QUIS - Quality, Interoperability and Standards in e-learning
2004-3538/001-001 ELE - ELEB14

QUIS requirement specification for a next generation e-learning system

Authored by the QUIS team.
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QUIS
Quality, Interoperability and Standars in e-learning

QUIS requirement specification for a next generation e-learning system

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Introduction

The requirement specification for a next generation e-learning system is the result of work performed in the QUIS project (QUality, Interoperability and Standards in e-learning), funded by the European Union (2005-06).

A lot of effort has been put into developing systems for e-learning, but the main focus until now has been on administrative functionality and on content (reusable learning objects). The IMS-Learning Design [IMS Learning Design, 2003] turned the focus to learning activities. What will be the characteristics of a nest-generation e-learning system? Proposing an answer to this question is the goal of WP6, and our answer will be found in this requirement specification. The requirement specification will also provide input to ongoing standardization and interoperability processes.

WP 6 base its work upon work package 4 (WP4) “Analysis of commercial and experimental e-learning systems” [Di Domenico et al., 2005] and work package 5 (WP5) “E-learning standards” [Bianco et al., 2005], which conclude with a need of further development within e-learning. WP4 has provided insight to WP6 when it comes to what already exists and what is not yet found in the existing e-learning systems.

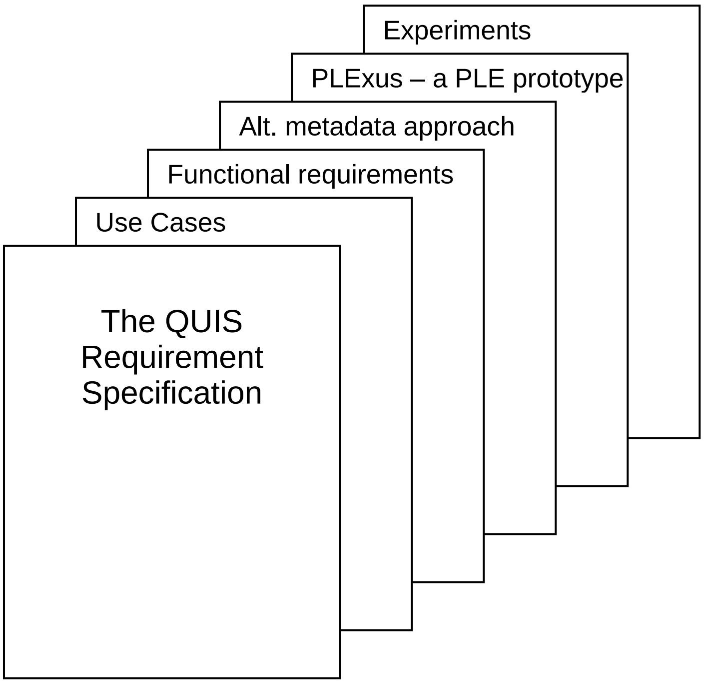
The results from work package 5 (WP5) have provided input about existing e-learning standards; their major advantages, but also their weaknesses. Standards are important to ensure interoperability between systems, and therefore we need to take this into account in the work of defining a next generation e-learning system. The requirement specification is also connected to WP3 (Quality Assurance System), since WP6 covers pedagogical quality assurance at a course level.

The QUIS requirement specification is an attempt to clarify and concretize the vague buzz term “next generation e-learning system”. Like the term “web 2.0” [O’Reilly, 2005], “next generation e-learning” is often used, but there is no precise definition of the term. Looking at research in the e-learning field, it is clear that there are many different opinions about what a “next generation” e-learning system is. The UNFOLD project claims that activity-based e-learning is the next generation e-learning [Griffiths, 2004], while others argue that mobile learning is the next generation e-learning [Dye et al., 2005; Traxler, 2006]. Finally the PLE project at CETIS suggests the PLE (Personal Learning Environment) to be the future within e-learning [Johnson, 2006].

The requirement specification of a next generation e-learning system is the main output of WP 6 in the QUIS project. The project will however not implement the system, with the exception of some prototypes. The requirement specification is therefore a specification on a generic level, where researchers and developers of e-learning systems are considered the users of the requirement specification.

The requirement specification is structured in six main parts. Part 1 describes the project drivers, like the purpose, background and goals of the project in addition to the user description. Part 2 describes the project constraints and includes design constraints and definitions, in addition to relevant facts and assumptions. Part 3 describes the functional requirements, and describes the context of the work (methods and experiments) in addition to use cases and functional requirements. Part 4 describes the non-functional requirements with a main focus on how topic maps may realize a personalized learning environment. Part 5 includes the conclusions and part 6 is the appendix, where the lists of use cases and requirements are to be found together with the experiments and a dissemination list.

The QUIS requirement specification is inspired by the Volere requirements specification template [Robertsen, 2005], but since the work has focused on a generic description of a next generation e-learning system and is not a system ordered from a specific organization, we use the parts of the Volere Template useful in our case. We acknowledge that this document uses copyright material from the Volere Requirements Specification Template (Copyright ©1995-2004 the Atlantic Systems Guild Limited).



Specification prepared by the QUIS team: 2006.12.31.

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Summary

The main goals of work package 6 were to develop a requirement specification for a next generation e-learning system and to provide experience and advice to system developers, content providers and researchers in order to enhance quality within e-learning.

The QUIS requirement specification for a next generation e-learning system is divided into six main parts; 1) Project drivers, 2) Project constraints, 3) Functional requirements (and use cases), 4) Non-functional requirements, 5) Conclusions, 6) Appendix. The QUIS requirement specification includes about 70 functional requirements divided into the categories assessment, content, collaboration, teaching, student / learning environment and quality assurance. In addition, it contains about 30 use cases, where all scenarios are described from both a student and a teacher perspective. Qualitative methodology is used in the development of the requirement specification.

The main focus of the QUIS requirement specification is the pedagogical and the technological parts of a next generation e-learning system, not the administrative part. The QUIS requirement specification has a holistic pedagogical approach, and covers several theories of learning, pedagogical methods and learning activities. It also covers different types of learning objectives, taxonomies and assessment tools, and defines the heterogeneous student group through multiple intelligences and proficiency stages.

The QUIS requirement specification provides new insights within the e-learning research field. We conclude that a next generation e-learning system must be based on an eclectic learning view and not focus on a single learning view e.g. socio-constructivism. An eclectic learning view is important to ensure variation and differentiation, which are important pedagogical principles within e-learning.

A holistic pedagogical approach and an eclectic learning view require an online learning environment that provides possibilities for personalization. PLE (personal learning environment) has been suggested as a future goal within e-learning, but the concept of PLE has so far a variety of interpretations. Our definition of a PLE is an online learning environment where the student is able to customize his / her learning environment based on pedagogical and personal choices.

The need for a PLE within e-learning also entails that a next generation e-learning system must be based on other architectures than is found in existing learning management systems (LMS) / virtual learning environments (VLE). A future e-learning architecture must handle extensive information structures. We suggest that topic maps could be one way to achieve a personalized user interface, and based on the introduced e-learning ontology we present a prototype of a pedagogical-based PLE.

We have also experienced that a pedagogical-based PLE requires new approaches to standardization of learning objects. Pedagogical elements of the existing standards are not extensively used. The experiment of using design patterns as a new metadata approach for learning objects is interesting because it focuses on pedagogical elements and uses free-text. An alternative learning object metadata standard that strengthens the pedagogical aspects is proposed.

We also conclude that there is a need for an “open source” mentality with collaborative development of learning activities, learning objects and assessment activities within e-learning. The “open source” mentality should be built into the e-learning systems to allow sharing

among online teachers and online students. Marketing of learning objects could be done via PSI (Published Subject Indicators), available in the topic maps architecture.

The characteristics of a next generation quality assurance system (at the course level) are that it should be built into all parts of the e-learning system. A course QAS should be implemented for learning improvements, not for control, and must have both a student and a teacher perspective.

The QUIS requirement specification provides a concretization of the vague concept of a “next generation e-learning system”. The project has used the Bologna process as a basis for the work and the QUIS requirement specification contributes with a European added value, by proposing new insights and input concerning the pedagogical quality within e-learning to the ongoing Bologna process and the e-learning field.

1 The Purpose of the Project

1a. Background of the project.

The results of work package 4 (WP4) and work package 5 (WP5) of the QUIS project show us that there is a need for further development of e-learning systems.

The WP 4 report [Di Domenico et al., 2005] describes and analyzes the main features of 16 Learning Management Systems (LMS) with the aim to collect and summarize the state-of-the art of the products available as commercial packages, open-source packages and research projects. The report concludes that tools for four areas are common in the analyzed LMSs: content delivery, class / student management, cooperation and self assessment. “These tools allow for the hand- crafted construction of courses that follow different pedagogical styles and there are no specific automated tools available to help the teacher implementing more complex pedagogical settings” [Di Domenico et al., 2005]. The next generation e-learning system has to address this by offering a teaching environment where the teacher get access to tools that are based on a variety of pedagogical aspects and by offering a differentiated learning environment to the student based on pedagogical principles.

The WP4 report also concludes that only a few systems have started to address the issues of personalization. “There are no LMS yet available that uses a formal semantic-based approach to the construction, analysis and delivery of learning elements and neither are model-based tools that adapt the system to a model of the student yet available” [Di Domenico et al., 2005]. The concept of PLE (Personal learning environment) is suggested as a solution within e-learning [Johnson et al., 2006], but there are for the time being no running PLE system available. There are different interpretations of the concept “PLE”, from “empowering users of informal learning resources away from institutions” or “an extended portfolio” to “a superfluous accessory to the technologies of the desktop operating systems and the World Wide Web” [Johnson et al., 2006]. The variety of interpretations illustrates how diffuse the concept still is. Our definition of a PLE is an online learning environment where the student is able to customize his / her learning environment based on pedagogical and personal choices, and a next generation e-learning system should offer this.

The WP 5 report about standards for e-learning describes four major advantages in standard development and use, specifically in the field of e-learning:

- Durability – no need for modification as versions of system software change.
- Interoperability – operability across a wide variety of hardware, operating systems, web browsers and Learning Management Systems.
- Accessibility – indexing and tracking on demand.
- Reusability – possible modification and use by many different development tools [Bianco et al., 2005].

Lessons learned from the use of Learning Management Systems, Learning Content Management Systems, administrative systems etc that have not been able to interoperate, is important to remember when describing a next generation e-learning system.

“In all standards…, a good share of metadata is devoted to administering and reusing resources; so educational information should be extended, in order to provide more expressiveness in describing educational context…” [Bianco et al., 2005]. This is also important when it comes to architecture for a future e-learning system: The educational focus should be strengthened.

1b. Goals of the project.

The goals of the project are to develop a requirements specification that describes the characteristics of a next generation e-learning system and to provide experience and advice to researchers, system developers and content providers in order to enhance quality within e-learning.

The QUIS requirement specification will pay attention to the fact that both students and teachers are heterogeneous groups with different needs also in a computer-based learning environment.

A next generation e-learning system should give the users (both students and teachers) an improved learning and teaching environment, with possibilities for a variety of pedagogical principles (e.g. variation, individualization, differentiation, meta-learning and best practice).

Fit criterion:
Students may have multiple intelligences (visual, verbal, logical, kinaesthetic, musical, interpersonal, intrapersonal, naturalistic), different stages of intellectual behaviour (novice, advanced beginner, competence, proficiency, expert) and different cultural dimensions. The partners in the QUIS project want to provide the heterogeneous student group with a suitable and improved technology-based learning environment that will increase learning.

The partners in the QUIS project also want to provide to teachers a suitable and improved technology-based teaching environment based on different theories of learning (behaviourism, cognitivism, constructivism, socio-constructivism etc.), teaching styles, pedagogical methods (drill, presentation, tutorial, game, demonstration, discovery, problem solving, simulation, discussion and cooperative learning) and assessment activities that will increase learning among students.

2 Client, Customer and other Stakeholders

2a. The client is the person/s paying for the development.

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2b. The customer is the person/s who will buy the product.

European Higher Education Institutions providing web-based courses, “blended learning” courses and “on campus” courses with technology-based support.

2c. Other stakeholders.

The QUIS requirement specification will provide experience and advice to researchers, content providers and system developers of e-learning systems.

3 Users of the Product

3a. The hands-on users of the product

User name: **Higher education students.**

User role: The higher education students have chosen an education, and have expectations concerning the teachers' role and own work. There are however different motivations for choosing to study. The motivation for using technology in their study program will differ between the students choosing to study on campus versus online students.

The students will have a consumer and a producer role in the system. The student group is heterogeneous and will have different needs depending on e.g. job, family status, learning style, cultural background, intellectual stages etc.

Subject matter experience: Novice.

Technological experience: The student group's technological experience is highly diverse, from novice to master. Attitude to technology is also diverse.

Age group: Life-long learning in combination with e-learning's flexibility entail a HEI student group of diverse age.

Gender: Male and female.

Physical abilities/disabilities: Universal design.

Intellectual abilities / disabilities:

- Multiple intelligences [Gardner, 1985]:

    1. Visual / spatial intelligence: The ability to visualize and make mental maps. Persons using mind maps are using this intelligence.

    2. Verbal / linguistic intelligence: The ability of reading, writing and communicating with words. This intelligence is well developed among writers, journalists, speakers etc.

    3. Logical / mathematical intelligence: The ability of logical thinking, performing calculations and abstract thinking. Mathematicians, engineers and lawyers often have a well-developed logical / mathematical intelligence.

    4. Bodily / kinaesthetic intelligence: The ability of body coordination and conscious use of own body and hands, - an ability typically well developed among athletes, dancers, actors and craftsman.

    5. Musical / rhythmic intelligence: The ability of singing, playing, composing and having a good musical ear, usually found among composers, conductors and musicians etc.

    6. Interpersonal intelligence: The ability of understanding people and communicating, usually well developed among competent diplomats, charismatic leaders and among "persons that people like".

    7. Intrapersonal intelligence: The ability of understanding our "self".

    8. Naturalistic intelligence: The ability to recognize and classify elements / patterns of the natural world.

- Different intellectual stages [Dreyfus, 1998]:

  1. Novice: needs models, rules, prescriptions.

  2. Advanced beginner: starts to recognize based on experience.

  3. Competence: chooses a plan of progress to reach the goal based on instruction and experience.

  4. Proficiency: the theory connected with the skill will gradually be replaced by situational discriminations accompanied by associated responses

  5. Expert: sees what needs to be done, but also sees how to achieve the goal.

- Cultural dimensions [Hofstede, 2001]:

  1. Power Distance Index: The extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally.

  2. Individualism vs. Collectivism: The degree to which individuals are integrated into groups.

  3. Masculinity vs. Femininity: The distribution of roles between the genders.

  4. Uncertainty Avoidance Index: A society's tolerance for uncertainty and ambiguity.

  5. Long-term vs. Short-term Orientation: Thrift and perseverance versus respect for tradition, fulfilling social obligations, and protecting one's "face".

