and metacognition as a resource for active learning. Furthermore, learning strategies and metacognition are only models of structures, which must be adapted to the individual situation of the learner. Therefore, the learner constructs his or her own learning strategies and metacognition.

Cognitive learning strategies

Artelt (2000) summarizes that strategies are competencies or skills taken out from their automatic context and that behavior, which is carried out consciously, can be characterized as a strategy. A strategy is always conscious and goal-oriented according to a specific function and context. A behavior related to learning does not have to be a strategy, only if it is carried out consciously and goal-oriented or intentionally, which means that a strategy is always linked to a person or only a person can be strategic and not the behavior in itself (Artelt, 2000). Research has shown that most generally seen strategies seem to be domain-, situation-, or task-specific and only limited for transfer over time, setting, and tasks (Volet, 2001; Artelt, 2000). Furthermore, it could be demonstrated that similar strategies can be employed for different motivations (Kember, 1996; Biggs, 1999).

According to Baumert and Köller (1996), learning strategies are complex cognitive operations, which are hierarchically placed over task-oriented procedures, and they can be understood as sequences of activities for achieving learning goals. They differentiate between several forms of learning strategies:

a) *Implementation strategies.* There are several levels of implementation strategies. *Repeating information by rehearsal* is a surface learning strategy. *Organization*, which means the grouping of items depending on certain characteristics, is a deep learning strategy. Also *elaboration,* which is the construction of a meaningful context, which can be either verbal or visual, can be seen as a deep learning strategy.

Simple rehearsal is usually less effective than other strategies, as it requires processing the material more actively by organizing related ideas or elaborating new ideas by making connections to previous knowledge or, in other words, by reconstructing the existing knowledge base.

Children begin to use these types of strategies at a very early stage of development. Rehearsal strategies develop in early elementary school. Organization and elaboration strategies appear later in elementary school and secondary school. Elaboration strategies – making meaningful associations – require an extensive knowledge base, which increases as the child gets older (Chan et al., 1992).

b) *Summarizing strategies* are effective strategies (Kintsch and van Dijk, 1978). Brown and Day (1983) and Taylor and Beach (1984) taught children to extract main ideas and summarize text and the consequence of this was improved comprehension and memory retention of text.

c) *Self-questioning***.** Asking questions about the text or material to be learned can greatly improve learners' performance (What is the main idea? What is important to know? What do I want to know?). Learners who had lessons in generating and responding to inferential questions, which required explanatory answers, understood and remembered the material to be learned better than learners without any training (King, 1989, 1990, 1994). Constructing questions for self-testing contributes to a better understanding of the material as well (Dole et al., 1991). According to Andre and Anderson (1978, 79), poor learners may benefit even more than bright learners from self-questioning although they all need training to use it effectively. Armbruster, Anderson and Ostertag (1987) taught learners to ask for the problem/solution structure of a text. The learners learned to summarize the problem and to resolve it.

d) *Mental imagery***.** Mental imagery is an active construction of a concrete image.

e) *Representational image.* Rosenblatt (1978) indicates that an effective way to be a good reader is to construct images of the meanings conveyed by the text. Instructions for generating representational images facilitate learning of textual material in middle-elementary school years (Gambrell and Bales, 1986; Pressley et al., 1988). Many studies show that representational images support a deep understanding of what we read (Sadoski, 1983, 1985; Sadoski and Quast, 1990).

f) *Transformational imagery.* Well known in this field are studies about the keyword method, which is effective in the school learning context when pupils have to construct connections between different types of information (Levin, 1982, 1986). This kind of memorizing leads to an increase in content learning where a symbolic or a mimetic reconstruction of the content is obvious (Mastropieri and Scruggs, 1989).

g) *Note-taking***.** Note-taking encourages learners to transform the material to be learned in a memorizing way: learners select information relevant to the studies in a summarized form and construct a new form for their own knowledge base. Furthermore, good note-taking also includes organizing and elaborating on the material. Generally, when note-takers are more active they perform better and learn far more and in a deep learning way (Bretzing and Kulhavy, 1981). The format of note-taking influences the quality of later performance. Kiewra (1991) investigated three different forms of note-taking formats: conventional, outline and matrix. Conventional formats are often brief, disorganized and with verbatim accounts of the material to be learned. The outline format is appropriately organized to the topics of the material. The matrix format is organized in a two-dimensional format where the main topics are listed across the top of the page and the subtopics along the left margin. The learners listed the notes in the intersecting cells. The outline and matrix format lead to a much deeper understanding of the context than with notes taken in the conventional format.

Other possibilities to take notes are mind mapping, diagrammatic notes or other graphical models. If note-taking is meant to be effective, then learners should do it in an organized and elaborated form. However, learners have to find their own ways of structuring the content to be learned.

An important strategy when using multimedia in the Scenario 2 is *knowledge management*. It contains the following steps:

- Identifying exactly what information is needed;
- Selecting and evaluating the information found;
- Embedding the information into a context;
- Giving relevance to the information;
- Constructing knowledge from information and developing new knowledge;
- Linking knowledge and creating knowledge nets;
- Transmitting, transferring and distributing knowledge;
- Exchanging and adding knowledge;
- Applying and transposing knowledge;
- Evaluating knowledge-based actions;
- Developing new knowledge from the evaluated actions.

Additionally, teachers should support cooperative learning for constructive knowledge exchange among course participants (see the section on collaborative learning).

Applying strategies

When learning with multimedia materials, pupils apply different learning strategies, but in many cases these strategies are not very effective and well worked out (van den Brink et al., 2000). In classes where teachers strongly support learners with knowledge about adequate strategies, students seem to be much more satisfied with the lessons and, according to the pupils and teachers, they perform better. Our own observations have shown that different types of multimedia materials demand strategies according to the products: encyclopedia products demand mainly effective searching strategies, whereas learning programs demand more comprehension and elaboration strategies.

The level of interactivity seems to have an influence on the use of implementation strategies: as more interactivity is possible (i.e. Scenario 4: KidPix), as more deep learning strategies (organization, elaboration) are applied. Pure drill-and-practice applications (Scenario 3) do not invite pupils' pool of learning strategies per se. Here, the strategies are quite limited. The strategies most used are practicing and memorization. The more possibilities the program offers (high interactivity, meaningful associations, different perspectives on one problem, collaborative problem solving approach, Scenario 4 tools, etc.) and the more open the teacher's approach is, the more it leads to discussion, exchange and joint decision-making among the members of the small group that share the computer.

Metacognition

Effective learners monitor and control their own learning process during the process of knowledge construction. It means they plan, comment, and evaluate their own learning process from a meta-level. The term 'metacognition' refers to the knowledge and the experiences about their individual cognitive processes and their conditions and prerequisites – to know and to understand why, when and where to apply learning strategies in an effective and useful way. Learners only establish deep learning if they are able to understand why they use certain strategies (Pressley, Borkowski and O'Sullivan, 1984, 1985). Metacognitions are important for knowledge transfer and maintenance

(Borkowski, 1985). According to Borkowski (1985), problems such as maintenance and transfer failures are caused by a lack of or deficiencies in metacognitions. Pupils who are informed about the utility of several strategies are much more likely to maintain the strategy than pupils who are not provided with this information (Borkowski, 1985). Several studies have shown that pupils who are taught in metacognitions use learning strategies far more effectively than pupils who did not get the training (O'Sullivan and Pressley, 1984). Good results promise more studies in the field of self-directed learning. 'Students, who attempt to control their behavior through the use of planning, monitoring, and regulating strategies, do better' (Pintrich and Garcia, 1994, p. 120).

The 'ideal' self-regulated learner seems to be a learner with a broad domain-specific knowledge and high abilities in reflection, planning, designing, and implementation of the learning projects, whereas metacognitive aspects seem to be the most important ones (Dubs, 1993).