User name: **Higher education teachers.**

User role: preparing the learning environment to increase learning among the students.

Subject matter experience: Master

Technological experience: Diverse (from novice to master)

Attitude to technology: Diverse

Education: Higher education

Linguistic skills: good

Age group: 25 +

Gender: Females and males.

User name: **Tutors.**

User role: Tutoring the student through the online learning environment.

Subject matter experience: Competence / Proficiency

Technological experience: Diverse (from novice to master)

Attitude to technology: Positive

Education: Higher education

Linguistic skills: good

Age group: 20 +

Gender: Females and males.

User name: **Technical support staff.**

User role: Maintenance of the online learning system.

Subject matter experience: Master

Technological experience: Master

Attitude to technology: Positive

Education: Most of them have a higher education degree.

Linguistic skills: good

Age group: 25 +

Gender: Females and males.

User name: **Administrative staff.**

User role: Administrative tasks in an educational institution.

Subject matter experience: Master

Technological experience: Diverse (from novice to master)

Attitude to technology: Diverse

Education: Diverse

Linguistic skills: good

Age group: 25 +

Gender: Females and males.

3b. The priorities assigned to users

Key users:

- Students: It is necessary that a heterogeneous student group finds the system useful for learning.
- Teachers: The teacher must feel that there is a gain in using the e-learning system that spans beyond the burden of having to learn how to use and actually use the system. Among the reasons to feel so:

  - The teacher feels that the material s/he adds in the system is “enriched” by its appearance and administration in the system; for instance it is better available and exploited during the course and further;

  - The teacher feels that her/his interrelation with each student is enriched (improved) beyond the difficulties of distance and the burden to use the system.

Secondary users:

- Technical support staff: responsible for the computer system in which the e-learning system is installed and running; the system must be affordable to install, upgrade and maintain, available to save images of the data; available to remote maintenance.
- Administrative staff: using e-learning system to

  - Configure the learning/teaching environment;

  - User administration;

  - Admin communication (related to user registration and messaging);

Unimportant users:

Researchers.

3c. User participation

Teachers have participated actively in the development of the requirement specification. The writers of the requirements presented in this document are teachers from several higher education institutions, coming from the QUIS partners: TISIP Research Foundation, (Norway), Norwegian University of Science and Technology (Norway), Mid-Sweden University (Sweden), Universita' di Roma "La Sapienza" (Italy), SZAMALK Education and Information Technology Ltd. (Hungary).

Student participation has been performed through brainstorming sessions among students at HiNT (The University College of Nord-Trøndelag), interviews with master students at NTNU and statistical results from experiments using Marratech in blended learning at NTNU [see appendix V and VI].

4 Mandated Constraints

This section describes constraints that are necessary to take into consideration developing a next generation e-learning system.

Constraint name: Web browsers
Description: The system should be able to run via web browsers.
Rationale: The system must not be dependent on one specific web browser, and to implement the interactivity and pedagogical requirements, there is also expected extended functionality and a further development of today’s web browsers (to achieve what is described as Web 2.0 [O’Reilly, 2005].
Fit Criterion: It must be possible to run the system from well-known web browsers.

Constraint name: Different operating systems
Description: The system should not be dependent on one operating system, but be able to run on different operating systems.
Rationale: Students are using different operating systems, and there should not be necessary to demand the student to use a specific operating system to run the e-learning system.
Fit Criterion: The system must be possible to run from different operating systems, e.g. Windows, Linux and Mac.

Constraint name: Mobile devices
Description: The system should be able to run on mobile devices.
Rationale: Mobile learning is by some seen as the future e-learning (Dye et al., 2005; Traxler, 2006]. We choose to consider mobile learning as one of several technological solutions, and think that many of the functional requirements [appendix II] also are applicable in a mobile environment.
Fit Criterion: The functionality of the system possible to run on mobile devices must be made accessible on mobile devices.

Constraint name: Offline work
Description: The system must allow some offline work.
Rationale: Most of the system will require online work, but where it is possible it should also allow the users to work offline.
Fit Criterion: Where it is possible, the system must allow offline work.

Constraint name: E-learning standards
Description: The system must conform to the e-learning standards accepted in the e-learning field to ensure reuse and interoperability.
Rationale: The Bologna process entails that the students from higher educational institutions in Europe will take courses across institutions and nations. The system must take into consideration that the students will have access to a variety of software, e.g. off-the-shelf production software like presentation software, mind tools, graphical software, word processors, web editors, record audio, spreadsheet, databases etc.

One problem within e-learning is that there is not one standard, but many standards (e.g. SCORM, IEEE-LOM, CanCore, DublinCore, IMS Learning Design etc). In addition studies show that pedagogical aspects in today’s standards are not widely used [see appendix III]. There must be considered at the time of the system development which standards to conform to, based on trends in the field.

Fit Criterion: The system must conform to the current e-learning standards.

Constraint name: Anti-virus software
Description: Users of a variety of anti-virus software must be allowed to use the system.
Rationale: There is a variety of antivirus software applications, and the current (and necessary) focus on security can be problematic to higher education institutions that have a heterogeneous student group.
Fit Criterion: Students must not have to conform to one specific antivirus application to use the system.

Constraint name: Physical interface devices
Description: Different in-data and out-data devices should be allowed.
Rationale: There is a variety of in-data and out-data devices available, e.g. mouse, keyboard, microphone, speaker, haptic devices, Braille-printer etc.
Fit Criterion: The system must allow a variety of in-data and out-data devices.

Constraint name: Collaborative applications
Description: Collaborative applications must be identified and conformed to.
Rationale: There are many collaborative applications within education; student administrative systems, content creation tools, assessment creation tools etc.
Fit Criterion: There must be identified what applications are collaborative applications, which the system must conform to.

5 Definitions

This section gives definitions of terms, including acronyms, used in the project.

Assessment

The process of documenting, in measurable terms, a student's skills, knowledge or attitudes in an educational context.

Blended learning

To teach / learn combining classroom learning activities with online learning.

Context of the Product

The boundaries between the product that we intend to build and the people, organizations, other products and pieces of technology that have a direct interface with the product.

Context of the Work

The subject matter, people and organizations that might have an impact on the requirements for the product. The context of study identifies the intersection of all the domains of interest.

Client

The person or organization for which the product is being built. The client is usually responsible for paying for the development of the product.

Customer

The person or organization who will buy the product (note that the same person/organization might play the client, customer and sometimes user roles). In the case of internal customers we often say that they "buy into" the product. In other words they are not actually paying money but they support the product because it satisfies their needs.

CVE

Collaborative Virtual Environments.

Design patterns

A design pattern "describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem in such a way that you can use this solution a million times over, without ever doing it the same way twice" [Alexander 1977].

Developers

The people who specify and build the product / system.

Differentiation

To vary the teaching / learning activities according to the different needs of a heterogeneous student group.

E-learning

Learning facilitated and supported through the use of information and communication technology. E-learning can cover a spectrum of activities from supporting learning, to blended learning to learning that is delivered entirely online [JISC, 2004].

Eclectic

Coming from a variety of sources.

Fit Criterion

Objective measure for quantifying the meaning of a requirement, and eventually testing whether a given solution satisfies the original requirement.

Functional Requirement

An action that the product must be able to take, something that the product must do.

Haptic devices

Technology that interacts with the user via the sense of touch (forces, vibrations, motions etc). (See also motion sensitive tools).

HCI

Human Computer Interaction, a discipline concerned with the study, design, construction and implementation of computer systems that people interact with.

HEI

Higher Education Institution

Holistic

To consider the whole subject / object, not the parts.

Learning activity

A learning activity is the task undertaken by the student, which is based on the subject's characteristics, the learning objectives, level of difficulty, different intelligences, cultural dimensions and pedagogical methods [Inspired by Conole, 2005].

Learning object

A digital learning object consists of two parts: a learning part that is the smallest element of stand-alone information required for an individual to achieve an enabling performance objective or outcome and a metadata part.

Learning objective

The learning goal intended to be achieved (and which is achievable).

LMS

Learning Management System.

Metadata

Data about data. Metadata can describe how, when, by who etc an e.g. learning object is produced.

Meta-learning

The state of "being aware of and taking control of one's own learning" [Biggs, 1985].

Mobile learning

The ability to learn everywhere at every time without permanent physical connection to cable networks [Georgiev et al., 2004].

Motion sensitive tool

Technology where the user interacts with the system via the sense of touch (forces, vibrations, motions etc). (See also haptic devices).

Non-Functional Requirement

A property of quality that the eventual product must have.

Open source

Software source code available for anyone (mainly other software developers) to view, modify and re-distribute.

PSI

Published Subject Identifier.

PLE

Personal Learning Environment.

QAS

Quality assurance System.

QUIS

Quality, Interoperability and Standards in e-learning. An EU-project in the E-learning Initiative (2005-06).

Requirement

A measurable statement of intent about something that the product must do: or a property that the product must have: or a constraint on the system.

SCORM

Sharable Courseware Object Reference Model.

Stakeholder

A stakeholder is a person or organization who has some demand on the product and/or is affected by its outcome/success.

Taxonomy

The classification into categories.

Topic map

A topic map is a technology for knowledge integration, describing concepts and their relations [Garshol, 2006].

Use case

A user-defined piece of activity within the context of the product.

User or Hands-on User

Someone who has some kind of direct interface with the product.

Wiki

Hypertext website editor where anyone can edit the content.

We will in the requirement specification use concepts, taxonomies and theories of educational concepts. The map of concepts, see figure 1, contains three super concepts: methods; learning objectives; student heterogeneities. The super concepts are containers for sub concepts. The super concept “Methods” contains ten categories of pedagogical methods [Heinich et al., 2001], which will all be elaborated in the functional requirements and the use cases. We use three classes of learning objectives which includes several taxonomies used to classify learning objectives. The taxonomies, which are expanded in the super concept “Learning Objectives” branch in the figure, are referred to in the functional requirements and the use cases. The super concept “Student heterogeneities” is divided into three sub concepts; multiple intelligences; proficiency stages and cultural dimensions.

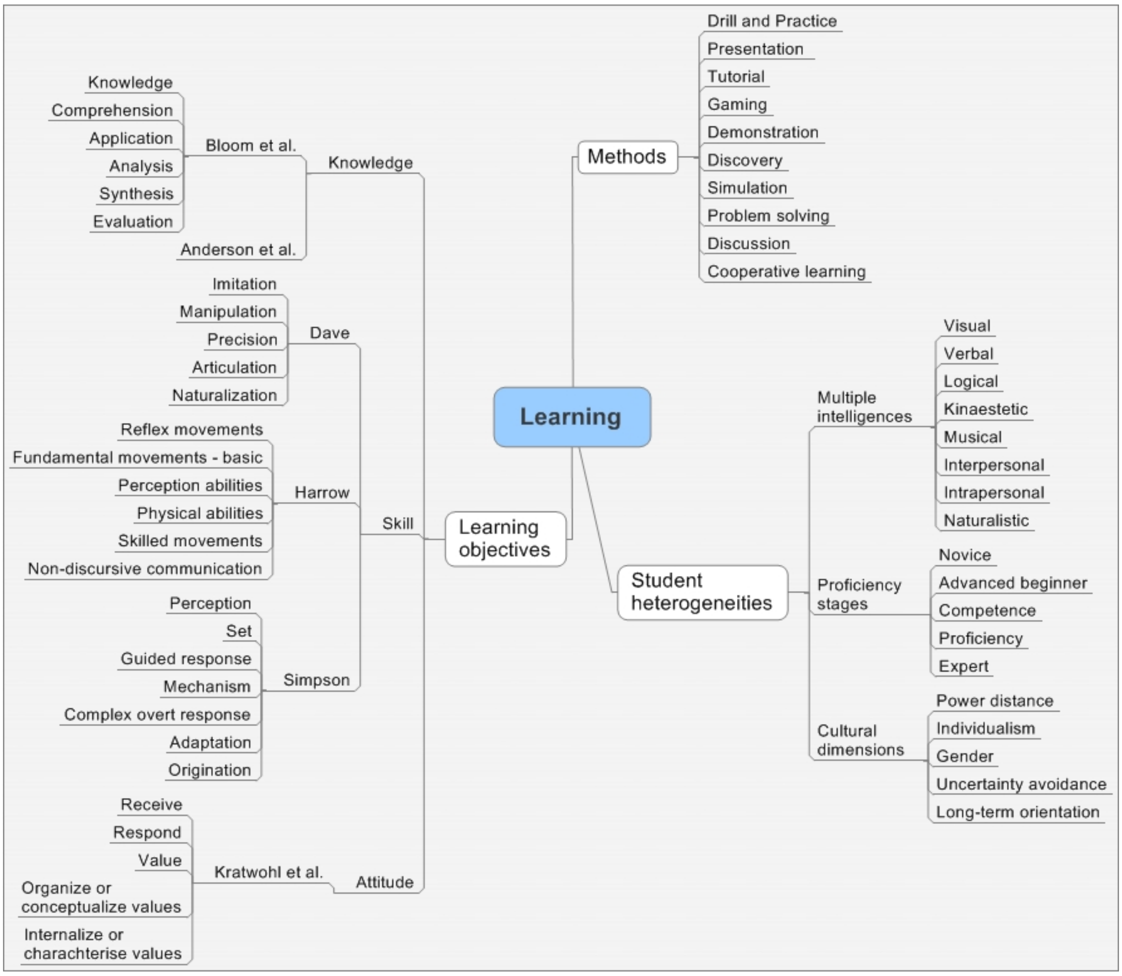


Figure 1: Map of concepts used in the QUIS requirement specification.

6 Relevant Facts and Assumptions

6a. Factors that have an effect on the product, but are not mandated requirements constraints.

The Bologna process is an international joint project aiming at creating the European Higher Education Area. The process started in 1999 and is planed to be implemented in 2010. The Bologna process has three main goals:

- Promotion of mobility by overcoming obstacles to the free movement of students, teachers, researchers and administrative staff.
- Promotion of employability (to create a European space for higher education in order to enhance the employability and mobility of citizens and to increase the international competitiveness of European higher education).
- Increase the international competitiveness of European higher education.

The process defines, in the current version, a three-tier higher education system with the internationally recognised degrees “bachelor” as the first degree after 3 to 4 years of study and the “master” as a possible second degree after an additional 1 to 2 years of study. The third level, doctorial, will be reached after another 3 years study. There are also priorities assigned to quality assurance systems and recognition of competence between participating countries.

It is important that future e-learning systems for higher education apply to the framework of the Bologna process. We will in this requirement specification adapt to the Bologna framework.

To fulfil the mobility goal, learning objects should apply to syllabuses designed according to the Bologna declaration.

6b. Assumptions that the team is making about the project

We will in the requirement specification not cover the administrative concern of e-learning, but focus on pedagogical and technological concerns.

We have chosen not to adapt to IMS Learning Design [2003], even though some of the concepts in the requirement specification are inspired by the IMS Learning Design, e.g. the concept of learning activities. Our definition of a learning activity is however “the task undertaken by the student, which is based on a subject’s characteristics, the learning objectives, level of difficulty, different intelligences, cultural dimensions and pedagogical methods”.

The requirement specification will not be committed to only one learning theory, on the contrary several learning theories like behaviourism, information processing, constructivism and socio-constructivism [Koschmann, 1996] will be considered.

The requirement specification will cover quality assurance at the course level, while WP3 will cover other aspects of quality assurance in e-learning [Komáromi, 2006].

We are using the concept of “open source mentality” in the requirement specification, and by this we mean the collaborative development of learning objects, learning activities, assessment activities etc. to improve e-learning. We do not mean that the commercial products should be replaced, but the collaborative development e.g. learning objects should be available in addition to commercial products.

We assume that teachers and students using the system have access to desktop / laptop / mobile devices, and assume that the users have access to internet / intranet. We did consider writing a use case covering mobile learning, but found that the functional requirements described in appendix II will append to mobile devices as well as desktop devices.

We also assume that the implementation of a next generation e-learning system will take into account the individuals’ and the organization’s interests in the phase of implementing the system in an organization.

7 The Scope of the Work

7a. The current situation

Many universities / colleges expect a larger demand for their courses when they present their previously “on campus courses” as “online courses” (both qualifying courses and post-qualifying courses). In the process of transforming an “on campus course” into an online course, many challenges (e.g. pedagogical, technological and administrative tasks etc.) must be solved.

Higher Education Institutions have the last years been using Learning Management Systems, and the analysis of commercial and experimental e-learning systems (WP4) concludes that these tools allow for the hand-crafted construction of courses that follow different pedagogical styles and there are no specific automated tools available to help the teacher implementing more complex pedagogical settings” [Di Domenico et al., 2005].

E-learning courses for higher education usually are based on a VLE / Learning Management System (e.g. Blackboard and Fronter). “The weakness of these systems is that they give too much attention to online administration and too little attention to pedagogical concerns” (Britain & Liber 2004).

Problems in today’s learning management systems are that sharing among students is not encouraged and that the student is considered a consumer, not a producer [Kolås, 2006]. In addition the tools in the LMS are not as good as the “dedicated” tools (e.g. Fronter chat versus Windows Live Messenger), and the use of the LMS tends to be teacher-oriented, not student-oriented.

Standardization has been an important research issue in e-learning the last years, first standardization of content, and then in 2003 the IMS Learning Design specification was presented, which has been the basis of several research-based e-learning systems like LAMS [LAMS, 2006] and Reload [Reload, 2006].

Personal Learning Environment (PLE) has been proposed as the future e-learning systems. Johnson et al. describes the variety of interpretations of the concept of PLE:

- Some see the PLE as having a significant effect in empowering users of informal learning resources, away from institutions.
- Some see the PLE as an extension to e-portfolio.
- Others see PLE as a superfluous accessory to the technologies of the desktop operating system and the World Wide Web [Johnson et al. 2006].

7b. The context of the work.

Methodology:

The method used in the work of the requirement specification is a qualitative approach, more specifically the grounded theory approach [Glaser & Strauss, 1967; Strauss & Corbin, 1990] with data collection from brainstorming sessions and depth interviews among the user groups (students, teachers and researchers), in addition to literature review from the fields of pedagogy and educational technology. We have also conducted experiments with topic maps, online tutoring and learning object metadata standards.

Experiment 1:

The currents standards and specifications of learning object metadata have been criticized for being too comprehensive and failing to describe the pedagogical content of the learning object. We have conducted an experiment using design patterns to describe the learning parts allowing the user to focus on the pedagogical information, in addition to introducing the idea of creating the metadata in several steps. The result of this experiment is a running prototype of the metadata editor. The experiment is described thoroughly in appendix III.

Experiment 2:

We have conducted an experiment called “Online Tutoring – distributed interactive learning arena with synchronous video and audio” [see appendix V]. The experiment sought to promote a flexible tutoring environment, where tutors and students were using an online environment with real-time transfer of audio and video as well as application sharing and whiteboard. The pilot project was performed in 2005 at NTNU (Norwegian University of Science and Technology) using action research with data collection through interviews and two surveys. The conclusions are that anxiousness is a factor which has led to inopportune use of communication channels and that new tutoring technology should not be introduced within the same organizational frames as traditional tutoring. The experiment and results are further described in appendix V.

Experiment 3:

”Online interactive learning arena over the internet” was a pilot project carried out in the spring of 2006 at NTNU (Norwegian University of Science and Technology). The online interactive learning arena covered online lectures, online tutoring and online group work. A survey was conducted to collect data. The main strength of having an online interactive learning arena is the mobility it offers both the lecturer and the students. An experience from the pilot project was that only the most motivated students made use of online tutoring. The survey shows that the student avoid asking questing in public areas online, but want to see the questions that other students ask. We believe that it could be useful to develop and to offer the users training in a special etiquette for how to apply online tutoring. The experiment and results are further described in appendix VI.

8 The Scope of the Product

Use case list

See appendix I: List of use cases.

The list of uses cases has 30 use cases described. All use cases are described from both the student and the teacher perspective.

The use cases are based on the ten categories of pedagogical methods [Heinich et al., 2002]:
1. Drill
2. Presentation
3. Tutorial
4. Gaming
5. Demonstration
6. Discovery
7. Simulation
8. Discussion
9. Cooperative learning
10. Problem solving

In addition there are use cases covering:
- Collaborative annotation of tags
- Assessment
- Meta-learning

The template:
The template used to describe the use cases is inspired by the Volere requirement specification template [Robertson, 2005]:

Use case number:
Use case title:
User name:
Description:
Fit criterion:
Scenario:

<u>Explanation of terms:</u>

Use case number:
Each use case has a unique number. The use cases that are connected to each other (described with two perspectives (student and teacher perspective) has the same main number, but different decimals, e.g. Use case nr 1.1 Drill and Practice (student perspective) and Use case nr 1.2 Drill and Practise (teacher perspective).

Use case title:
A short, descriptive title of the use case.

User name:
Description of user (online student or online teacher).

Description:
A one sentence summary of the use case.

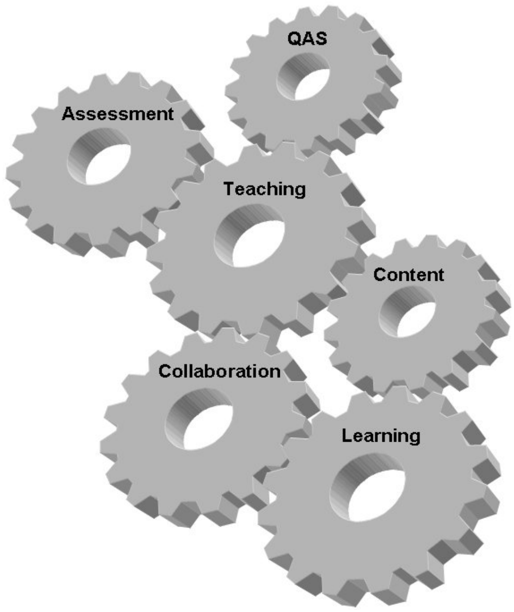
Fit criterion:
An objective measure of the meaning of the use case.

Scenario:
A description of how the user will experience the system in each use case.

9 Functional Requirements

See appendix II: List of functional requirements.

The list of functional requirements consists of about 70 requirements and is divided into six categories:



1. Assessment: The assessment requirements are divided into three main categories based on different types of learning objectives to be assessed; knowledge, skill and attitude. Each category is described by well-known taxonomies to make sure all aspects of assessment are covered in the requirement specification.

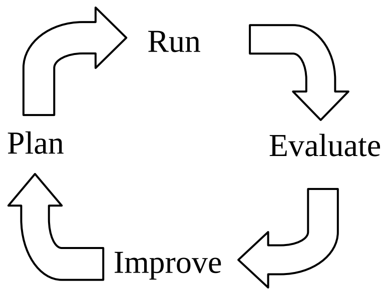
2. Content: The content requirements put into concrete terms how the learning objects provided in an online learning environment should cover different proficiency stages (from novice to expert) and how the "open source" mentality should be utilized in online learning situations.

3. Collaboration: The collaboration requirements cover the need of awareness in an online learning environment, and describes how the "open source"-mentality should be utilized in collaboration. This category also covers the perspective of the learner in a producer role in addition to a consumer role.

4. Teaching: The teaching requirements category puts into concrete terms how it is possible and necessary to vary teaching methods and media types to meet the demands of a heterogeneous student group. It is important to differentiate to meet the requirements of future online students.

5. Student environment / Learning environment: This category covers how the online student / learning environment could be personalized and adapted to the individual student.

6. Quality assurance of the course level: Quality Assurance Systems (QAS) are on the agenda for most of the academic institutions for the moment. QAS are implemented in every aspect of the activities from the promotion of the courses and enrollment of students until graduating students are leaving the academic institutions. This category of requirements focus on quality assurance on a course level, with both the student and the teacher perspective (The QUIS WP3 report "Quality Assurance System" covers quality assurance in a wider perspective). The use of e-learning systems gives us a good opportunity to create systems both for monitoring the quality and for rapidly adjust the activities in a wanted direction. The QAS should be implemented to improve the course, not to control the students / teachers. Characteristics of a next generation e-learning system should be that quality assurance of the course level should be built into all parts of the e-learning system as a spiral model [Boehn, 1988]:



The template used for writing requirements:

Requirement name:
Requirement #:
Requirement type:
Use case #
Description:
Rationale:
Source:
Fit Criterion:
Conflicts:
Dependencies:

Explanation of terms:

Requirement #: a unique requirement number.

Use case: a user-defined piece of activity within the context of the product.

Description: A one sentence statement of the intention of the requirement. The most common form of writing the description is: The product shall do a specific thing for a specific person.

Rationale: A justification of the requirement. The rationale explains why the requirement is considered to be important.

Source: Pointers to literature relevant for the requirement.

Fit criterion: A measurement of the requirement such that it is possible to test if the solution matches the original requirement (it is the criterion for evaluating whether or not a given solution fits the requirement. If a fit criterion cannot be adequately specified, then the requirement is ambiguous, or ill understood. If there is no fit criterion, then there is no way of knowing whether a solution meets the requirement).

Conflicts: Keeps track of other requirements that disagree with this one.

Dependencies: A list of other requirements that have some dependency on this one.

10 Look and Feel Requirements

10a. The interface

The functional requirements [Appendix II] indicate that in a next generation e-learning system it must be possible to personalize the user interface. Being able to present an online learning environment which covers the heterogeneous needs of a student group when it comes to e.g. different intelligences, different intellectual levels, different cultural background and a teaching environment covering the needs to vary e.g. pedagogical methods, media types, learning objectives and assessment activities, there is necessary that the system is able to have personalized views / interfaces.

Our definition of a PLE (Personal Learning Environment) is an online learning environment where the student is able to customize his / her learning environment based on pedagogical and personal choices.

A PLE must provide a student interface allowing customized views of the learning objects and learning activities. Examples of the students' views of the learning objects and learning activities could be views based on:

- Themes.
- Time (the newest learning objects / learning activities).
- Pedagogical methods [Heinich et al., 2002].
- Media type / intelligence [Gardner, 1985].
- Proficiency stages [Dreyfus, 1998].
- Learning objective (knowledge / skill / attitude / meta learning).
- Student productions of learning object / learning activities.
- Ranking score (the learning objects with the highest ranking scores).
- List of learning object recommended by the system based on behavior of previous students (the students who liked a specific learning object also liked these learning objects).
- Guided learning paths produced by teacher.
- (Free text) search.

One HCI (human-computer interaction) solution, which will make it possible to achieve personalization are topic maps. There exist other solutions as well, e.g. semantic web, but QUIS WP6 focus on topic maps [see Appendix IV]. Topic maps are an ISO standard - ISO/IEC 13250:2003. "A topic map is a technology for knowledge integration, describing concepts and their relations" [Garshol, 2006].

Appendix IV (topic maps) provides a short introduction to topic maps, presents an e-learning ontology, and suggests using topic maps as an HCI-solution in a Personal Learning Environment. The appendix also describes the important primary constructions in topic maps applicable in a PLE, and presents our experiment developing a PLE prototype using topic maps through conceptual models, screen shots and system overview.

11 Usability and Humanity Requirements

11a. Ease of use.

The system shall be adaptable to a heterogeneous user group, differing from novice to master, different cultural background and different intelligences.

The system must also be designed according to the principles of "universal design".

The system must be tested in a usability laboratory before launching it.

11b. Personalization and internationalization requirements

The student interface based on a topic map will allow semantic-based customized views of the learning objects and learning activities. Examples of the students' views of the learning objects and learning activities could be views based on:

- Themes
- Time (the newest learning objects / learning activities)
- Pedagogical methods [Heinich et al., 2002]
- Media type / intelligence [Gardner, 1985]
- Proficiency stages [Dreyfus, 1998]
- Learning objective (knowledge / skill / attitude / meta learning)
- Student productions of learning object/ learning activities
- Ranking score (the learning objects with the highest ranking scores)
- List of learning object recommended by the system based on behaviour of previous students (the students who liked a specific learning object also liked these learning objects).
- Guided learning paths produced by teacher
- (Free text) search.

The interface must also make possible the personalization of:

- The language
- The icons / graphics
- The screen layout
- Use of input and output devices
- Training (online help, tutorials, reference material, wizards, templates etc.).

11c. Understandability and Politeness requirements.

The system shall display an interface that indicates it is a learning (and teaching) environment, and not look like any other website.

The product shall use symbols and words that are naturally understandable by the user community. The product shall not force the student to understand pedagogical concepts like learning objectives' taxonomies or learning theories like socio-constructivism, but shall hide the pedagogical theories in the interface. The student should be able to choose learning strategies based on practical experiences.

The system must avoid a pure masculine or feminine interface. There must be considered that both genders will be users of the system.

12 Conclusions

Goals and achievements

The main goals of work package 6 was to develop a requirement specification for a next generation e-learning system, and provide experience and advise to system developers, content providers and researchers in order to enhance quality within e-learning. To reach the goals we have conducted several experiments in the design / development process.

The QUIS requirement specification for a next generation e-learning system is divided into six main parts; 1) Project drivers, 2) Project constraints, 3) Functional requirements (with use cases), 4) Non-functional requirements, 5) Conclusions, 6) Appendix.

The QUIS requirement specification includes about 70 functional requirements divided into the categories assessment, content, collaboration, teaching, student / learning environment and quality assurance. In addition, it contains ca 30 use cases, where all scenarios are described from both a student and a teacher perspective.

The UNFOLD project claims activity-based learning is the next generation e-learning (Griffiths 2004), and the model of learning activity design [JISC, 2004] places the learning activity in the centre. Based on a holistic pedagogical approach, our opinion is that a learning activity is just one of several factors that are important within e-learning. Other important factors are e.g. learning objects, assessment activities etc.