Investigations on classes of compulsory school pupils from six different countries (van den Brink et al., 2000) found the following results:

a) Reflections on one's own activities. When using Scenario 2 (encyclopedia/Internet) most pupils discussed the way through the Internet or the applications they had chosen again and again, often they tried out other ways, new wording when searching.

b) Comprehension, monitoring and checking. In the use of another Scenario 2 (e.g. The History of Portugal) signs of comprehension, monitoring and checking were found. The pupils tried to match new content with information they had already consulted and, in case of doubt, they turned back and re-checked it. Other pupils working with Scenario 3 (a combination of drill-and-practice and adventure game, a German Grammar and Spelling program) recognized by themselves that they had problems with spelling and comma placement. Then they practiced more tasks, even if it was not required for getting points for the spaceship (the award within the material). Pupils working with a Scenario 3 material (Le Francais Facile, a drill-and-practice) recognized their problems with the pronunciation. They listened to the pronunciation of the words again and again and asked for help from other pupils and the teacher.

c) Feedback checking. Most pupils using Scenario 3 checked the feedback function. In these applications, using the feedback function is a voluntary decision. They did it because – as they said in the interviews – they wanted to know which words they wrote incorrectly. Some kids wrote down their mistakes and wanted to practice these words at home.

The impact of metacognitive experiences (such as the feeling of knowing, of familiarity with the content, of difficulty, of confidence, of satisfaction, etc.) is not to underestimate because it emphasizes the self-determination in the learning process. These experiences can trigger interest, motivation and resource management through the evaluation of the learning process (Efklides et al., 2001).

Often, learning processes fail due to the wrong selection of learning strategies, i.e. students do not employ effective metacognitions.

Taylor (cited in Biggs, 1988) refers to metacognition by posing two questions: 'What do I want out of this?' and 'How do I propose going about getting there?' which seems to be also adequate when it comes to learning with new technologies.

Pedagogical approach

Teachers/trainers can provide course participants with appropriate strategies and encourage them to shape those strategies individually. Furthermore, course participants can be invited to make conscious connections between the current task and their previous knowledge. The use of multimedia in Scenario 4 supports the organization of objects in different ways, or the elaboration of ideas in a way that helps them to visualize their ideas by drawing with a painting program.

The course trainer can also encourage course participants to use word processors for summarizing their activities (Scenario 4).

Moreover, the course trainer can encourage course participants to practice self-questioning.

Provide course participants with a pool of different strategies for modifying them into personal strategies and facilitate and support the use of these strategies. Use multimedia programs, which provide sections in which the learner can construct his/her own ideas of the content to be learned or applications, which invite the learner to construct his/her own mind maps, diagrammatic notes, etc. (Scenario 2, 3 and 4, cognitive tools).

Teach the pedagogical approach in a metacognitive way – reflect on and discuss it with participants.

Content to be learned	**Proposals for didactical methods**
Learning theories: learning strategies/ cognitive strategies/metacognitions/ applying strategies	See Unit 1, material and references, teaching strategies
Implementation strategies	Scenario 1, 2, 3 and 4 support strategies
Information management strategies	Scenario 1, 2 support strategies
Self-questioning	Scenario 3, 4 support strategies
Note-taking	Scenario 4 support strategies
Mental imaging	Scenario 4 support strategies
Metacognition, reflection on one's own activities	Scenario 4 support strategies and portfolio assessment
Comprehension, monitoring, checking	Scenario 4 support strategies and portfolio assessment
Feedback checking	Scenario 3 support strategies
Reflection: content/own learning/ processes/ pedagogical approach for use in schools – how-to-teach strategies	Give homework/support portfolio assessment/group discussion/hints to references according to the topic. Explain your pedagogical approach

Self–directed learning with multimedia (Session D)

Self-directed learning (also self-organized or self-regulated learning) is concerned with the autonomy, maturity and responsibility of the learner. Most models of self-directed learning suggest that learners are not just passive recipients of information from teachers or others, but rather active, constructive meaning makers. Learners can potentially monitor, control, and regulate certain aspects of their own cognition, motivation, and behavior as well as some features of their environments; there are biological, developmental, contextual, and individual constrains that can interfere or impede individual efforts at regulation (Pintrich, 2000). Self-directed learning is a competency, which has to be learned and practiced over a longer period of time. Studies have shown that the competency of self-directed learning is not well developed within most people. This method can be acquired with the help of direct training (Friedrich and Mandy, 1996), where the learner develops his/her own way of self-directed learning and influences the design of the learning environment – in this case – the multimedia material. A synthesis of both can be an effective solution (Friedrich and Mandy, 1996).

Having the ability to learn in a self-directed way enables the learner to confront deep learning material. Self-directed learning is a process in which the learner is a self-starter:

- Diagnosing his or her own needs concerning learning;
- Establishing what to learn (learning goals);
- Identifying necessary human and other resources;
- Choosing and implementing learning strategies;
- Evaluating the results.

Successful self-directed learners co-ordinate the use of task-specific and goal-oriented strategies – strategies to monitor the learning progress and to plan the learning activities. They have a structured knowledge about where, when and how to use these strategies adequately (metacognitive knowledge). Additionally, they are convinced that successful learning demands effort, concentration and engagement (positive self-efficacy and high intrinsic motivation). Furthermore, they have a bright domain-specific knowledge and a good general education, or previous knowledge (Pressley, Borkowski and Schneider, 1987).

Self-directed learning implies independent and active learning. The specific characteristics of multimedia such as interactivity, giving feedback, simulations of complex contexts, etc. support optimally this type of learning. However, self-directed learning is most productive when learners come with a previous knowledge base about the topic in question (Hofer and Niegemann, 1990).

Pedagogical approach

Provide course participants with learning strategies and metacognition and invite them to construct their own self-regulation strategies. In some cases, course participants can be invited to sketch a personal plan for self-directed learning.

Furthermore, facilitate their learning process by supporting their work and providing them with direct help within specific situations. In some cases, one can use multimedia applications, which provide selected feedback and help to the learner.

Moreover, provide course participants with questionnaires for identifying their learning.

Content to be learned	**Proposals for didactical methods**
Learning theories: self-regulated learning and multimedia	See Unit 1, material and references Teaching strategies
Finding out about his or her own needs concerning learning Establishing what to learn (learning goals) Identifying the necessary human and other resources Choosing and applying learning strategies Evaluating the results	Apply a questionnaire for identifying students' learning (Biggs and Collis, 1982).
Reflection: content/own learning processes/ didactics for use in schools – how-to-teach strategies	Give homework/support portfolio assessment/group discussion/ hints to references according to the topic. Explain your pedagogical approach

Computer–supported problem solving with hypermedia games (Scenario 3) (Session E)

When it comes to problem solving, Whitebread (1997) recommends the use of computer-based problems. In particular, he recommends using problem sets in the context of so called 'adventure games.' Multimedia adventure games can be seen as information sets where possible pathways and the questions, which can be asked, are predetermined. Normally, this type of games varies in the number of possible pathways, in the level of difficulty and sophistication, and in the complexity of answers to predetermined questions or problems.

The following aspects support the use of adventure games for problem-solving approaches:

*a) Help and support***.** Due to the interactive nature of this type of games, the pupils get feedback, help and support from the computer. It is likely that children in this learning environment still need a teacher for some guidance.

b) Coping with a variety of responses. Well-designed games provide a broad variety of possible responses. The range of responses is one of the key elements in determining the level of cognitive demand within these games. Problems can be solved in many different ways. One advantage is that pupils are confronted with different response possibilities in the sense of responding according to different perspectives. From a more negative point of view, this prescribed feature of giving possible solutions can limit pupils' creativity.

c) Time effectiveness. Most games are well designed and offer the possibility to save the data at any point and return to this point at a later time.

d) Trial and error learning. Computer games offer opportunities for boundless experimentation in the field of problem solving. The pupils can experiment with the different possibilities in a very short period of time. In reality, it is difficult to provide this type of trial and error learning in an appropriate period of time and very often it is not possible to test different possibilities in the fields of science.

e) Interest and commitment. Children really like this type of games because the games place everything in the meaningful context of a compelling fictional world that seems to be real and living.

Problem solving is a complex intellectual process involving the coordination of a range of demanding and interrelated skills, which include:

- understanding and representing the problem and identifying what type of information is relevant for the solution;
- gathering and organizing relevant information;
- constructing and managing a plan of action or a strategy;
- reasoning, hypothesis-testing and decision-making;
- using various problem-solving tools, monitoring solutions, and evaluating results.

1) Understanding and representing the problem. Adventure games can support understanding and representation. The way in which a problem is understood and mentally represented has a huge impact on the likelihood of its solution. A further major effect is

the prior knowledge of the learner. The teacher can ask pupils to use their prior knowledge and transfer it to a new context. The contexts of the games are often embedded into meaningful contexts and this helps pupils to see what is important and what is irrelevant. Furthermore, adventure games provide the possibility of transferring knowledge by serving problems. Many adventure games have a very similar structure and integrate common problem-solving skills, which are presented visually and imaginatively in different environments. Whitebread (1997) suggests that pupils should use different adventure games for learning the skill of transfer. They learn to look for analogous problems or relevant things they already know. Furthermore, they learn to analyze the problems by considering the underlying structure rather than their superficial features.

2) Gathering and organizing information. What information is relevant for solving a problem? Children should learn the skill of gathering and organizing information. Many games provide learners with information on different levels. The simplest way is an explicit way of information presentation, when the learner is told to remember a given piece of information. In a further stage, information has to be gathered in a more complex way. Pupils need to search for information in different locations and the information needs to be remembered and used to correctly construct organized sequences of actions, which are needed for solving a special problem.

Some games provide a total freedom in the order in which the information is gathered. Furthermore, within some games the user needs to use different search strategies to find relevant information.

3) Planning and strategies. Adventure games can support the ability to plan ahead – forming mental representations or models and making them explicit. The structure of most of the games is a plan: discovering a successful chain of actions through an environment, which provides the necessary information in the correct order. Furthermore, many games demand the development of strategies – for example, within the program *Lemmings*, where a set of lemmings has to be guided safely from one door to another in a limited period of time. The user can transform the lemmings into several groups of lemmings, whereby each group can perform different tasks. The user has to decide how much lemmings he or she needs from each group to bring them safely to the other door. This procedure demands a plan. By putting ideas into actions the user can see the consequences immediately – if the user forgot to make a bridge over a gap, all the lemmings will fall into the gap. Therefore, the user has to work out a plan to deal with all the problems. When the user has developed a safe route, he or she can decide for a higher level of difficulty.

These aspects of adventure games enable pupils to develop metacognitive strategies, which they have to adapt and coordinate together for developing a plan of action, which they have to use appropriately in different contexts. So, adventure games can be powerful tools for learning planning and developing strategies.

4) Reasoning, hypothesis-testing and decision-making. According to Whitebread (1997), adventure games provide a wide range of possibilities for developing these skills. The simplest level is to decide in which direction the user will go for his/her next move. Higher levels serve the opportunities of making predictions about what will happen after making a particular move – this is making a hypothesis and testing it. Exploring

a less prestructured environment leads to making inferences and examining the cause and effect.

Whitebread points out that adventure games stimulate a playful approach to learning, place problems into meaningful contexts and inspire collaborative work and discussion. Games are one of the most powerful and effective learning media for pupils. According to Bruner (1976), the playing is elemental to human learning. Playing gives the opportunity to try out different possibilities, to combine elements of a problem or a situation in new and flexible ways, to see what would happen if... All these aspects take place within an adventure game in complete safety, which means that it is not necessary to test these activities in reality. According to Whitebread (1997), research has shown that providing learners with open-ended, exploratory and playful tasks enhances problem-solving ability rather than with closed tasks, where one correct answer is needed.

According to Moyles (1989, cited in Whitebread, 1997) two different kinds of playing are differentiated: an unstructured and a structured playing. Children play in an unstructured way when they simply play in any way they like to with the material available. They play in a structured way when they are posed with problems and exposed to new possibilities, etc. Structured games enhance intellectual development and unstructured ones enhance emotional and social development. Adventure games can be good examples of structured games and therefore they enhance intellectual development.

Adventure games provide children with fictional contexts, which contain real human motivations and purposes. The child is able to 'help' the king and the queen to save their child or to find all relevant items to ensure the survival of the dragon. From this, pupils understand the nature and meaning of problems. This enables them to increase their reasoning and thus learn very effectively from their own experience. Furthermore, meaningful contexts help to motivate the learner. Fairy tales with witches, dragons and elves excite pupils in the age group of around 10 years. According to investigations carried out by Whitebread (1997), the problem-solving elements in these types of adventure games really enthrall pupils.

5) Problem solving. According to Vygotsky and Bruner, two key aspects play an important role within pupils' understanding and solving of problems. First, problems are better understood by articulating them in social situations and secondly, language is used in the social context for scaffolding, supporting and guiding problem-solving processes and procedures.

Children's interactions while learning around the computer are dependent on the quality of the multimedia software used. According to Crook (cited in Whitebread, 1997; see also van den Brink et al., 2000), the richest discussions take place while playing (and learning) with adventure games. Within his investigations, Whitebread identified many discussions among ten-year-old pupils while using adventure games which provide a powerful environment that helps the user to develop his or her own problem-solving skills. Furthermore, this enables children to persevere at the task and to solve various demands together. They remind one another about important information, develop a broader selection of ideas and strategies, and they check one another's reasoning.

Pedagogical approach

Implement an adventure game for course participants. To limit time, course participants might play just a part of the game if possible. Provide enough time for reflecting on what is going on with regards to:

- Aspects of problem solving;
- Motivation;
- Collaborative learning.

Content to be learned	Proposals for didactical methods
Learning theories: problem-solving with Scenario 3 – adventure game	See Unit 1, material and references Teaching strategies
Understanding and representing the problem and identifying what type of information is relevant for the solution Gathering and organizing relevant information Constructing and managing a plan of action or a strategy Reasoning, hypothesis-testing and decision-making	Apply different adventure games, course participants can choose one game Course participants work on it in a metacognitive way
Reflection: content/own learning processes/ didactics for use in schools – how-to-teach strategies	Give homework/support portfolio assessment/group discussion/ hints to references according to the topic. Explain your pedagogical approach

Social interaction (Session F)

Today we approach a generation of students that has grown up with new technologies and the World Wide Web. Many of these children or young adults are highly connected – they use digital applications and the Internet for many of their daily life activities, such as staying in touch with friends and relatives, getting information whenever they want, creating knowledge and different forms of communication. This session deals with the social, collaborative use of multimedia applications to foster learning (see also Chapter 5 regarding the organization of collaborative learning).

Social interaction in learning

Current theories on learning and knowledge acquisition consider the social-cultural side of knowledge as much as the cognitive side. According to Vygotsky (1978), learning begins in the social world. Within this approach, understanding its development means to consider the social and cultural environment, in which the individual developmental and learning processes occur.

Furthermore, this view builds on the assumption that social institutions, specific culture and its tools such as technology and language influence learning. 'Learning is not only inside the person, but in his or her ability to use a particular set of tools in productive ways and for particular purposes' (Säljö, 1999, p. 147). The computer is one of these cultural tools.

Collaborative interactions around computers

According to the complexity between variables such as group size, group composition, and the nature of the task it is impossible to establish causal links between the conditions and the effects of collaboration (Littleton, 1999). This has led to a more process-oriented investigation style, which considers talk and joint activities of learners working together on a task as a social mode of thinking (Littleton, 1999, p. 180). Other authors focus more on classrooms as communities while working with computers (Crook, 1999), or on the important role of conflict, which can help to increase pupils' individual understanding of science (Howe and Tolmie, 1999).