The NKI-project suggests that mobile learning is the next generation e-learning [Dye et al., 2005]. Their argument is understandable if we agree that the technological solution is the main factor in the transition from one generation to another. We focus on pedagogy in addition to technology, and consider mobile learning to be a technological solution that like computer-based e-learning will find the pedagogical requirements in the QUIS requirement specification useful.

PLE (Personal Learning Environment) is also suggested to be the future within e-learning [Johnson, 2006], but the term PLE has so far been variously interpreted. The QUIS requirement specification agree that personalization is an important factor in the transition to a new generation e-learning, and we define the term PLE to be an online learning environment where the student is able to customize his / her learning environment based on pedagogical and personal choices. We concretize our definition of PLE through requirements, use cases, experiments and prototypes.

A next generation e-learning system will also be an open system, where both students and teachers produce learning objects, learning activities and assessment activities that may be shared between institutions across Europe.

A holistic approach to learning and teaching

The main focus of the QUIS requirement specification is the pedagogical and the technological parts of a next generation e-learning system, not the administrative part. The QUIS requirement specification has a holistic pedagogical approach, and covers several theories of learning, pedagogical methods and learning activities. It also covers different types of learning objectives, taxonomies and assessment tools, and defines the heterogeneous student group through multiple intelligences and proficiency stages.

The holistic approach also entails that a next generation e-learning system must provide good solutions both for students and teachers. There should not be a student-centred, nor teachercentred system, but a user-centred system, and important users of e-learning systems are both students and teachers. This requires good learning environments as well as good teaching environments. An experience in the work of developing the requirement specification has been the importance of keeping both a student and a teacher perspective in the development.

New insights

The QUIS requirement specification provides new insights within the e-learning research field. We conclude that a next generation e-learning system must be based on an eclectic learning view and not focus on a single learning view e.g. behaviourism, cognitive constructivism or socio-constructivism. An eclectic learning view can be defined as a learning view drawn upon multiple learning theories, where a behaviouristic as well as a socio-constructive learning perspective is accepted in a learning situation. The student group is heterogeneous and to be able to personalize and differentiate the learning environment and learning process, an eclectic learning view is necessary. The specific subject's distinctive characters allow a variety of pedagogical methods to be used to reach the learning objectives, e.g. to learn how to use the German reflexive pronouns different pedagogical methods can be used, e.g. presentation, demonstration, drill and practice, game etc. Variation and differentiation has been important pedagogical principles within learning for many years, and variation and differentiation is equally important within e-learning.

A holistic approach to e-learning and an eclectic learning view require an online learning environment that provides possibilities for personalization. Our definition of a Personal Learning Environment is an online learning environment where the student is able to customize his / her learning environment based on pedagogical and personal choices. Like O'Reilly [2005] describes Web 2.0 software as services, not products, a next generation e-learning system will be a number of services presented with personalized views. The QUIS requirement specification describes what services are needed in a teaching and learning environment.

The need for a PLE within e-learning also entails that a next generation e-learning system must be based on other architectures than is found in existing LMS / VLE. A PLE architecture must handle extensive information structures. We suggest that a semantic technology like topic maps could be one way to achieve a personalized user interface, and based on the introduced e-learning ontology we present a prototype of a pedagogical-based PLE.

We have also experienced that a pedagogical-based PLE requires new approaches to standardization of learning objects. Pedagogical elements of existing standards are not extensively used. The experiment of using design patterns as a new metadata approach for learning objects is interesting because it focuses on pedagogical elements, uses free-text and introduces the idea of creating the metadata in several steps. We propose an alternative learning object metadata standard using design patterns that strengthens the pedagogical aspects.

We also conclude that there is a need for an "open source" mentality with collaborative development of learning activities, learning objects and assessment activities within e-learning. The "open source" mentality should be built into the e-learning systems to allow sharing and collaboration among online teachers and online students.

Another experience from the developing process of the requirement specification is that a future e-learning system must focus on meta-learning ("the state of being aware of and taking control of one's won learning" [Biggs, 1985]).

Future challenges within the development and use of topic maps within e-learning is to standardize a PSI (Published Subject Identifier) within educational technology, so that the same topics are assigned the same topic names. Marketing of learning objects could be done via PSI, available in the topic maps architecture.

The characteristics of a next generation quality assurance system (at the course level) are that it should be built into all parts of the e-learning system. A course QAS should be implemented for learning improvements, not for control, and must have both a student and a teacher perspective.

The QUIS requirement specification provides a concretization of the vague concept of a “next generation e-learning system”. The project has used the Bologna process as a basis for the work and the QUIS requirement specification contributes with a European added value, by proposing new insights and input concerning the pedagogical quality within e-learning to the ongoing Bologna process and the e-learning field.

References

Alessi, S.M. and Trollip, S.R (2001). *Multimedia for learning – Methods and development 3rd edition*. Allyn & Bacon – A Pearson Education Company. ISBN 0-205-27691-1.

Alexander, C. et al. (1977). *A pattern language: towns, buildings, construction.* New York: Oxford University Press. ISBN 0195019199.

Anderson, L.W., & Krathwohl (Eds.). (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.

Apache Cocoon (2006). *The Apache Cocoon Project*. http://cocoon.apache.org/

Betz, M.K. (2006). *Solo and Social Learning in Online Courses: Implications for Information Processing Theory*. International Journal of Instructional Technology and Distance Learning, vol 3, no 2. http://itdl.org/Journal/Feb_06/Feb_06.pdf

Bianco, A.M., De Marsico, M., Temperini, M. (2005). *Standards for e-learning.* Project QUIS: QUality, Interoperability and Standards in e-learning, Agreement n. 2004 -- 3538 /001 -- 001 ELE--ELEB14. The TISIP Research Foundation, Trondheim, Dec. 2005, Dec. 2006, ISBN 82-8055-018-6. Available: http://www2.tisip.no/quis/public_files/wp5-standards-for-elearning.pdf

Biggs, J. B. (1985). *The role of metalearning in study processes*. British Journal of Educational Psychology, 55, 185-212.

Bloom, B. (Ed.) (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York; Toronto: Longmans, Green.

Boehm, B. (1988). *A Spiral Model of Software Development and Enhancement.* IEEE Computer, vol.21, #5, May, pp 61-72.

Britain, S. and Liber, O. (2004). *A Framework for the Pedagogical Evaluation of eLearning Environments*. Available from http://www.cetis.ac.uk/members/pedagogy/files/4thMeet_framework/VLEfullReport (accessed 28 June 2006).

Conole, G. & Fill, K. (2005). *A learning design toolkit to create pedagogically effective learning activities*. University of Southampton, Journal of Interactive Media in Education (Portable Learning. Special Issue, eds. Colin Tattersall, Rob Koper), 2005/08. ISSN:1365-893X [jime.open.ac.uk/2005/08].

Conole, G. (2005). *Mediating artefacts to guide choice in creating and undertaking learning activities*. CALRG seminar 05.11.01.

Conole, G. (2004). *Report on the effectiveness of tools for e-learning*. University of Southampton, Available online at: http://www.jisc.ac.uk/uploaded_documents/Report%20on%20the%20effectiveness%20of%20tools%20v5_Martin_Oliver.doc (accessed 28 June 2006).

Conole, G., Dyke, M., Oliver, M. and Seale, J. (2004). *Mapping pedagogy and tools for effective learning design*. Computers and Education, 43 (1-2), 17-33.

Dale, L. E. (2004): Kultur for tilpasning og differensiering, Utdanningsdirektoratet, http://www.utdanningsdirektoratet.no/upload/Rapporter/Kultur_for_tilpasning_differensiering.pdf

Dave, R. H. (1970). *Psychomotor levels*, in: Armstrong RJ, ed., *Developing and Writing Behavioral Objectives*. Tuscon, AZ: AZ:Educational Innovators Press.

Dichev, C., Dichva, D., Aroyo, L. (2003). *Using topic maps for e-learning*. In proceedings of the IASTED International Conference on Computers and Advanced Technology in Education, CATE 2003.

Di Domenico, F., Sterbini, A., Temperini, M. (2005). *Analysis of commercial and experimental e-learning systems*. Project QUIS: QUality, Interoperability and Standards in e-learning, Agreement n. 2004 -- 3538 /001 -- 001 ELE--ELEB14. The TISIP Research Foundation, Trondheim, Dec. 2005, Dec. 2006, ISBN 82-8055-017-8

Dreyfus, H.L. (1998). *Intelligence without Representation*. http://www.hfac.uh.edu/cogsci/dreyfus.html

Dye, A., Fagerberg, T. and Rekkedal, T. (2005). *Designing an Always-Online Learning Environment for Mobile Learners and Teachers*. EU Leonardo Project "Mobile learning: The next generation of Learning", NKI Distance Education. Available online at: http://learning.ericsson.net/mlearning2/files/workpackage2/designing.doc (accessed 28 June 2006).

Exist (2006). *eXist – Open source native XML database*. http://exist.sourceforge.net/

Gardner, H. (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Garshol, L.M. (2006). *Topic maps – Overview and use cases*. Ontopia. Available: http://www.vestforsk.no/seminar/Ontopia.pdf

Georigiev, T., Georgieva, E., Smrikarov, A. (2004). *M-learning – A new stage of e-learning*. International Conference on Computer Systems and Technologies 2004. Available online at: http://ecet.ecs.ru.acad.bg/cst04/Docs/sIV/428.pdf (accessed 24 Sept 2006).

Goldfarb C. F. (2003). *White paper – The topic maps handbook*, Empolis, http://www.empolis.com/downloads/empolis_TopicMaps_Whitepaper20030206.pdf

Griffiths, D. (2004). *UNFOLD: Participate in creating the next generation of eLearning*. LCCN Newsletter 8th issue, Available online at: http://www.learningcitizen.net/articles/UNFOLDparticipateinc.shtml (accessed 28 June 2006).

Grønmo, G.O. (2006). *Creating semantically valid topic maps.* Available: http://www.ontopia.net/topicmaps/materials/tm-schemas-paper.pdf

Gutwin, C. and Greenberg, S. (2001). *A descriptive framework of workspace Awareness for real-time groupware*, Computer Supported Cooperative work (CSCW). The Journal of Collaborative Computing, Kluwer Academic Press.

Harrow, A. J. (1972). *A taxonomy of the psychomotor domain*. New York: David McKay Co.

Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). *Instructional media and technologies for learning 7th edition*. Merrill Prentice Hall. ISBN 0-13-030536-7.

HiNT – SNN (2006): *Evalueringsplan*. The University College of Nord-Trøndelag, Norway.

Hjeltnes, F. (2006). *Topic maps*. Master Thesis, The Department of Computer and Information Science, Norwegian University of Science and Technology.

Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations (2nd edition*). Saga Publications, Inc. ISBN 0-8039-7323-3

IMS Learning Design (2003). *Learning Design Specification*. Available online at: http://www.imsglobal.org/learningdesign (accessed 28 June 2006).

ISO/IEC 13250 (2003) *Topic Maps*. ISO; the International Organization for Standardization, IEC; the International Electro technical Commission form the specialized system for worldwide standardization.

JISC (2004). *Effective Practice with E-learning*. HEFCE (Higher Education Funding Council for England). Available online at: http://www.jisc.ac.uk/uploaded_documents/jisc%20effective%20practice3.pdf (accessed 22 November 2006).

Johnson, M., Liber, O., Wilson, S., Sharples, P., Milligan, C., Beauvoir, P. (2006). "*Mapping the future: The personal learning environment reference model and emerging technology*". ALT-C 2006 The next generation Research proceedings. ISBN 0-9545870-5-7

Koschmann, T. (1996). *CSCL: Theory and Practice of an emerging Paradigm*. Southern Illinois University, ISBN 0805812463.

Kolås, L. (2005). *Variation and Reusability in E-learning: not Compatible*? E-learn 2005 Proceedings. AACE.

Kolås, L. (2006). *Topic maps in e-learning: An ontology ensuring an active student role as producer*. E-learn 2006 Proceedings. AACE.

Kolås, L. (Forthcoming). *The e-learning circle - A holistic approach to next generation e-learning*. Submitted to an international journal.

Komáromi, L., Bardocz, A., Zárda, S. (2006). *Quality Assurance Systemin E-learning*. Project QUIS: QUality, Interoperability and Standards in e-learning, Agreement n. 2004 -- 3538 /001 -- 001 ELE--ELEB14. The TISIP Research Foundation, Trondheim.

Koper, R. (2001): *Modeling units of study from a pedagogical perspective – the pedagogical metamodel behind EML*. http://eml.ou.nl/introduction/docs/ped-metamodel.pdf

Kratwohl, D.R., Bloom, B. S., and Masia, B. B. (1964). *Taxonomy of educational objectives, Handbook II: Affective domain*. New York: David McKay Company, Inc. ISBN 0-679-30210-7, 0-582-32385-1

LAMS (2006). *LAMS International*. http://www.lamsinternational.com/

Lauvås, P. (2003). *Vurdering for læring - viktigere enn eksamen (vurdering av læring).* Fredrikstad : Høgskolen i Østfold. http://klaff.hiof.no/~pla/Formativ-vurdering-hiof.htm (accessed 02 October 2006).

Mace, R. *About Universal Design*, The Center for Universal design at the North Carolina State University. http://www.design.ncsu.edu/cud/about_ud/about_ud.htm (accessed 14 September 2006).

McGhee, R. and Kozma, R. (2003). *New Teacher and Student Roles in the Technology-Supported Classroom*. Available: http://edtechcases.info/papers/teacherstudentroles.pdf

MECA-ODL (2002). *Methodological Guide for the Analysis of Quality in Open and Distance Learning delivered via Internet.* http://www.adeit.uv.es/mecaodl (Accessed 01 September 2006).

O'Reilly, T. (2005). *What is Web 2.0? Design Patterns and Business Models for the Next Generation of Software.* http://www.oreillynet.com/lpt/a/6228 (Accessed 05 September 2006).

Park, J.(ed), Hunting, S. (2003). *XML Topic Maps: Creating and using topic maps for the Web*. ISBN 0-201-74960-2, Addison-Wesley.

Pepper, S. & Moore, G. (ed.) (2001). *XML Topic Maps (XTM 1.0)*. Topic Maps.Org http://www.topicmap.org/xtm

Pepper, S. (2002). *The TAO of Topic maps – Finding the way in the Age of Infoglut*. Ontopia, available: http://www.ontopia.net/topicmaps/materials/tao.html

Reload (2006). Reload – reusable eLearning object Authoring and Delivery: Learning Design Editor and Player. http://www.reload.ac.uk/

Robertson, J. & Robertsen, S. (2005), *Volere requirements Specification Template*, edition 10.1, http://www.systemsguild.com/GuildSite/Robs/Template.html

Rosvoll, S., Staupe, A., Kolås, L. (2006). *Learning objects – A proposal for a new learning metadata standard using design patterns.* Project QUIS: QUality, Interoperability and Standards in e-learning, Agreement n. 2004 -- 3538 /001 -- 001 ELE--ELEB14. Available: http://www2.tisip.no/quis/

Simpson, E. J. (1972). The *Classification of Educational Objectives in the Psychomotor Domain. The Psychomotor Domain*. Washington DC: Gryphon House.