Brown et al. (1989) state that learning occurs through cooperative action and that cognitive concept is progressively developed through action. According to Bruner (1985), learners' potential for learning is revealed by studying with others.

Additionally, the development of interaction between learners is highly influenced by the type of multimedia material used during interaction. When using trial-and-error software, i.e. with large number of choices available, pupils tend to adopt a risk taking behavior. In an investigation by Littleton (1999), pupils did not reflect on their current situation and their forthcoming activities. They only focused on carrying out the work as fast as possible and obtaining good marks.

Mercer and Wegerif (1999), who investigated collaborative working while using educational multimedia, promoted a set of ground rules for collaborative talk, which were accepted by the children (10-11 years of age). The rules were taught through modeling and learned through practice. The rules included mutual respect, careful consideration

of everyone's ideas and opinions and finally reaching an agreement on a group idea after discussion. By practicing these rules, the children were learning how to learn together and they created a collaborative community.

Collaborative learning with multimedia materials

The computer can support different forms of collaborative interaction depending on what form of collaborative activity is wished. When trying to solve a problem while participating in computer-based group work, the focus should be on a clear task structure and the provision of feedback on solutions made within the group (Howe and Tolmie, 1999, van den Brink et al., 2000). Multimedia offers unique opportunities for the production and representation of shared classroom experience.

'Computer technology will never replace communication between learners; rather it holds the potential to resource their collaborative endeavor in new and exciting ways' (Littleton, 1999, p. 193).

Multimedia material supports pupils' involvement in conversations with partners with whom they can exchange ideas and articulate general conceptual issues about the presented subject. 'The interactive character of modern technology can support reasoning by amplifying the nature and boundaries of scientific models of objects and events. But the full realization of the potentials of such experiences will still rely on pupils' access to conversation partners who carry on discussions in which these models and concepts are validated. The creation of knowledge is essentially a matter of learning to argue, and no technology will ever replace the need for learners to participate in ongoing conversations with partners sharing interests and commitments. Technology should not be seen as replacing such communication but rather as providing a resource for supporting it' (Säljö, 1999).

In accordance to socio-cultural theories, learners need support from responsive and more competent others to think through the many problems to achieve progress (see also the results in van den Brink et al., 2000). In this sense, cognitive development increases largely because the child gets hints, prompts and assistance from others (i.e. school teachers and classmates) when he/she needs it and can also benefit from social interactions. Teachers can support students' interactions around digital technologies in different ways (van den Brink et al., 2000). They can encourage and enable learners to practice critical thinking in the classroom by having an exploratory talk (discourse talk). The teacher can act as a model – a discourse guide – 'a crucial mentor for pupils' initiation into culturally based discourse practices' (Littleton, 1999, p. 191). According to Watson (1997), it is very difficult for teachers to build up a culture of collaboration in the classroom. This demands a working partnership between teachers and learners. Furthermore, from teachers it requests a deep trust in the creative competencies of children and young people.

Learning by social interaction in Web 2.0

The term Web 2.0 is used in connection with interactive and collaborative applications of the World Wide Web. Easy-to-handle applications enable Web 2.0 users to create, edit and distribute content within a virtual community. Web 2.0 applications include wikis, blogs, social networking sites and podcasts.

Some of the following examples and explanations are taken from two books by Solomon and (2010) and Richardson. The two books explain in detail the use of Web 2.0 tools in the classroom. Solomon and Schrumm (2010) present, among other things, a number of crucial aspects when working with Web 2.0 applications:

Communication. Students can post and share their work and get feedback from a global audience or a selected group of users. Communication with a real audience motivates students to work harder on their projects.

Collaboration. With the help of different applications, students can work together on the same website, provide feedback to each other, discuss concepts and project stages, share research, etc. (see Chapter 5). Peer editing becomes another important dimension of real-time collaboration.

Connectedness. According to Stephen Downes, 'knowledge is distributed across a network of connections and therefore learning consists of the ability to construct and traverse those networks. Knowledge, therefore, is not *acquired*, as though it were a thing. It is not *transmitted*, as though it were some type of communication.'

Learner communities. Social networks can be used within the classroom. Schools can create learning communities around specific topics in order to give students the opportunity to deepen their knowledge and expertise through ongoing communication.

Contextualization. In order to construct new knowledge, students need to integrate new information or experiences or practices into the framework of already existing and connected knowledge. Using the web for this reason seems to support the view that new and existing knowledge are extremely connected with each other and knowledge in one subject (literature) can be easily used in another one (history).

In order to establish collaboration not only as a pedagogical method or a strategy but as a culture of living together and a certain state of mind, we need to look at what makes cooperative learning work.

According to many authors (see for example Slavin, 2010), learning in groups collaboratively almost always improves affective outcomes – students love to work together, they make friends, they become more tolerant. When it comes to achievement, the organization of collaborative learning seems to be very important. Research has shown that two aspects are crucial: group goals and individual accountability (Slavin, 2010, Webb, 2008). It seems that group members need to achieve common goals or to earn rewards or recognition and that group success should depend on individual learning processes of each group member. If the group task is a certain learning outcome of each student, so every group member should be interested in spending time and effort to explain the concepts to be learned to other group members in order to be sure that everybody understands them. According to Webb (2008), students who give and receive elaborated explanations are the ones who profit most from collaborative learning environments. It seems that these two aspects (group goals and individual accountability) motivate students to find explanations and to take seriously the learning needs of themselves and other students. Furthermore, in this research, giving and receiving answers without elaborated explanations correlates negatively with understanding.

Slavin (2010) states that cooperative learning generally works equally well for all types of students, even for high achievers, due to the fact that giving elaborated explanations to others leads to asking more questions and to deepening the existing knowledge base.

Slavin (1995) summarizes effective cooperative learning in the following way: group goals which are based on learning processes of all group members leads to social cohesion. These processes should establish different forms of motivation such as the motivation to learn, to encourage groupmates to learn and to help groupmates to learn. These motivational aspects lead to elaborated explanations (peer tutoring), to peer modeling, cognitive elaboration, peer practice, and peer assessment and correction, which finally enhances learning of all group members.

Research shows that even if teachers use more and more collaborative learning, it seems that these practices are used in an informal way and not within the framework of common goals and individual accountability (Slavin, 2010). Teachers need trainings and follow-up support for different methods of collaborative learning.

The human brain seems to be primed for learning in social interaction (Hinton and Fischer, 2010). Our proper experiences and research have shown that the human brain is tuned to experience the experiences of others by empathy. When we are deeply engaged in the observation of others – for instance, during a football match or a romantic movie – the so called mirror-neurons simulate the experiences of others. These special neurons are thought to be crucial when it comes to build up relations and when people learn in a social situation. These research findings – our relatedness to others and learning from others – propose that positive relationships facilitate learning; therefore learning should be community-oriented (look for more explanations on Google: mirror neurons video).

Web 2.0 tools for the classroom

Blogs

A blog (the combination of the words web and log) is a kind of website, where the blogger (the person or the persons who created the blog) publishes regularly short texts of just a few paragraphs (and additionally other data). This can be a personal journal or a site focused on a certain topic. In most cases, blogs are public and readers are welcome to post comments there. Blogs are based on an easy-to-use online application or a hosting platform.

Due to the predominant use of short texts, blogs can be used as an effective medium to develop *writing competencies*. The potential audience – teachers, classmates, friends, random visitors – seems to be a stronger *motivating factor* than in the case of writing only for one teacher. These public characteristics of blogs force students to *think carefully* about what they are going to write, to *reflect* deeply on the content and their way of *communicating their ideas*. Short texts oblige the authors to express their ideas clearly and concisely. Well-chosen *images* or other media can *enhance posts*. Students can interact with each other as peer reviewers.

Blogs can also be used as *sources of information*. However, before using a blog as information resource, it is necessary to evaluate its validity and reliability. This can be a good

exercise for students: they need to find out whether they can trust information sources and evaluate them as valid and reliable. Common techniques are finding out as much as possible about the blogger, his/her reputation, expertise in the field, etc. This can lead students to critical thinking and reflection.

Many other educational uses are possible. For more detailed information see Solomon and Schrumm (2010) and Richardson (2010).

Solomon and Schrumm (2010) provide some rules for blog commenting and assessing. When it comes to commenting, one must read the blog carefully, consider its strengths and weaknesses, provide specific (positive or negative) feedback.

With blog assessment, one should raise the following questions:

- How well did the student address the curricular topic and/or discussion theme?
- How well-reasoned was the logic of what the student wrote?
- Was the writing of high quality?
- How well did the student communicate his/her ideas?
- To what extent did the blog generate real discussion?

Blogging tools*:* blogger.com; antville.com; wordpress.com; bloglines.com; blogspot.com; coveritlive.com; livejournal.com.

Social networks

A definition of social networks: 'Social networking refers to the aspect of Web 2.0 that allows users to create links between their online presence such as a webpage or a collection of photos. These links may be through joining online groups or by assigning direct links to other users through lists of 'friends' or 'contacts' (Green and Hannon, 2007, p. 13).

Online social networks function according to the interests and/or activities, and goals of the members of the social networks. Social networks are seen from many young people as a virtual social space to meet, to exchange, to hang around together. Dodge, Barab, and Stuckey (2008) assume that social networks are 'third spaces... informal public spaces such as coffee houses affording novelty, diversity, and learning. Unfettered by school protocol or family emotions, third spaces allow groups to meet in generous numbers, and while no individual constitutes the third space, close friendships can be developed unlike those found at home or school' (p. 229). Using social networks in classrooms is built on the assumption that individuals creating their own network might be better able to organize, protect and define the goals of that 'space'. Ning (www.ning.com) is an example of such platform that provides individuals with an opportunity to create their own social network. The advantages of such social networks are evident: small groups can collaborate with each other, members can post questions and ideas, classroom activities can be stored or reflected on, absent students can catch up on work, and work can be shared with others.

Pedagogical use. Many students are used to be members of social networks such as Facebook, MySpace, Friendster, etc. in order to communicate with their friends (friendship-based use of social networks). However, another motivation lets students be members in a social network: their specific personal interests, which allow them to explore the Internet and its social networks on specific subjects (interest-based use of social net-

works). Using this voluntary student habit as a pedagogical tool in the classroom seems to create a rather positive motivating ambiance due to the familiarity with the Web 2.0 environment. According to the US-American school boards Association, in 2007 almost 50 % of students using social networks discussed their homework or other school related topics in their networks. This means that students use networks for educational reasons.

'Network learning is committed to a vision of the social that stresses cooperation, interactivity, mutual benefit, and social engagement. The power of ten working interactively will invariably outstrip the power of one looking to beat out the other nine' (Richardson, 2010).

Wikis

Wikipedia is the most known and used wiki on the Internet. Wikis are websites whose contents can be read, created and edited directly online by web users (with the help of wiki-software). The main idea of wikis is a collaborative work on one text (complemented by images or videos) aiming at expressing the experiences and knowledge of the authors. Wikis can be open to everybody (like Wikipedia) or to a restricted group of people. Due to the fact of being open to alteration, wikis are prone to vandalism and the editing of false information but the same characteristics allow a quick fixing of the wikis.

Pedagogical use of wikis. Wikis allow students to create, edit, and add multimedia elements for collaborative projects. All participating students share the responsibility for the quality of their wiki – they research, analyze, sum up the needed information and coordinate the project while ongoing evaluation and editing of each other's contributions takes place. Students can access the wiki from every connected computer, they can also engage into discussions after the school hours. This work demands higher order cognitive thinking competencies (critical thinking, organization, reflection, problem solving, etc.) as well as collaborative competencies (evaluating the work of others, agreeing on a common scope, on meaning or on relevance of contributions, discussion competencies, etc.) due to the fact that the process of creating wikis is democratic – everyone can edit, delete, add, or change content. Problems can appear, when students are encouraged to change or delete the work of their classmates. In order to avoid such situations, teachers should create a high collaborative environment from the beginning so that each student has the sense of belonging to group and will not get angry, when his or her personal contribution will be changed or partially deleted. The assignment of a wiki project should also be treated collaboratively (see portfolio assignments). It is possible that the teacher can track students' work (their contributions and corrections of others' work) – this might motivate all students to do their work and avoid situations when some students do all the work and while others take advantage of them. Furthermore, by taking ownership of their contributions and the joint product, they can learn to accept and respect the work of others.

In order to avoid vandalism from outside, class wikis can be restricted to only class experiences and not open to a larger audience.

Another opportunity to work with wikis in the classroom is to use already existing wikis on the web. If students work hard on a certain topic, they can look at wikis – for instance, in Wikipedia – and evaluate and edit an existing wiki, if they think they can add a useful contribution. Within the process, students can follow what happens with their entry –

if other wikipedians change their entries or not. Because students are very engaged in the process, this can be a strong learning experience.

Tools: Wikispaces.com, Pbwiki.com. For further examples see the multimedia collection (Appendix 1).

Podcasts and vodcasts. Podcasts (or netcasts) are audio files and vodcasts are audio-video files stored on a public or private website or on websites specialized on audio and audio-video files (i.e. iTunes, Podcast Alley, Podcast Directory) and podcasting is the – private or public – creation and distribution of these files.

Looking at Youtube.com we see the fast development of podcasts within the last years that is due to the fact that nowadays audio and video files are easy to create, distribute and consume. It is possible to subscribe to a podcast series which enables the subscriber to be alert when a new podcast episode is created. A further possibility is that the subscribed podcasts can be downloaded automatically if needed. In comparison with traditional audio or video media, podcasts are much easier to produce and make available to a global audience.

Pedagogical use of podcasts. One opportunity to use podcasts in class could be the creation of radio shows, or podcasts for language or science lessons. Like in the case of blogs, there are practically no limits here. By creating their own podcasts, students can experience their own knowledge and learning processes, present their opinions, their understanding of complex topics. Furthermore, getting acquainted with storyboards makes students plan carefully, reflect on the order, prominence, and emphasis of the elements of the podcast.

Editing. MovieMaker, iMovie, JayCut.com.

Live television – live streaming web TV. Class performances such as music, dance or theatre pieces, school conferences, etc. can be easily broadcasted by live television online. Prerequisites for a school's own television station are a fast and stable Internet connection, a computer with a microphone, a webcam or built-in video camera and a free account at an online video streaming site (ustream.tv).

Another opportunity would be to follow up regular podcasts by scientists because the class is involved in a similar topic. By subscribing to the podcast, the user will be alerted when new podcasts are available.

Examples for podcasts for children include http://kids.podcast.com, www.bookwink.com, www.storynory.com, www.kid-cast.com.

Pedagogical approach

Introduce the content to course participants by following the methods used in Unit 1. Connect course participants' knowledge; build on their previous knowledge from Units 1 and 2. Provide time for reflection – i.e. how can we assess these collaborative forms of learning, etc. Ask questions similar to: Why is it not possible – according to these theories – to transmit knowledge from one person to another? What does this mean for being a teacher? Use collaborative forms of learning around the computer. Reflect on different opportunities in the room and group organization of collaboration while working with

multimedia. Provide course participants with relatively easy tasks – let them search in small groups (2/3/4 course participants) for information on the Internet – according to the topic *Collaborative Learning in School,* and the task can be focused on the content and search strategies.