TM4J (2006). *TM4J – Topic Maps for Java*. http://tm4j.org/

TM4Web (2006). *TM4Web – Topic Maps for Web*. http://tm4j.org/tm4web.html

Traxler, J. (2006), *The evaluation of next generation learning technologies: the case of mobile learning*, ALT-C 2006 The next generation Research proceedings. ISBN 0-9545870-5-7

Vavik, L. (2004). *Perspektiver på samarbeid og veiledning i nettbaserte læringsomgivelser* in: Sigmundson, Hermundur & Finn Bostad (Red.), Læring. Grunnbok i læring, teknologi og samfunn. Universitetsforlaget. Kap 6, ISBN 8215006302.

Appendix

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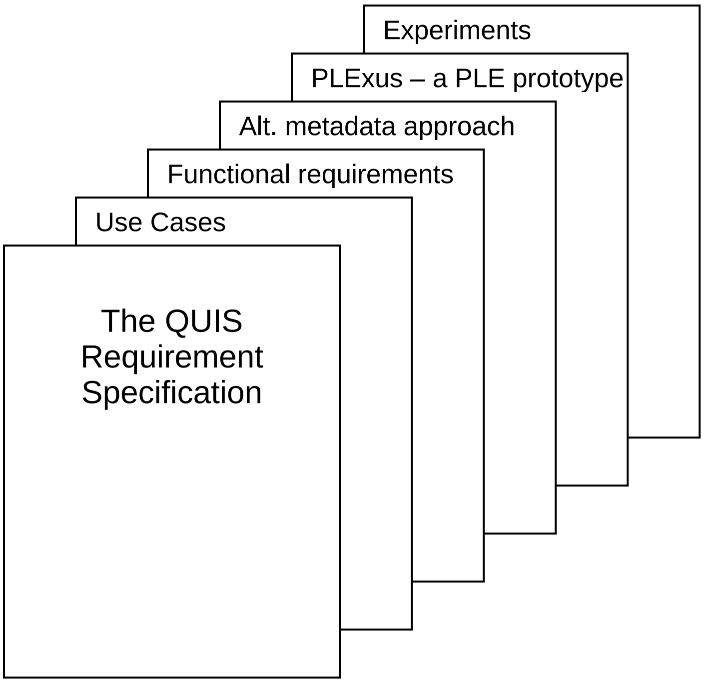

Appendix I:

Use cases

The list of uses cases has ca 30 use cases described. All use cases are described from both the student and the teacher perspective.

The use cases are based on the ten categories of pedagogical methods [Heinich et al., 2002]: Drill, presentation, tutorial, gaming, demonstration, discovery, simulation, discussion, cooperative learning and problem solving. In addition there are use cases covering collaborative annotation of tags, assessment and meta-learning.

The template:

The template used describing the use cases is inspired by the Volere requirement specification template [Robertson, 2005]:

- Use case number
- Use case title
- User name
- Description
- Fit criterion
- Scenario

Explanation of terms:

Use case number:
Each use case has a unique number. The use cases that are connected to each other (described with two perspectives (student and teacher perspective) has the same main number, but different decimals, e.g. Use case nr 1.1 Drill and Practice (student perspective) and Use case nr 1.2 Drill and practise (teacher perspective).

Use case title:
A short, descriptive title of the use case.

User name:
Description of user (online student or online teacher).

Description:
A one sentence summary of the requirement.

Fit criterion:
An objective measure of the meaning of the use case.

Scenario:
A description of how the user will experience the system in each use case.

Table of content:

Use case 1.1: Drill and Practice (student)

User name: Online student

Description: Learning English grammar through drill and practice.

Fit criterion:
The student must have access to a set of drill & practice learning activities; s/he must have the possibility to select one of them and perform it; after a drill & practice learning activity, the student must get feedback. The student also must have access to a drill & practice learning activity editor, in order to have the possibility of modifying an existing drill & practice learning activity or add a new one in the system.

Scenario:
The student logs into the system and want to learn about English grammar. S/he gets access to several learning activities with the same learning objective, but based on different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he chooses a drill learning activity.

S/he gets three choices:
1. To run a pre-made drill & practice learning activity (produced by fellow students or a teacher).

2. To modify an existing drill & practice learning activity (e.g. change or expand).

3. To produce a new drill & practice learning activity (basically the student will use the same tools as the teacher and step through the same phases as the teacher do, while producing drill & practice learning activities, see use case 1.2). In principle the resulting learning activity is not made available to other students until it has passed some a validation process (conducted by the teacher). There is, however, the possibility that it is stored in a temporary/limited public repository to be preliminary made available, while waiting for validation.

The online student chooses to go through a pre-made drill & practice learning activity where s/he steps through the phases of questions, answers and feedback.

At the end of the activity the student is directed back to the higher level menu in the e-learning system (where another learning activity can be started).

Use case 1.2: Drill and practice (teacher)

Username: Online teacher

Description: The teacher produces a learning activity, teaching English grammar, based on the drill & practice method.

Fit criterion:
The teacher must have access to a drill & practice editor, to have the possibility of defining a learning activity applying the drill and practice method and make it available to students, via an appropriate repository.

Use case scenario:
The teacher wants to teach English grammar, by preparing a drill and practice learning activity.

S/he opens the “learning activity wizard” and gets to choose wizards based on ten different methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning} [Heinich et al. 2002]. S/he chooses the “drill and practice” wizard.

The teacher gets two choices:
1. Modify already existing drill & practice learning activity
2. Create a new drill & practice learning activity

S/he chooses to create a new drill & practice learning activity.

S/he has to state the learning objective, and chooses “skill” from {skill, knowledge, attitude, meta-learning}. S/he chooses Dave’s taxonomy [Dave, 1970], from {Dave, Harrow [1972], Simpson [1972]…}, then marking the precision skill level from {Imitation, Manipulation, Precision, Articulation, and Naturalization}. The system then provides a form to state the learning objective/s in free text and preferably by using the provided verbs of the chosen taxonomy level (in order to enhance the measurability of the learning objective/s). In this case the verbs connected to the precision level of Dave’s taxonomy will be provided to the teacher { demonstrate, complete, show, perfect, calibrate, control}.

The teacher must also state what context the learning activity will be used in, by selecting values from a vocabulary that is partly internationally standardized, partly self-defined, e.g. study program {bachelor, master, PhD…}, field {English as second language, …} and subject {Grammar, History, Culture, …}.

The drill & practice wizard allows specifying a drill-exercise out of a set of predefined exercise-types {memory, matching couples, true/false, fill in blanks in a sentence, select a single choice, select multiple choices, drag and drop}. Different choices at this stage give rise to different interfaces.

The teacher chooses "fill in blanks in a sentence" and chooses text as media type from {text, audio, video…}. S/he gets access to a tool similar to a word processor, where s/he is able to write a paragraph. After saving the paragraph s/he is able to mark words (e.g. verbs, prepositions) that should be hidden by the system when presenting the exercise to the student. The student is supposed to match such hidden words during the exercise.

Depending on system support, the teacher might have the possibility to specify several correct synonyms and several incorrect answers for the same word, to allow that some answers are not unique. The student will be asked to fill in a blank by direct writing or by selection from a menu showing possible choices.

The teacher now has to state what kind of feedback the student should get {Grading from the number of exact/incorrect answers, weights for each answers, written feedback, aural feedback…}.

The teacher then saves the new learning activity in a learning activity repository and activates the learning activity to the students.

Examples of exercises connected to the different levels of Dave's taxonomy [1970]:

- *Imitation:*
    - *Read a short English text and write the same text from memory.*
    - *Listen to recordings in English and imitate.*
- *Manipulation:*
    - *Give instructions about some grammar rules; then present the student with some examples of according sentences and ask her/him to apply the above grammar rules to write similar but not equal sentences.*
- *Precision:*
    - *Ask the student to write a short story on a given theme. Review the text and ask the student to rewrite. Repeat until the student masters this type of writing.*
- *Articulation:*
    - *Ask the student to write a short paper on a given subject. Other students are encouraged to give feedback.*
- *Naturalization:*
    - *The students will randomly be picked and supposed to on a short notice talk about a given theme.*

Use case 2.1: Presentation (student)

Username: Online student

Description: Learning theme x using presentation as method.

Fit criterion: The system must provide opportunities for the student to watch and produce different types of presentations.

Use case scenario:
The student logs into the system and want to learn about theme x. S/he gets access to several learning activities with the same learning objective, but based on different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he chooses a presentation learning activity.

S/he gets three choices:
1. To watch a pre-made presentation (produced by fellow students or the teacher).

2. To modify an existing presentation.

3. To produce a new presentation learning activity (basically the student will use the same tools as the teacher and step through the same phases as the teacher do, while producing a presentation learning activity, see use case 2.2). In principle the resulting learning activity is not made available to other students until it has passed some a validation process (conducted by the teacher). There is, however, the possibility that it is stored in a temporary/limited public repository to be preliminary made available, while waiting for validation.

The student chooses to watch a pre-made presentation based on the content created by the teacher, the student chooses how s/he wants theme x to be presented (the choices are presented based on e.g. technical issues like bandwidth and based on prior knowledge of the student), e.g. synchronous or asynchronous presentation. The student chooses an asynchronous presentation and gets to choose between:

- Text presentation (linear text)
- Hypertext presentation
- Mind map presentation
- Concept map
- Slide presentation
- Aural presentation
- Video presentation (with speech recognition it is also possible to add subtitles)
- Role-play presentation
- Map (via a geographical information system).

The system presents a specific (personalized) view of the presentation.

The student chooses between different levels of granularity (e.g. a high-level description of the presentation, or detailed visualisations).

After the presentation the student can rate the presentation as clear /difficult / rate learning outcome etc. and then move on to other learning activities.

Use case 2.2: Presentation (teacher)

Username: (Novice) online teacher

Description: Teaching a cognitive learning objective (knowledge), using presentation as a pedagogical method to reach the comprehension level [Bloom, 1956].

Fit criterion: The system must provide opportunities for the teacher to create different types of synchronous and asynchronous presentations.

Use case scenario:
The (novice) online teacher logs into the system and wants to prepare a learning activity theme x. S/he opens the "learning activity wizard" and gets to choose wizards based on ten different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}.

S/he opens the "presentation wizard" and has to state the learning objective in free text. S/he also has to state the learning objective type, and chooses "knowledge" from {skill, knowledge, attitude, meta-learning}. S/he chooses Bloom's taxonomy [Bloom, 1956], from {Anderson [2001], Bloom [1956]…}, then marking the comprehension level from {Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation}. The system then provides a form to state the learning objective/s in free text and preferably by using the provided verbs of the chosen taxonomy level (in order to enhance the measurability of the learning objective/s). In this case the verbs connected to the comprehension level of Bloom's taxonomy will be provided to the teacher {Explain in own words, give examples, summarize, reiterate, reword, critique, classify, illustrate, translate review, report, discuss, re-write, estimate, interpret, theorise, paraphrase, reference}.

S/he is then able to choose if the student is allowed to add (public) notes or ask questions during the presentation, and if the student is allowed to mark the presentation as clear / difficult / rate learning outcome etc. The teacher can decide if the student feedback should be available only to the teacher (which the teacher can use to improve the presentation) or available to all the students taking the course (to provide formative assessment and improve the meta-learning process of the students).

The teacher then chooses if s/he wants to create a synchronous or asynchronous presentation. The teacher chooses an asynchronous presentation and feeds the system with content:
- Text presentation (linear text)
- Hypertext presentation
- Mind map presentation
- Concept map
- Slide presentation
- Aural presentation
- Video presentation (with speech recognition it is also possible to add subtitles)
- Role-play presentation
- Map (via a geographical information system).

(The system encourages filling in all the content, but it is not mandatory – s/he can choose what presentation types s/he wants to use.) The system is able to translate some of the presentation input data to other types e.g. from role-play to text presentation with speech recognition.

The teacher is encouraged to mark the different sections of the presentation based on different levels of granularity. The system saves the content using a syntax (e.g. theme maps) that makes it possible for the system to present the content in several personalized views.

Use case 3.1: Tutorial (student)

User name: Online student

Description: Learning a theme through a tutorial.

Fit criterion:
Access must be given to the tutorial learning activity; presentation part and following assessment part must be provided; there must be an evaluation of the assessment part such that the student can be addressed to the following learning activities or be submitted with an iteration “deepening presentation part”-“assessment part”, as provided by the learning activity definition.

Use case scenario:
The student logs into the system and want to learn about English grammar. S/he gets access to several learning activities with the same learning objective, but based on different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he chooses a tutorial learning activity.

The student accesses the tutorial learning activity and a presentation part followed by an assessment part (possibly randomly generated by the system and automatically corrected) is proposed to the student. After the assessment part, based on the evaluation of the student's work, the system computes:
- Feedback (explanation of the results).
- A "proceeds status", expressing how the tutorial is going to proceed:
    - if the assessment is positive, the student can “pass” the learning activity and proceed for the next learning activity in her/his course;
    - if the assessment is negative, the student is presented with a supplementary presentation part (one out of those prepared in the learning activity, to deepen the explanation of certain aspects of the learning activity’s teaching content); then the student is presented with a new assessment part, of the same kind as the failed one. This will be repeated until the student passes.

Use case 3.2: Tutorial (teacher)

User name: Online teacher

Description:
Teach a subject with knowledge as learning objective by using tutorials as teaching method.

Fit Criterion:
The system must make it possible for the teacher to create a tutorial learning activity based on several presentations and assessments, and the system must compute if the student's assessment result requires a new presentation / assessment or if the result was satisfying.

Use case scenario:
The online teacher logs into the system and wants to prepare a learning activity with a cognitive learning objective (knowledge). S/he opens the "learning activity wizard" and gets to choose wizards based on ten different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}.

S/he opens the "tutorial wizard" and has to state the learning objective type, and chooses "knowledge" from {skill, knowledge, attitude, meta-learning}. S/he chooses Bloom's taxonomy [Bloom, 1956], from {Anderson [2001], Bloom [1956]…}, then marking the comprehension level from {Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation}. The system then provides a form to state the learning objective/s in free text and preferably by using the provided verbs of the chosen taxonomy level (in order to enhance the measurability of the learning objective/s). In this case the verbs connected to the comprehension level of Bloom's taxonomy will be provided to the teacher {Explain in own words, give examples, summarize, reiterate, reword, critique, classify, illustrate, translate review, report, discuss, re-write, estimate, interpret, theorise, paraphrase, reference}.

The "tutorial wizard" is divided into two main parts, the presentation part and the assessment part, and the teacher first prepares the presentation part.