Content to be learned	**Proposed didactical method**
Learning theories: constructive perspective on learning/ important aspects on learning/ social influence on learning/ computer as a cultural tool	Use methods from Unit 1 Distribute material/references according to topics Ask questions, collect ideas, refer to the last sessions and Units 1 and 2 Course participants develop ideas/models in groups
Collaborative learning with computers/ multimedia Web 2.0 tools	Collaborative task with multimedia, i.e. search in the Internet or in an encyclopedia in groups according to a topic – plan/monitor and evaluate strategies Material and references Experience together with the participants some Web 2.0 tools
Reflection: content/own learning processes/ didactics for use in schools	Homework/portfolio assessment/ group discussion

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Appendix 1: Collection of multimedia

The collection includes a broad spectrum of websites to be used in education. Twenty of these are annotated in order to save time and provide an overview.

Bearing in mind that education takes place in many subjects with many various objectives, it is difficult to recommend particular sites. In the end, digital resources used by students have to be chosen referring to the given learning objectives and conditions.

Wikimedia.org

The owner of this website states that it is 'operated by the Wikimedia Foundation, a non-profit foundation dedicated to bringing free content to the world.'

Moreover, it is a non-profit organization 'dedicated to encouraging the growth, development and distribution of free, multilingual content, and to providing the full content of various wiki-based projects to the public free of charge'.

The Foundation operates the world's largest collaboratively edited reference projects. These projects include:

- Wikipedia, an encyclopedia applying Web 2.0 technologies and thus many-to-many communication;
- WikiBooks, open-content textbooks in various languages ;
- WikiSource, an online library of older publications, collected and maintained by the users.

Applying one or more of these sites into an educational setting, the students can be assigned the role of end users (Scenarios 1-2) as well as the role of producers (Scenario 4).

Due to the limited amount of time in practice, educators may want to focus on the first role, i.e. on presenting and retrieving linear and non-linear information about a given subject matter.

The information is usually considered valid, since it is provided and edited by many users, but learners can criticize the content based on comparisons with similar content from another updated source.

WDL (www.wdl.org)

The objectives of the WDL (The World Digital Library) are, among other things, to expand the volume and variety of cultural content on the Internet and to provide resources for educators, scholars, and general audiences.

Furthermore, the owner of the website states that the mission is 'to make available on the Internet cultural treasures around the world.'

These resources include manuscripts, maps, rare books, musical scores, recordings, films, prints, photographs, and architectural drawings.

The learners can be assigned the role of end users of WDL (Scenarios 1–2). Since the multimedia resources are categorized, the learners can look for resources regarding a particular topic, place, time, or institution. Moreover, they can browse for specific types of items. Finally, they can enter their own search words.

MERLOT (www.merlot.org)

MERLOT (Multimedia Educational Resource for Learning and Online Teaching) is a website, which gathers free and open online resources. It is mainly designed for use in higher education. The aim is to share high quality learning materials and pedagogy.

The content is assembled from various sources worldwide. Everybody can contribute to MERLOT after accepting certain rules.

The activities of the MERLOT website are based on the collaboration and support of its individual members, institutional and corporate partners, as well as the editorial board. The materials are peer reviewed and catalogued by registered members.

Key services include building and sustaining online academic communities, online teaching and learning initiatives, and building, organizing, reviewing and developing applications of online teaching-learning materials. Input comes from an ongoing communication with its worldwide supporters and contributors.

The site is owned and operated by the California State University in partnership with higher education institutions and professional societies.

Since the website contains the categories Home, Communities, Learning Materials, Member Directory, My Profile and About Us, the navigation is intuitive.

At HOME the users can browse a collection of subject categories in order to search for learning materials (arts, business, education, humanities, mathematics and statistics, science and technology, social sciences, workforce development). Furthermore, this part of the website offers some explanations about the site, a link to the MERLOT Journal of Online Learning and Teaching, a peer-reviewed open access online publication since 2005 about all aspects of online learning and teaching.

In COMMUNITIES users can explore the most common college and university disciplines. Each community portal is characterized by five categories: teaching, people, learning materials, beyond MERLOT (professional organizations, online journals, discussion forums, teaching resources), and showcase.

In LEARNING MATERIALS all resources are ordered either by subject or by material types.

In MEMBER DIRECTORY users can find a list of all members who submitted materials, authored materials, commented, wrote about learning exercises or provided personal collections.

OCW Consortium (www.ocwconsortium.org)

The OCW (Open CourseWare) Consortium is a worldwide community of higher education institutions and associated organizations committed to advancing open courseware, i.e. free and open digital publication of educational materials for colleges and universities.

The consortium states that its materials are 'organized as courses, and often include course planning materials and evaluation tools as well as thematic content.'

Educators can search courses using a specialized search engine, browse courses by the language in which they are published. Educators can also explore courses from a particular source or publishing institution.

For example, a search for 'e-Learning' results in a link to a course entitled 'Accessibility of E-learning', which is described in the following way:

'It is part of a teaching professional's skills to understand the needs of a diverse population of students. This unit introduces the challenges for disabled students who may use computers in different ways when taking part in e-Learning or may need alternative teaching methods. It covers the technology and techniques used by disabled students, the adjustments to teaching methods that might be reasonable, design decisions which affect the accessibility of e-Learning tools and strategies for evaluation.'

The website offers materials in many curricula areas including science and social sciences. For example, educators are offered materials dealing with issues like the history of science or maths for science. Other resources address the issues of 'Developing reading skills in relation to the social sciences' and 'The brain and cognitive sciences.'

Another example of a learning resource is aimed at social sciences addressing the issue of how arguments are constructed and used in the social sciences (using extracts from a radio program originally broadcasted on BBC).

Open educational resources portal (www.temoa.info)

The title of this website, 'temoa', represents the words 'to seek, investigate, inquire'. It is proposed by Tecnológico de Monterrey, a private, non-profit academic institution situated in Mexico.

The owner states that the website is a 'multilingual catalogue of open educational resources … described and evaluated by an academic community.'

The resources are 'categorized by area of knowledge, educational level and language' and more. Moreover, the website provides a search engine with 'intuitive filters.'

The educational materials are, among others, provided by:

- Massachusetts Institute of Technology;
- Exeter Research and Institutional Content archive (ERIC);
- Access to Research Resources for Teachers (ARRT);
- Rice University;
- The Open University;
- HowStuffWorks (A Discovery Company).

The latter covers general topics, such as cars, electronics, travel, recipes, health and more. It also includes such topics as the technologies of augmented reality, teleconferencing, intranet, HTTP, MP3, and Google Earth (the latter is described in detail in another section in this Appendix).

FREE (www.free.ed.gov)

FREE (Federal Resources for Educational Excellence) is a website hosted by the federal government of the United States and maintained by the U.S. Department of Education. The aim of this site is providing high quality educational resources for free.

Contributors are federal agencies, such as museums, libraries, governmental departments, etc.

At the time of writing, the site offered freely more than 1500 teaching and learning resources. The topics are: arts and music, health and physical education, language arts, math, science, world studies, US history topics, US time periods, which can be accessed also in the alphabetical order within the specified topics.

Documents are also categorized as animations, primary docs, photos and videos. The resources are links to websites offering media supported learning and teaching material. Moreover, the website offers a search engine and a page with information about new resources added on the site. The site also offers RSS services.

Since the website is easy to use and characterized by a very simple structure that enables the user to find multimedia materials easily, it can be used according to Scenarios 1–2.

ERIC (www.eric.ed.gov)

ERIC (Educational Resource Information Centre) is an online digital database of education research and information resources.

It is owned by the U.S. Department of Education and is the world's largest digital library of education literature. The owner states that 'ERIC provides ready access to education literature to support the use of educational research and information to improve practice in learning teaching, educational decision making and research.'

The main service of the website is offering unlimited access to more than a million bibliographic records of journal articles, books, research syntheses, conference papers, technical reports, policy papers, and other education-related materials going back to 1966. This database is weekly updated with new records and links to full texts if available.

The target groups include teachers, students and the general public. They can be assigned the role of end users (Scenarios 1–2).

They can search for information with the help of the Thesaurus of ERIC descriptors, which is a controlled vocabulary containing a list of education-related words.

Example: If a user looks for literature on 'motivation in math primary school', he or she gets more than a hundred entries. The order of appearance can be sorted by relevance, publication date, title, author or source. The concordant records give information about the author(s), source, descriptors, abstract, related items and full-text availability options as well as the direct link to the source.

ERIC is an important database for everybody searching for detailed and peer-reviewed information on very specific topics within the broad field of education.

The Gateway (www.thegateway.org)

The Gateway to 21st Century Skills is one of the oldest websites serving teachers as a starting point for many educational resources. It is hosted by JES and Co., a non-profit organization. The owner states that the access to the Gateway site is free and does not demand any membership.

The learning resources can be searched by subjects (arts, science, mathematics, social studies, language arts, featured resources). Within the subjects, the number of resources is indicated (for instance, around 7,000 for social studies).

The learning resources can also be searched by keywords. When searching by keywords, it is possible to use filters by subjects (in social studies: geography, anthropology, social work, etc.) by type (lesson plan, activity, collection, curriculum support, primary source), by education level (class level), by medium (txt/html, gif, PDF, jpeg, mp4), by teaching method (computer-assisted instruction, thematic approach, discussions), by language (English, Spanish, etc.), by mediator (teachers, elementary school teachers, secondary school teachers), by price code (free, partially free, fee based), by beneficiary (students, general public, teachers), by assessment method (observation informal assessment, self-evaluation), by interaction method (large group instruction, individual instruction, small group instruction, etc.).

The gateway website offers all types of teaching resources for all subjects and all education levels. Teachers can either use these resources, which are tested mostly according to U.S. national standards, or get some orientation for their own class preparation (Scenarios 1–2).

OER Commons (www.oercommons.org)

OER (Open Educational Resources) Commons is sponsored by the Institute for the Study of Knowledge Management in Education. The objective of the project is that 'resources can be shared, adapted, and remixed to fit individual teaching and learning needs.' In addition, the main goal is to create an education ecosystem built around the open sharing of resources and knowledge that can support improvements in teaching and learning.

The website gathers more than 30,000 open educational resources about teaching technologies. Open educational resources imply 'teaching and learning materials freely available online for everyone to use.' Education levels include all school levels and college courses.

The multimedia resources allocated at the site include full courses, course modules, textbooks, syllabi, lectures, homework assignments, quizzes, lab and classroom activities, pedagogical materials, games, simulations and other education resources from around the world.

Main subject areas are arts, business, humanities, mathematics and statistics, science and technology, and social sciences. It is also possible to search for different types of material (such as lesson plans, readings, full courses, games, etc.), libraries and collections.

The website invites users to add links to materials or news related to the field of open education.

Moreover, the site provides the opportunity to rate materials, to adapt them to standards, to review and to tag them. Users can provide content to educational topics and also obtain and share information on intellectual property, tools and technologies, and other topics.

Adobe TV (http://tv.adobe.com)

The multimedia collection contains a number of websites with content relevant to the subject of education in general. Others provide information on topics related to particular pieces of software. This is the case with the Adobe website. It is closely related to the portfolio of products developed and sold by the company. The content, however, is more general than the content of traditional user guides.

The owner of the website states that it is 'Adobe's online TV network, offering free training, inspiration, and information about the latest Adobe products and services.' For example, the user can learn to handle images, videos, etc. in general terms. Moreover, the user can 'see a full range of programs, from entertainment through instruction.'

The site contains 'a variety of program lengths, episode frequency, and formats, from highly creative productions to desktop walk-throughs.' In addition, it includes a growing number of channels tailored to different audiences, including channels for photographers, designers, and developers.

The site's content more useful in education of ICT-professionals (Scenario 4) rather than in mainstream education.

World Lecture Project (http://world-lecture-project.org)

The website is hosted by the World Lecture Project association. It contains video lectures on a variety of topics from all over the world (Scenario 1).

At the time of writing, there are more than 1,100 videos from 203 countries in 9 languages. Each video lecture has additional information, such as title, summary, faculty, institution, country, language, type, tags and views.

The structure of the website is simple. The categories offered are faculty, institution, country, and language. It is possible to add videos. The site's search engine helps the user to find specific lectures.

The World Lecture Project is an interactive website where everybody is invited to add videos (Scenario 4), to comment, and to add information on the lectures.

Video Lectures Net (http://videolectures.net)

Video Lectures Net is a free and open-access educational video lectures collection covering many fields of science. The site is owned by the Centre for Knowledge Transfer, Jozef Stefan Institute in Slovenia. The aim of the portal is to promote science, exchange ideas and foster knowledge sharing by providing educational videos to the academic community and the general public. Users are encouraged to leave comments, rate lectures and link them to their homepages.

The collection contains almost 15,000 videos on educational topics (Scenario 1). The topics include arts, business, computer science, history, humanities technology, economics, education and many others.

The site's map contains the following: search engine, home, browse lectures, people, conferences, academic organizations. HOME gives an overview of lectures categories, recent and upcoming events, top authors, news, and the opportunity to subscribe to the newsletter.

YouTube and YouTubeEdu (www.youtube.com; www.youtube.com/education)

YouTube is a video portal owned by Google. It provides the possibility to watch, edit and comment videos. It has a simple structure and is available in 15 different languages.

The site has a search engine, different categories for searching and the opportunity to add videos.

The *YouTubeEdu* website collects videos from different colleges and universities, ranging from lectures to student films to athletic events. The site offers videos for all education levels starting from early childhood.

The collection includes academic lectures (e.g. from Stanford and MIT) but also student made presentations, which do not always have a high quality (Scenarios 1 and 4).

MIT World (www.mitworld.mit.edu)

MIT (Massachusetts Institute of Technology) hosts a website called MIT World, which is 'a free and open site that provides on-demand video of significant public events at MIT.'

MIT World's video index contains more than 800 videos (Scenario 1). Some examples are 'Open education for an open world' by Charles Vest (2010), 'Computers for everyone' by Nicholas Negroponte (2011), 'Plays well with others: leadership in online collaboration' by Amy Bruckman (2011), 'Technology: Do kids need more or less' by Alan Gershenfeld (2011) and 'How disruptive innovation will change the way the world learns' by Michael Horn (2011).

Each film is accompanied by lecture details: summary, citations and related videos.

The user can browse all videos, the most popular and the ones added recently. The search engine helps users find videos according to their needs. Furthermore, one can browse the site by speakers (all speakers, MIT alumni, MIT faculty Nobel laureates), topics (architecture, education, engineering, technology, etc.), MIT hosts and series.

Google Earth (www.google.com/intl/en/earth/index.html)

Google Earth is an application that allows its users to navigate and explore geographic data on the 3D globe. In particular, the application allows for exploring 3D imagery and terrains.

It can either be installed on a computer or be a plug-in in a standard web browser.

The geographic information is divided into layers, and the user can view these layers on top of each other.

The user can choose a terrain in various ways. For example, the user can fly to his/her current location. It is also possible to pan, zoom, and tilt the view while traveling the globe. Moreover, one can search for cities, places and businesses around the world.

In educational settings, the software or plug-in can be used the same way as printed maps have been used for ages. However, the geographical information provided by Google Earth is interactive, allowing the user to add and remove layers of information as well as to zoom and switch between 2D and 3D views (Scenario 2).

BioDigital Human (www.biodigitalhuman.com)

During their school years, many students examined models of skeletons and parts of the human body. These models vary a lot with regards to details in the representation of muscles, veins, organs, bones, etc. A digital equivalent produced by Google allows the user to explore the body in 3D using a browser (the website provides information and guides the user with respect to updates needed to use the 3D platform).