The teacher gets two choices:
1) To add a presentation from a learning object / learning activity repository (The system then provides means to select learning objects (from a repository or from the teacher's computer) according to the stated learning style and knowledge levels).
2) To create a new presentation.

S/he chooses to create a new presentation, and the system displays available tools to compose new presentation learning activity (See use case 2.2)

The wizard then proposes to the teacher to create additional presentations on specific sub themes, which may be submitted to the students that fail the assessment part.

After the presentation is created the system provides a form to set up a progressive assessment of the student; the assessment is managed through questions (which the teacher is invited to define).

The "assessment editor" provides different types of tests {matching, true/false, complete sentence, select single choice, select multiple choices...}.
If automated correction is wanted the teacher must define the correct answers, in addition to hints / help connected to false answers. In case of negative assessment, the system must determine which sub themes are to be re-explained using some of the additional presentation parts.

"The assessment editor" provides guidance to the teacher according to the levels of Blooms taxonomy (making sure that the assessment part fits the presentation part) and to different intelligences {visual, verbal, logical, kinaesthetic, musical, interpersonal, intrapersonal, naturalistic}.

The system proposes to put the new "tutorial" learning activity made by the teacher in the learning activity repository, and the teacher accepts this.
The system automatically fills in a metadata form based on information about:
- Time,
- Author,
- Heading of presentation,
- Choice of teaching method,
- Level of taxonomy covered,
- Set of learning objects involved,
- Learning objectives.

The teacher has to accept or make changes to the proposed metadata.

The teacher is invited to add extra metadata e.g. what kind of intelligences [Gardner, 1985] the learning activity covers {visual, verbal, logical, kinaesthetic, musical, interpersonal, intrapersonal, naturalistic}; proficiency stages (novice, advanced beginner, competence, proficiency, expert) etc.

Use case 4.1: Game (student)

Username: Online student

Description: Learning a skill using gaming as a pedagogical method.

Fit criterion:
The system must allow the student to be both the consumer and producer of learning activities based on different categories of games (adventure games, business games, board games, combat games, logical games and word games [Alessi & Trollip, 2001]).

Use case scenario:
The student logs into the system and plans to work with theme x. The student chooses the learning activity about theme x marked “board game”.

The student completes the board game individually, using books, the internet etc for help.

After completing the board game, the student gets three choices:
- To finish the learning activity
- To create a new board game
- To expand the existing board game.

The student chooses to expand the existing board game, and the system opens a board game editor where the student gets two choices:
- To expand the existing board game according to the existing rules.
- To expand the existing board game adding a new "level" with new rules, where the student gets access to the same tools as the teacher (see use case 4.2).

The student chooses to expand the existing board game according to the existing rules. S/he gets access to the specific board game tool and fills in the information to expand the board game (e.g. adding new questions and answers, adding new categories of questions and answers).

When s/he is done expanding the board game, s/he gets an option to leave the new learning object in an open learning object repository (accessible for other students), and also an option if s/he wants the teacher to quality assure and add the learning object to the course material.

Use case 4.2: Game (teacher)

User name:
Online teacher

Description:
Teach a subject with skill as learning objective by using gaming as teaching method to reach the manipulation level [Dave, 1970].

Fit Criterion:
The system must let the teacher be able to define learning activities based on different categories of games (adventure games, business games, board games, combat games, logical games and word games [Alessi & Trollip, 2001]).

There should exist a "game editor" to support the development of such games. A game editor is a tool that defines the general environment for a certain game type. For instance, in the same "board game" category there might be different board game types, with a variety of input data sets and interaction ways, e.g. written input, audio input, kinaesthetic input; consequently different tools for different board games might be needed.

Use case scenario:
The online teacher logs into the system and wants to prepare a learning activity with a psychomotor learning objective (skills).

S/he opens the "learning activity wizard" and gets to choose wizards based on ten different methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he chooses the "game wizard", and has to state the learning objective type, and chooses "skill" from {skill, knowledge, attitude, meta-learning}. S/he chooses Dave's taxonomy [Dave, 1970], from {Dave, Harrow [1972], Simpson [1972]…}, then marking the manipulation level from {Imitation, Manipulation, Precision, Articulation, and Naturalization}.

The system then provides a form to state the learning objective/s in free text and preferably by using the provided verbs of the chosen taxonomy level (in order to enhance the measurability of the learning objective/s). In this case the verbs connected to the manipulation level of Dave's taxonomy will be provided {re-create, build, perform, execute, implement}.

The teacher then must choose what kind game category s/he wants to use {adventure games, business games, board games, combat games, logical games, word games}. The teacher decides to produce a board game, and gets access to a list of suitable board game tools. S/he chooses board game editor x. The system then provides means to select resources from a repository, or from the teacher's computer, e.g. pictures, diagrams, video clips, audio clips, animations etc.

Then the game can be activated as a learning activity, including it into the student learning material. The system proposes to put the new "gaming" learning activity made by the teacher in the learning activity repository, and the teacher accepts this. The system fills in a metadata form based on information about time, author, choice of teaching method, level of taxonomy covered etc which the teacher has to accept (or modify).

Use case 5.1: Demonstration (student)

User name: Online student

Description: Learning a theme through demonstration.

Fit criterion:
The system must provide tools for the student to both watch demonstrations and to create own demonstrations.

Use case scenario:
The student logs into the system, and s/he wants to learn about theme x. The system presents several learning objects on the specific theme, based on e.g. different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}.

The student chooses the demonstration method, and gets two choices:

1. To watch a ready-made demonstration (video, screen capture, animation etc), prepared by e.g. the teacher. The student then chooses the screen capture learning object made by the teacher. The system runs the learning object. The student may now evaluate the learning object and the system provides some hints for further learning based on statistics of other students' behaviour in the system.

2. To create his own demonstration. The student gets access to the same wizard and tools as the teacher (see use case 5.2). After making the demonstration the system proposes to save the demo in an open student learning objects repository.

Use case 5.2: Demonstration (teacher)

User name: Online teacher

Description: Teaching a theme through demonstration

Fit criterion:
The system must provide tools to create different types of synchronous and asynchronous demonstrations.

Use case scenario:
The teacher logs into the system, and wants to prepare a learning activity using demonstration as pedagogical methods. S/he opens the "learning activity wizard" and gets to choose wizards based on ten different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}.

S/he opens the "demonstration tutorial" ", and has to state the learning objective type, and chooses "skill" from {skill, knowledge, attitude, meta-learning}. S/he chooses Dave's taxonomy [Dave, 1970], from {Dave, Harrow [1972], Simpson [1972]…}, then marking the Imitation level from {Imitation, Manipulation, Precision, Articulation, and Naturalization}.

The system then provides a form to state the learning objective/s in free text and preferably by using the provided verbs of the chosen taxonomy level (in order to enhance the measurability of the learning objective/s). In this case the verbs connected to the imitation level of Dave's taxonomy will be provided to the teacher {copy, follow, replicate, repeat, adhere}.

The teacher now gets two choices:
1. To create a synchronous demonstration (remote control / live session) or
2. To create an asynchronous demonstration (screen capture, animation, and video).

The teacher chooses asynchronous demonstration and screen capture. The screen capture tool is activated and the teacher is able to record his activities on the screen. The wizard gives suggestions and ideas (time length etc). Afterwards s/he gets the option if s/he wants to add an audio recording and / or text information to the screen capture file.

The system proposes to put the new "demonstration" learning activity made by the teacher in the learning activity repository, and the teacher accepts this. The system fills in a metadata form based on information about time, author, choice of teaching method, level of taxonomy covered etc which the teacher has to accept (or modify).

Use case 6.1: Discovery (student)

User name: Online student

Description: Executing a discovery-based learning activity.
“The discovery method is a teaching strategy that proceeds as follows:
- Immersion in a real or contrived problem situation
- Development of hypothesis
- Testing of hypothesis
- Arrival at conclusion” [Heinich et al., 2002].

Fit criterion:
The student must have the possibility to have gradual access to the various parts of the learning activity: first get access to problem description, and then be able to develop a hypothesis. The system must provide tools like surveys, vote-tools, statistical tools, online library (e.g. statistical databases), encyclopaedias, computer-based laboratories etc. in the phase of testing the hypothesis. Finally the system must provide tools to the student to express, save and submit for assessment the findings and conclusions.

Use case scenario:
The student logs into the system and want to learn about English grammar. S/he gets access to several learning activities with the same learning objective, but based on different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he chooses a discovery learning activity.

The student accesses the discovery learning activity and is proposed with the initial content: the introduction to a real or contrived problem situation. This can be presented as either a:
- multimedia-based experience: the student is exposed to the experience and then s/he is given the possibility to:
  - either state an observation (textual description to be submitted for further evaluation),
  - or to have an observation suggested by the system; further observations will be suggested on demand, according to their relations (as possibly specified by the teacher in the definition of the learning activity);
- problem statement:
  The statement is given to the student and the student can
  - either propose a hypothesis: in this case s/he is challenged to describe textually the hypothesis and can then
    - Test the hypothesis.
    - Get a suggestion about a general way to test the own-proposed hypothesis.
  - or get access to a list of possible hypothesis prepared by the teacher; in this case the student can
    - Select one of the possible hypothesis and do the testing of the chosen hypothesis on her/his own;
    - Get (on demand) a suggestion of principles and procedures about how the selected hypothesis can be tested; and then do the testing.

During the process of testing the hypothesis the student has access to:

- ready-made information resources (prepared by the teacher),
- online libraries for information searches (e.g. online encyclopaedias, statistical databases),
- communication with the teacher via synchronous and asynchronous communication tools,
- statistical tools,
- computer-based laboratories.

The student saves the testing results in the system.

The student then has to express textually her/his findings and conclusions, and if required submit the findings and conclusions for assessment.

Use case 6.2: Discovery (teacher)

User name: Online teacher

Description:
Teach a subject with knowledge as learning objective by using discovery as teaching method.

Fit Criterion:
The system must make it possible for the teacher to prepare a learning activity based on the discovery learning method: preparation of an experience, which the students will observe; preparation of the problem statement, with suggestions for possible solutions and suggestions of methods to evaluate the solutions.

Use case scenario:
The online teacher logs into the system and wants to prepare a learning activity in the discovery pedagogical method. S/he opens the "learning activity wizard" and gets to choose wizards based on ten different methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he chooses the "discovery wizard", and has to state the learning objective type, and chooses “knowledge” from {skill, knowledge, attitude, meta-learning}. S/he chooses Bloom’s taxonomy [Bloom, 1956], from {Anderson [2001], Bloom…}, then marking the synthesis level from {Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation}.

The system then provides a form to state the learning objective/s in free text and preferably by using the provided verbs of the chosen taxonomy level (in order to enhance the measurability of the learning objective/s). In this case the verbs connected to the synthesis level of Bloom’s taxonomy will be provided to the teacher {categorize, combine, create, design, modify, reconstruct, develop, plan, build, create, design, organise, revise, formulate, propose, establish, assemble, integrate, re-arrange}.

The discovery learning activity wizard is based on the following steps in the:
- Immersion in a real or contrived problem situation
- Development of hypothesis
- Testing of hypothesis
- Arrival at conclusion.

The teacher has to decide how the problem description should be presented to the student, and get to choose one or several of the following choices:
- Text
- Audio
- Video
- Animation
- Illustration.

The teacher then gets to choose if s/he wants to prepare:
- A list of possible hypothesis (in case the student likes to have suggestions)
- Suggestions about how to test the hypothesis

- Suggestions about how to test a hypothesis “in general terms”: this is supposed to cover the case in which the student devised an own hypothesis instead of selecting one out those listed by the teacher.
- A library of information resource (links, learning objects etc) connected to the specific problem description.
- Toolkit of hypothesis testing tools; e.g. surveys, vote-tools, statistical tools, online library (e.g. statistical databases), encyclopaedias, computer-based laboratories.
- Communication channels (synchronous and asynchronous) to ensure communication between student and teacher if necessary.
- A “submit” possibility if the student’s findings and conclusions should be assessed by the teacher.

Use case 7.1: Simulation – knowledge (student)

Username: Online student

Description: Learning about the laws of dynamics through a simulation.

Fit criterion: The system must provide tools to the student to perform teacher-prepared simulations, in addition to providing simulation production tools.

Use case scenario:
The student logs into the system. S/he wants to learn more about the laws of dynamics and their usage.

S/he gets access to several learning activities with the same learning objective but based on different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he chooses a simulation learning activity.

S/he then creates a "learning flow" (workflow) of several learning activities (drag and drop from a learning activity toolkit) based on conscious choices (learning objectives, intellectual stages, multiple intelligences etc) which s/he wants. The system will control that the learning flow is valid.

The student gets to choose between different types of simulations {physical, iterative, procedural, situational simulations} [Alessi & Trollip, 2001]. S/he chooses the physical simulation learning activity and gets access to a tool where s/he is assigned an environment of a physics experiment. The simulated environment happens to be on an unknown planet with unknown physical constants. His / her task is to design and carry out experiments appropriate to establish the unknown constants. There are some noises inserted in the measures so the student has to apply some statistic computations to establish the constants.

After finishing the learning activity, the student gets three choices:
- To finish the learning activity.
- To expand the existing learning activity.
- To produce a new simulation learning activity (basically the student will use the same tools as the teacher and step through the same phases as the teacher do, while producing simulation learning activities, see use case 7.2).

S/he chooses to expand the existing learning activity and gets the options:
- Add annotations
- Ask questions to the teacher.
- Ask questions to fellow students.
- Write FAQ.
- Write summary.
- Etc.

S/he chooses to add annotations stating what s/he perceived as difficult.

When s/he is done expanding the simulation learning activity, s/he gets an option to leave the expanded learning activity in an open learning activity repository (accessible for other students), and also an option if s/he wants the teacher to (quality assure) the learning activity and add it to the course material.

S/he chooses to leave the expanded learning activity in an open learning activity repository and s/he also submits the expanded learning activity to the teacher to be quality assured.

S/he then logs out of the system.

Use case 7.2: Simulation – knowledge (teacher)

Username: Online teacher

Description: Teaching the law of dynamics (cognitive domain: application level) using simulation as pedagogical method.

Fit criterion: The system must provide tools to produce different types of simulations (physical, iterative, procedural and situational simulations).

Use case scenario:
The teacher wants to teach the laws of dynamics and their usage to a student of first year of University.

S/he opens the "learning activity wizard" and gets to choose wizards based on ten different methods (drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning). S/he opens the "simulation wizard". S/he then chooses learning objective “knowledge” from {skill, knowledge, attitude, meta-learning}. S/he then chooses taxonomy “Bloom” from {Bloom, Anderson…}, then choosing the “application” level from {Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation}. S/he must specify what type of simulation s/he wants to use: {physical, iterative, procedural, situational simulations} [Alessi & Trollip, 2001].

S/he chooses physical simulation and gets access to a number of physical simulations editors. S/he chooses a tool where s/he is able to create an environment of a physics experiment and where s/he can change the general physics parameters of the simulated world/experiment (gravity, air pressure, temperature …). Then s/he is able to insert 3D (or 2D) objects in the simulation (cannon, ball, target, hills ….).