The owner of the platform states that it 'simplifies the understanding of anatomy, disease and treatments.'

In addition to the skeletal systems of males and females, the user can explore systems associated with digestion, respiration, nerves and muscles as well as various other systems.

The student is in control of the view of the body. The 3D image can be zoomed, moved, rotated, etc.

In addition to the so-called standard view of the system, the user can choose an 'isolated view,' in which the system is presented without the skeleton, and an 'X-ray view,' in which the skeleton is dimmed.

This content is relevant for various subjects dealing with the human body. It can be used to get an overview of a subtopic as well as to explore a given subtopic in closer details and answer questions regarding the various systems of the human body.

Appendix 2: Recommendations on equipment

In order to provide the course, it is necessary to have facilities for 'hands-on' as well as 'brain-on' activities. Resources for hands-on activities and demonstrations include:

- One or more examples of educational multimodal material on the Internet or intranet, adequate for Scenarios 1-3;
- One or more computers with a web browser that fulfill the technical requirements for this type of software;
- One or more easy-to-handle tools for producing one's own multimedia products (examples of such tools are given in Appendix 3; common software could be used).

Appendix 3: Examples of tools for multimedia production

When multimedia products are used for representational and communicational purposes, it is convenient to use either the Internet or an intranet to distribute materials produced by students and teachers. First, the content of this Appendix deals with some of the current web standards. Mainstream web standards include hypertext markup language (HTML) and cascading style sheets (CSS), and JavaScript. Second, the content of this appendix deals with some development tools that are used in educational settings. Since this course has an educational rather than technical focus, these standards and tools are explained only briefly.

Building blocks

Web pages are made of minor building blocks including texts, icons, pictures, tables, and interactive forms. Basically, the appearance and layout of these building blocks can be addressed via:

1) HTML standard. A web editor can surround each element of the content by opening and closing tags, which indicate the beginning and the end of particular fonts, colors, spacing, tables, etc. In 2012, most browsers support HTML5.

2) Cascading Style Sheets (CSS). It is a general mechanism for adding style elements, e.g. fonts, colors, and spacing to web pages. A web editor can create a content file (HTML) and a style sheet file with definitions of fonts, headlines, margins, etc. (CSS) and make them work together. In 2012, nearly all browsers support CSS.

These standards are developed by the World Wide Web Consortium, an international community made to ensure the long-term growth of the Web (www.w3.org).

The third standard is Java Script owned by Sun Microsystems. Basically, it specifies a programming language that is used in web pages to increase functionality and interactivity. A script can, among other things, be used to validate forms or communicate with a server. In general, browsers support this standard.

With applying Scenarios 1-3 into classrooms, the main objective is to learn *with* or *through* multimedia, not *about* it. Educators thus want to pay little if any attention to these standards. Since the time to learning tasks are limited, they want to focus on topics in their curricula. When dealing with Scenario 4 activities, a little bit of knowledge about these standards is, however, needed.

Need to know about web development

What do educators, those who are not devoted to programming and system development, *need* to know (as opposed to things that would be *nice* to know) in order to foster web development in their classrooms?

To organize student work focused on creating a website, only little technical knowledge is needed. This is due to the fact that web pages can be edited with standard software, with which the learners are already familiar. In order to focus on the primary content and ensure that the given learning objectives are met, students can proceed in the following manner:

They can handle texts including links and images using a standard word processor. When they save their work, they just have to choose the file type HTML. When they open their files in a browser, they get what they saw in the editing application.

Rapid prototyping designates a technique used to build software. It means that the producer makes a draft version, which can be tried out by end users. The principle of rapid prototyping can be applied into general education when students want to share their knowledge about a given topic. The process is iterative:

- First, the students consider the content as well as the form of its representation;
- Second, they make a rapid prototype with the applications they are already familiar with;
- Third, they present the prototype using a standard web browser;
- Then, the students make changes, watch and discuss the result, consider more changes, etc.

In addition to standard word-processing applications, the students can produce and transform PowerPoint file into PDF and share them via the Internet or an intranet. Similar, they can produces and share Google Docs presentations.

Nice to know about web development

Since the functionality of the kind of standard software presented in the previous section is tailored to main stream communication processes, it is often called *office* software. Another category of software is tailored to foster communication through animation and streaming video. Some examples are:

1) Adobe Edge, a web motion and interaction design tool that allows students and teachers to bring animated content to websites, using the web standards HTML5, JavaScript, and CSS3 described above (http://labs.adobe.com/technologies/edge);

2) Asynchronous JavaScript and XML (AJAX), a group of web development techniques that students and teachers can use to create asynchronous web pages that send data to and retrieve data from a server in the background without interfering with the display and behavior of displayed content (http://en.wikipedia.org/wiki/Ajax_(programming));

3) jQuery, a JavaScript Library that simplifies HTML document traversing, event handling, animating, and Ajax interactions for rapid web development (http://jquery.com);

4) Dojo, a tool that enables rapid development of web applications, including JavaScript and CSS features (http://dojotoolkit.org);

5) PHP, a scripting language that is suited for web development and can be embedded into HTML (http://www.php.net);

6) Java, a programming language, which the students and teachers can use to build client-server web applications (http://en.wikipedia.org/wiki/Java_(programming_language);

7) Flash, a development tool and a browser-based 'player' produced by Adobe. (www.adobe.com/products/flashplayer.html). The software provides viewing of 2D or 3D applications, content, and videos. It is not used in Apple's software and not needed according to the HTML5 standard;

8) Silverlight, a development tool and browser-based plug-in produced by Microsoft (www.microsoft.com/silverlight). It can be used for creating web applications with a relatively high level of interactivity.

Producing elements of multimodal material

As described, multimodality is the use of several semiotic resources, i.e. text, images, video, speech, and music – separately and together. Preparing these ingredients, students and teachers may use various editors. In addition to word processing, they can use:

- Software to view and edit images. For example, students and teachers can pick figures, crop images or produce a variety of effects. Moreover, they can change the format of images. Since size matters on the Internet, editors can also be used to compress images. Most often, the office software mentioned above includes software for image processing. An example of freeware for this purpose is IrfanView (www.irfanview.com).
- Software to turn photos into video (to use online). Students and teachers can use free software like Photo to Movie (www.lqgraphics.com/software/phototomovie.php) as well as the tools presented in the following paragraph. They can use the software, among other things, to display photos, add titles, backgrounds, music, and effects, and zoom into specific parts of photos.
- Video-editing software. For example, students and teachers can use this kind of software to select particular video clips and/or add cover text. Of course, they can also add speech, sounds and music. Some of this software is free, e.g. Windows Movie Maker (http://explore.live.com/windows-live-movie-maker). Two examples of professional tools are Premier (www.adobe.com/products/premiere.html) and After Effect (www.adobe.com/products/aftereffects.html) produced by Adobe.
- Audio editors and recorders. Students can handle elements like speech, sounds and music. For example, they can record audio from microphone, edit and convert existing sound files, change the speed of a recording, and mix sounds together. An example of free software of this kind is Audacity (http://audacity.sourceforge.net).
- Software to produce 3D presentations. For example, students and teachers can use Blender, free software to create interactive 3D content (www.blender.org). Professional software includes 3D Studio Max (http://usa.autodesk.com/3ds-max), AutoCad, and Mudbox (http://usa.autodesk.com/adsk/servlet/pc/index?id=13565063andsiteID=123112) produced by Autodesk.

- Software to produce e-learning objects. The students and teachers can use most of the software presented in the previous paragraphs for this purpose. Authoring freeware to assist teachers and students in the publishing of web content and e-learning objects (without the need to become proficient in HTML) includes Exe Learning (http://exelearning.org/wiki). Students and teachers can also apply commercial tools like Adobe Captivate (www.adobe.com/dk/products/captivate.html) or Articulate (www.articulate.com).

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