After saving the experiment definition s/he is able to set up a set of hidden parameters (gravity) that the student will have to find by calculating from data collected through the experiment. The teacher can also set up a set of “control variables” (e.g. cannon vertical angle) that the student can change to obtain the stated goal (e.g. hit the target). The teacher/system could insert some noise in the measures so that the student has to apply some statistics computations to fit the observed data with the physics formulas.

The teacher then saves the new learning activity in a repository and activates the learning activity to the students.

Use case 7.3: Simulation - skill (student)

Username: Online student

Description: Learn a skill (laparoscopy surgery) through a procedural simulation.

Fit criterion: The system must provide tools to the student to perform teacher-prepared procedural simulations, in addition to providing production tools for procedural simulations.

Use case scenario:
The student logs into the system and gets access to several learning activities with the same learning objective but based on different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he selects the simulation learning activity and gets access to the learning activity about laparoscopy surgery removing a "cyst in the kidney" as procedural simulation, which the teacher has provided into the system.

During this surgery simulation the system introduces a complication in the shape of decreasing blood pressure to a critical level. The student is supposed to react to the situation by finishing the surgery as fast as possible and asking the system to apply a blood transfusion. The system checks for proper execution of stitches and that bleeding is avoided both externally and internally.

After finishing the simulation learning activity, the student gets three choices:
- To finish the learning activity.
- To expand the existing learning activity.
- To produce a new simulation learning activity (The student will get access to the same production tools as the teacher, see use case 7.4).

S/he chooses to expand the existing learning activity. S/he can choose to expand by:
- Adding annotations stating what s/he perceived as difficult,
- Recording a student run of the simulation to create a demo,
- Asking questions to the teacher.
- Etc.

When s/he is done expanding the simulation learning activity, s/he gets an option to leave the new learning activity in an open learning activity repository (accessible for fellow students), and also an option if s/he wants the teacher to quality assure the learning activity and add it to the course material.

S/he chooses to leave the expanded learning activity in an open learning activity repository and s/he also submits the expanded learning activity to the teacher to be quality assured.

S/he then logs out from the system.

Use case 7.4: Simulation – skill (teacher)

Username: Online teacher

Description: Teaching a skill (laparoscopy surgery) using simulation as pedagogical method.

Fit criterion: The system must provide simulation tools to prepare procedural simulations.

Use case scenario:
The teacher wants to teach a third year university student laparoscopy surgery removing e.g. a cyst in the kidney.

S/he opens the "learning activity wizard" and gets to choose wizards based on ten different methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he opens the "simulation wizard", and has to state the learning objective type, and chooses “skill” from {skill, knowledge, attitude, meta-learning}. S/he chooses Dave’s taxonomy [Dave, 1970], from {Dave, Harrow [1972], Simpson [1972]…}, then marking the precision level from {Imitation, Manipulation, Precision, Articulation, and Naturalization}.

The teacher must specify what type of simulation s/he wants to create: {physical, iterative, procedural, situational simulations} [Alessi & Trollip, 2001]. S/he chooses a procedural simulation, and gets access to several procedural simulation editors. S/he chooses a medical simulation environment, with access to e.g. a laparoscopy surgery wizard.

The teacher chooses the part of the body s/he wants to simulate (kidney) and selects the laparoscopy surgery wizard, then places a cyst in the kidney to be removed by the student. Then s/he chooses the set of surgery tools the student should use. The surgery simulation wizard asks the teacher for patient characteristics, like gender, age, weight, height, blood pressure etc.

We assume that the surgery simulator properly simulates the life conditions of the patient during the surgery, and thus the student must finish the task without stressing the patient too much.

The system fills in a metadata form based on information about time, author, choice of teaching method, level of taxonomy covered etc which the teacher has to accept (or modify). The teacher then saves the new learning activity in a repository and activates the learning activity for the users.

Use case 8.1: Discussion (student)

Username: Online student

Description: Learning an affective learning objective through a discussion.

Fit criterion:
The system must provide tools for the student to attend in synchronous and asynchronous discussion learning activity, in addition to allow the student to start synchronous and asynchronous discussions outside specific learning activities.

Use case scenario:
The student logs into the system and sees that a synchronous discussion is planned. The system has suggested a time for the discussion based on data from the group members' calendars. The student is able to accept the suggested time, alternatively disapprove the suggested time, making the system look for another time. When all the group members have accepted the same time, each person's calendar will be notified and the system provides a reminder e.g. one day ahead of the discussion.

Before the discussion, the student must complete a pre-test created by the teacher.

The day of the discussion:
The student logs into the system and gets a reminder of the synchronous discussion. The system opens the "net meeting" application that makes sure all the right students get access to the right "group room". The students are able to see and hear each other.

Based on choices made by the teacher, the students get different roles in the discussion and they are encouraged to start with an individual pre vote (to be able to later measure if their attitude has changed).

After the discussion, the student must complete a post-test (similar to the pre-test).

The student is also able to start both synchronous and asynchronous discussions outside the specific discussion learning activities.

Use case 8.2: Discussion (teacher)

Username: Online teacher

Description: Teaching an affective learning objective using discussion as a teaching method.

Fit criterion:
The system must provide tools to create both synchronous and asynchronous discussion learning activities, in addition to intelligent calendar functionality.

Use case scenario:
The teacher logs into the system and wants to prepare a learning activity with an affective learning objective using discussion as pedagogical method to reach the learning objectives.

S/he opens the "learning activity wizard" and gets to choose wizards based on ten different pedagogical methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he opens the "discussion" wizard, and s/he states the learning goals of the session (to be displayed to the students) and also marks what learning objective type, taxonomy and level in taxonomy s/he would like to cover during the learning activity. The teacher chooses an affective learning objective and the "internalize values" level of the Kratwohl taxonomy [1964].

The system provides a tool for the teacher to prepare a pre- and post-test, measuring if attitude has changed. The tool provides the verbs connected to the chosen taxonomy level {act, display, influence, solve, practice…} to the teacher, as help to prepare the pre- and post-tests.

The wizard displays two choices: asynchronous and synchronous discussion. The teacher marks synchronous discussion, and then gets the following options:
- Video/audio discussion,
- Audio discussion,
- Text-based discussion.

The teacher marks video / audio discussion. Since this will be a synchronous discussion the teacher needs to state the time for the discussion, or make the system provide a planning tool for the students. (Alternative: the system suggests a time for the synchronous discussion based on data from the students' calendar).

The wizard requires that number of group members in a group is stated by giving a set of choices: the whole class, groups of x persons (fill in number). After the teacher chooses to have groups of five persons the system offers to randomly put the groups together from the list of students or let the teacher state what persons will be in each group. The teacher and marks "random organization" of the groups.

The wizard provides "best practice" hints that the teacher may skip or make use of, e.g.
- To ensure participation, the system suggests to start the discussion with a low-effort contribution and the teacher may choose a vote tool (and then needs to specify a statement to vote about), a yes or no-question, or a "agree / disagree tool".
- To help the socialisation process the system suggests that student presentations must be related to earlier experiences etc.

- Help group organizing: Distribute roles / responsibilities to the group members (e.g. leader of discussion, secretary who will take notes, observer assigned an observation task like “who are giving constructive feedback to other group members etc).

The system provides statistical results to the teacher after the students have completed the pre-test and the post-test.

Use case 9.1: Cooperative learning (student)

Username: Online student

Description: Learning theme x through a cooperative learning activity.

Fit criterion:
The system must provide both synchronous and asynchronous tools for the students to perform a cooperative learning activity.

Use case scenario:
The student logs into the system and knows from the semester plan that there will be organized a cooperative learning activity today.

S/he is presented to the group organization in the system, and gets access to the communication tool/s to use to get in touch with the other group members. This is decided by the teacher in advance.

In the online cooperative learning environment, the student together with the other group members get the group assignment (prepared by the teacher) announced.

When communicating with the other group members, planning the further work, the system provides project management tools, like milestone plans, brainstorming tools, to do list, mind map tools, concept map tools etc.

Working with the task, the system provides communication tools {instant messages, discussion forums, e-mail / asynchronous messages, audio / video conferences…} and group tools {group rooms, shared archives, version control of files, application sharing…}.

The user interface of the system also provides workspace awareness information related to the past and the present [Gutwin & Greenberg, 2002], so that the student can see what the other group members have done and what they are doing every time s/he logs into the system.

The system can also provide statistical results from the cooperative learning activity (how often where each student logged into the system, for how long where each person logged in, how many changes where made by each student, how many contributions have each student made in the discussion forum etc). This is helpful when the students evaluate the process of the cooperative learning activity.

Use case 9.2: Cooperative learning (teacher)

Username: Online teacher

Description: Teaching theme x using cooperative learning as pedagogical method.

Fit criterion:
The system must provide tools for the teacher to prepare a cooperative learning activity.

Use case scenario:
The teacher logs into the system. S/he opens the "learning activity wizard" and gets to choose wizards based on ten different methods {drill, presentation, tutorials, gaming, demonstration, discovery, simulation, discussion, problem solving and cooperative learning}. S/he chooses the "cooperative learning wizard".

The teacher has to state the learning objective type, and chooses “knowledge” from {skill, knowledge, attitude, meta-learning}. S/he then chooses taxonomy “Bloom” from {Bloom, Anderson…}, then choosing the “application” level from {Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation}.

The system then provides a form to state the learning objective/s in free text and preferably by using the provided verbs of the chosen taxonomy level (in order to enhance the measurability of the learning objective/s). In this case the verbs connected to the application level of Bloom’s taxonomy will be provided to the teacher {solve, apply, compute, demonstrate, use, apply, discover, manage, execute, solve, produce, implement, construct, change, prepare, conduct, perform, react, respond, role-play}.

S/he chooses type of group assignment;

- Teacher-made problem description
- Student-made problem description - leaving the student group with the task of defining the problem to solve.

In this case the teacher defines the group assignment.

The teacher also needs to specify how to define groups (teacher, system or students arrange grouping), what cooperative tools should be availably for the student groups (instant messages, forums, e-mail, audio / video conferencing, application sharing, shared archives etc). The teacher can also suggest some project management tools (e.g. shared calendar, mile stone plan, and project plan tool).

The teacher also has to mark what kind of statistical results s/he wants the system to provide during and after the cooperative learning sessions, and how the students can contact him/her.

Use case 10.1: Problem solving (student)

Username: online student

Description: Learning through problem solving.

Fit criterion: The system must provide tools to the student / student group to cover the needs of each phase of a problem solving learning process.

Use case scenario:
Based on a teacher-made progress plan of the subject s/he is studying, the online student knows that there will be a problem solving session today. The student logs into the system, and gets access to the problem description and gets to know who s/he is going to collaborate with.

The system provides a group room for the group where they can collaborate both synchronously (through e.g. chat / instant messages, video conference and application sharing) and asynchronously (through e.g. shared archives, discussion forums, message boards etc). The student take part in a synchronous video conference where the group discusses the problem description, formulates the initial learning needs and the group members divide tasks and responsibilities among the group members. The system provides project management tools (e.g. milestone plans, brainstorming tools, to do list, mind map tools, concept map tools etc). The group also plans the next group meeting using a project manager tool.

Then the students work individually with their tasks. The student needs in this phase to find out how to find information:
- Internet: search
- Library: search
- Tutors: tutor consulting
- Teacher: Consulting
- Other experts: Communication tools.

The process is then iterative: The group has several group meetings and the students work individually and / or in smaller groups in between the meetings until they finally find the most reasonable explanations / solutions / conclusions of the initial problem description.

The student group gets access to templates / masters describing how the finalized product should be handed in; this could be text document templates, video instructions / shooting script etc depending on what format the delivery should have.

Use case 10.2: Problem solving (teacher)

Username: online teacher

Description: Teaching a theme using problem solving as pedagogical method.

Fit criterion:
The system must provide tools to the teacher to support all phases of a problem solving learning process.

Use case scenario:
The teacher logs into the system and wants to prepare a learning activity using problem solving as pedagogical method to reach the learning objectives.

The teacher opens the "learning activity wizard" and gets to choose wizards based on ten different pedagogical methods {Drill, Presentation, Tutorials, Gaming, Demonstration, Discovery, Problem solving, Simulation, Discussion, Cooperative learning}. S/he opens the "problem solving wizard", and s/he states the learning objectives of the learning activity (to be displayed to the students) and also marks what learning objective type and level in taxonomy s/he would like to cover during the learning activity.

(Example: The Learning objectives:
- Skills: Learn to solve a medical problem (complete forms, operate instruments etc)
- Knowledge: Learn more about physiology, psychology …
- Attitude: Ethics / norms
- Meta-learning: Learn how to collaborate.)

The teacher must choose how the problem description should be stated:
- The teacher provides a problem description / problem case.
- The teacher allows the students to create their own problem descriptions. (The teacher must also specify if the student-made problem descriptions must be approved by the teacher).

The teacher can choose what media type s/he wants to use providing the problem {Textual description, add video recording, add audio recording, animation, illustration/image…}:
Example:
- Text: the patient has the following symptoms:
- Video: A video showing the patient talking to the doctor. The doctor asks how s/he feels, and the patient describes his symptoms.
- Audio recording: A patient describes his symptoms.
- Animation: Animation shows symptoms.
- Illustration / image: X-ray picture

The teacher is then asked to define groups of students. The teacher can choose if the groups are going to be defined manually (based on the student list) or automatically by the system (the teacher then must provide the number of students of a group).

The teacher then gets to choose if s/he wants to prepare:

- A library of information resource (links, learning objects etc) connected to the specific problem description.
- Group tools {progress / milestone tool, group rooms, shared archives, version control of files, application sharing…}.
- Communication channels (synchronous and asynchronous) to ensure communication between student and teacher / tutor if necessary.
- A “submit” possibility if the student’s findings and conclusions should be assessed by the teacher.

Use case 11.1: Collaborative annotations of tags (student)

Username: Online student

Description:
The students tag learning objects / learning activities to provide feedback to teachers and fellow students.

Fit criterion:
The system must allow both students and teachers to tag / mark the learning material and based on the marks the system must provide feedback / statistics to the teacher and the students.

Use case scenario:
The student is working with a learning activity in the system (see e.g. use case 1.1).

The student finds a learning object / activity that is annotated by the teacher and / or by fellow students. S/he can add hers/his new tags or use the available tags.

The student can search for themes tagged the same way, thus finding themes conceptually related to that one (the relation being defined by teachers and students) or s/he can look for "similar" themes, i.e. themes with a similar "set" of tags.

The student can also get immediate feedback on how his / her fellow students find the theme, e.g. "hard", "interesting" or ”boring".

If the student finds errors s/he can just add the "mistakes inside" tag to solicit the tutor for improvements.

Use case 11.2: Collaborative annotations of tags (teacher)

Username: Online teacher

Description:
The teachers prepares for collaborative annotations of tags of learning objects / learning activities to allow feedback to teachers and fellow students.

Fit criterion:
The system must allow teachers to choose if collaborative annotation of tags should be a mean to get feedback on the learning material and to share experience among the students.

Use case scenario:
The teacher creates a learning object / activity (see e.g. use case 1.2) and activates the learning object / activity in the e-learning system.

S/he adds tags (keywords) to the themes and asks the students to tag the themes in respect to a given set of keywords.

The keywords could convey different types of information:
- Properties of the theme: difficult to understand, hard exercise, too long, amusing, interesting etc.
- Concepts related to the theme (thus defining an implicit semantic of tags).

The students add new tags (or use the present tags) to annotate the learning material.

The teacher easily finds which themes s/he has to improve or which ones contain mistakes based on feedback and statistical information from the collaborative annotation of tags.

By looking at the number of students using tags s/he gets an idea of which additional material could help the students by filling gaps.

Use case 12.1: Assessment (student)

Username: Online student

Description: Assessment activity assessing the comprehension level of a cognitive learning objective (knowledge).

Fit criterion:
The system must validate the student id and then provide access to the assessment activity and the following feedback of the results.

Use case scenario:
The teacher has activated the assessment activity in the online student environment (see use case 12.2). Before the student starts the assessment activity, s/he has to validate that s/he is the right person to perform the assessment.

The student starts the assessment activity. A test is presented for the student, in this case a multiple choice test. After fulfilling the test s/he gets different types of feedback, e.g. the result showing how many and which goals of the learning activity s/he has reached, his / her achievement compared to the rest of the student group average etc.

Notes:
The tools used for assessment must be varied (beyond multiple choice tests), e.g. pre- / post-tests, logs, simulators, motion sensitive tools etc., dependent on the learning objective type and the learning objective level.
Example:

Learning objective type	Learning objective level	Examples of assessment tools
Skill	Imitation	Motion sensitive tools
Skill	Manipulation	Motion sensitive tools
Skill	Precision	Simulator, track tool
Skill	Articulation	Simulator, log
Skill	Naturalization	Simulator
Knowledge	Knowledge	MCQ, Memory, matching, true/false
Knowledge	Comprehension	MCQ, short answer, completion
Knowledge	Application	MCQ
Knowledge	Analysis	MCQ
Knowledge	Synthesis	MCQ, blog
Knowledge	Evaluation	Digital portfolio
Attitude	Receive	
Attitude	Respond	
Attitude	Value	Chat-log
Attitude	Organize values	Blog, discussion forum
Attitude	Internalize values	Pre/post survey tool

Use case 12.2: Assessment (teacher)

Username: Online teacher

Description: The teacher designs an assessment activity with questions attaining the desired taxonomy level of Bloom's taxonomy of the cognitive domain.

Fit criterion:
The system must allow the teacher to create assessment activities based on different learning objective types and different levels of well-known taxonomies (taxonomies for the cognitive domain [Bloom, 1956; Anderson, 2001…], taxonomies for the affective domain [Kratwohl, 1964…], and taxonomies for the psychomotor domain [Dave, 1970; Simpson, 1972; Harrow, 1972…]).

Use case scenario:
Each learning activity must have explicit learning objectives corresponding to one or more of the levels in one of the well-known taxonomies.

The teacher chooses a learning activity (e.g. a presentation learning activity, see use case 2.2) for which s/he wants to create an assessment. Based on the metadata produced as s/he created the learning activity (learning objective = (free text), learning objective type = knowledge, taxonomy level = comprehension) the system provides a set of assessment tools that are applicable {multiple choice questionnaire, short answer, completion…}

S/he chooses the multiple choice questionnaire and the system provides a template to fill in new questions and to fetch questions/answers from a local or a publicly available assessment activity repository. The system also provides the verbs connected to the specified level of the taxonomy {explain in own words, give examples, summarize, reiterate, reword, critique, classify, illustrate, translate review, report, discuss, re-write, estimate, interpret, theorise, paraphrase, reference}.

When the assessment activity is ready, the teacher can activate it to the student learning environment.

The teacher is also encouraged to publish the assessment activity in a public assessment activity repository.

Notes:
The quality of assessment tools is critical (e.g. for correct grading of exams), thus a quality system/process should be in place to verify the correctness of the learning activities/quizzes.

An anti-plagiarism tool must be available.

The tools used for assessment could be varied (beyond multiple choice tests), e.g. pre- / post-tests, logs, simulators, motion sensitive tools etc., dependent on the learning objective type and the learning objective level.

Example:

Learning objective type	Learning objective level	Examples of assessment tools
Skill	Imitation	Motion sensitive tools
Skill	Manipulation	Motion sensitive tools
Skill	Precision	Simulator, track tool
Skill	Articulation	Simulator, log
Skill	Naturalization	Simulator
Knowledge	Knowledge	MCQ, Memory, matching, true/false
Knowledge	Comprehension	MCQ, short answer, completion
Knowledge	Application	MCQ
Knowledge	Analysis	MCQ
Knowledge	Synthesis	MCQ, blog
Knowledge	Evaluation	Digital portfolio
Attitude	Receive	
Attitude	Respond	
Attitude	Value	Chat-log
Attitude	Organize values	Blog, discussion forum
Attitude	Internalize values	Pre/post survey tool

Use case 13.1: Meta-learning (student)

Username: online student

Description: The student has access to tools to improve their meta-learning skills before, during and after a learning activity.

Fit criterion:
The system must provide tools for the students to help improve the meta-learning process.

Use case scenario:
Meta-learning is the state of "being aware of and taking control of one's own learning" [Biggs 1985]. "Formative assessment means assessment for learning and is used to improve a student's learning process and learning outcome" [Lauvås, 2003].

The student logs into the system and gets access to a number of tools that will help improve his meta-learning process:

- Personal reflections tools: The student is encouraged / required to use blog, journal, process writing tool etc. as personal reflection tools.

- Learning management tools:
    - Brainstorming tool
    - Workflow tool
    - Learning path tools
    - Calendar
    - Reference manager tool
    - Address list
    - Etc.

- Assessment of the student's pre-qualifications: The student is encouraged / required to take a pre-test to diagnose his / her pre-qualifications in the subject. The results will also provide "reality information" to the student, telling him / her where pre-requirements are lacking. The results will also serve as information for the teacher preparing a differentiated learning environment.

- Mutual student assessment: The student is encouraged / required to provide feedback to fellow students and then receive feedback from fellow students. This can be valuable in a learning process.

- Self assessment: The student is encouraged / required to carry through self assessment / individual self-monitoring to check progress and to promote meta-learning skills. Self-assessment is hard to do, and the system provides help to the student in the self assessment process, e.g. by providing keywords, methods, techniques etc.

- Formative tests: The student is encouraged / required to carry through a formative test where the tests is a part of the learning process. The teacher does not have access to the results of the individual student, but has access to the average results.

- Visualize demands and criteria: The student is encouraged / required to assess last year's student reports / exam answers etc. Afterwards the student gets access to the grade (and comments) of the report /exam answers.

- Visualize progression: The teacher provides video clips, the first deliverable in the course etc. to let the student see own progression, which is motivating and valuable in the learning process [Lauvås, 2003].

The meta-learning tools are available to the student before, during and after the work of a learning activity or activated at specific times in the learning process by the teacher.

Use case 13.2: Meta-learning (teacher)

Username: Online teacher

Description: The system ensures that the teacher focuses on meta-learning as a learning objective, in addition to learning objectives like skill, attitudes and knowledge.

Fit criterion:
The system must provide meta-learning tools which the teacher actively can use in the online course.

Use case scenario:
The teacher gets via the learning activity wizard access to tools that help him focus not only on product objectives, but also process objectives. The teacher must specify meta-learning objectives as well learning objectives like skills, attitudes and knowledge.

The teacher is able to activate meta-learning tools like:

- Personal reflections tools: The student is encouraged / required to use blog, journal, process writing tool etc as personal reflection tools.

- Learning management tools:
    - Brainstorming tool
    - Workflow tool
    - Learning path tool
    - Calendar
    - Reference manager tool
    - Address list
    - Etc.

- Assessment of students' pre-qualifications: The result of a pre-test should diagnose the students' pre-qualifications in the subject and serve as information for the teacher preparing a differentiated learning environment, but also for "reality information" to the student, telling him / her where pre-requirements are lacking. In the future it will because of the Bologna process be easier for the students to take courses at other institutions / in other countries. This may cause that the student group's pre-qualifications in the subject will differ in a larger extent than earlier. To ensure that the learning environment will cover what the students need, an online pre-test in the subject could be helpful.

- Mutual student assessment: Giving feedback to fellow students and receiving feedback from fellow students can be valuable in a learning process.

- Self assessment: For individual self-monitoring and checking progress and to promote meta-learning skills. Self-assessment is hard to do, and the system must be able to provide help to the student in the self assessment process, e.g. provide keywords, methods, techniques etc.

- Formative tests: Tests where students uses tests as part of the learning process. The teacher does not have access to the results of the individual student, but has access to the average results.

- Visualize demands and criteria: It is important to try to describe the demands and the criteria of summative assessment, but this has only limited value. Other methods could be to hand out last years student reports / exam answers etc. and ask the students to assess these results. Then the students get access to the grade (and comments) of the report / exam answers.

- Visualize progression: It is motivating and valuable in the learning process to see your own progression. There is possible to plan for this, by keeping the first deliverable in the course, use video to film first try in professional training etc. [Lauvås, 2003], and then show this to the student in a later phase of the course.

The teacher is also able to connect meta-learning tools to each learning activity s/he creates.

Appendix II:

Functional requirements:

Categories of requirements:

1. Assessment
2. Content
3. Collaboration
4. Teaching
5. Student environment / learning environment
6. Quality assurance at the course level

The template used for writing requirements:

Requirement name:
Requirement #:
Requirement type:
Use case #:
Description:
Rationale:
Source:
Fit Criterion:
Conflicts:
Dependencies:

Explanation of terms:
Requirement #: a unique requirement number.

Use case: a user-defined piece of activity within the context of the product.

Description: A one sentence statement of the requirement's intention. The most common form of writing the description is: The product shall do a specific thing for a specific person.

Rationale: A justification of the requirement. The rationale explains why the requirement is considered to be important.

Source: Pointers to literature relevant for the requirement.

Fit criterion: A measurement of the requirement such that it is possible to test if the solution matches the original requirement (it is the criterion for evaluating whether or not a given solution fits the requirement. If a fit criterion cannot be adequately specified, then the requirement is ambiguous, or ill understood. If there is no fit criterion, then there is no way of knowing whether a solution meets the requirement).

Conflicts: Keeps track of other requirements that disagree with this one.
Dependencies: A list of other requirements that have some dependency on this one.

Content:

Category 1: Assessment

Requirement name: Assessment of knowledge level

Requirement #: 1.1.1

Use case #: 1.2, 3.2

Description:
Assessment of knowledge level (of the cognitive domain).

Rationale:
Bloom’s taxonomy of the cognitive domain consists of six levels: knowledge, comprehension, application, analysis, synthesis and evaluation.

The system should provide the opportunity to assess the knowledge level according to Blooms taxonomy of cognitive domain.

Examples of verbs to evaluate the knowledge level are: Reproduce, define, describe, identify, list, arrange, label, memorise, recognise, relate, select, state.

The system should help the producer of the assessment activity to cover each level specifically.

Source:
Anderson, L.W., & Krathwohl (Eds.). (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.

Bloom, Benjamin (Ed.) (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York; Toronto: Longmans, Green.

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system (e.g. multiple choice questionnaires, memory tests, matching testes, true/false tests etc.)?

Conflicts:
This requirement covers Bloom’s taxonomy, but also other taxonomies of the cognitive domain, e.g. Anderson’s taxonomy [Anderson & Krathwohl, 2001] could be used.

Dependencies:
4.2, 4.5, 1.1.2-1.1.6

Requirement name: Assessment of comprehension level

Requirement #: 1.1.2

Use case #: 2.2, 3.2

Description:
Assessment of comprehension level (of the cognitive domain).

Rationale:
Bloom’s taxonomy of the cognitive domain consists of six levels: knowledge, comprehension, application, analysis, synthesis and evaluation.

The system should provide the opportunity to assess the comprehension level according to Blooms taxonomy of cognitive domain.

Examples of verbs to evaluate the comprehension level are: Explain in own words, give examples, summarize, reiterate, reword, critique, classify, illustrate, translate review, report, discuss, re-write, estimate, interpret, theorise, paraphrase, reference.

Source:
Anderson, L.W., & Krathwohl (Eds.). (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.

Bloom, Benjamin (Ed.) (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York; Toronto: Longmans, Green.

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system (e.g. multiple choice questionnaires, short answer tests, completion tests etc.)?

Conflicts:
This requirement covers Bloom’s taxonomy, but also other taxonomies of the cognitive domain, e.g. Anderson’s taxonomy [Anderson & Krathwohl, 2001] could be used.

Dependencies:
4.2, 4.5, 1.1.1, 1.1.3 – 1.1.6

Requirement name: Assessment of application level

Requirement #: 1.1.3

Use case #: 3.2, 7.1

Description:
Assessment of application level (of the cognitive domain).

Rationale:
Bloom's taxonomy of the cognitive domain consists of six levels: knowledge, comprehension, application, analysis, synthesis and evaluation.

The system should provide the opportunity to assess the application level according to Blooms taxonomy of cognitive domain.

Examples of verbs to evaluate the application level are: Solve, apply, compute, demonstrate, use, apply, discover, manage, execute, solve, produce, implement, construct, change, prepare, conduct, perform, react, respond, role-play.

Source:
Anderson, L.W., & Krathwohl (Eds.). (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.

Bloom, Benjamin (Ed.) (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York; Toronto: Longmans, Green.

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system (e.g. multiple choice questionnaires)?

Conflicts:
This requirement covers Bloom's taxonomy, but also other taxonomies of the cognitive domain, e.g. Anderson's taxonomy [Anderson & Krathwohl, 2001] could be used.

Dependencies:
4.2, 4.5, 1.1.1 – 1.1.2, 1.1.4 – 1.1.6

Requirement name: Assessment of analysis level

Requirement #: 1.1.4

Use case #: 3.2

Description:
Assessment of analysis level (of the cognitive domain).

Rationale:
Bloom’s taxonomy of the cognitive domain consists of six levels: knowledge, comprehension, application, analysis, synthesis and evaluation.

The system should provide the opportunity to assess the analysis level according to Blooms taxonomy of cognitive domain.

Examples of verbs to evaluate the analysis level are: Analyze, compare, contrast, identify, illustrate, break down, catalogue, quantify, measure, test, examine, experiment, relate, graph, diagram, plot, extrapolate, value, divide.

Source:
Anderson, L.W., & Krathwohl (Eds.). (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.

Bloom, Benjamin (Ed.) (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York; Toronto: Longmans, Green.

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system (e.g. multiple choice questionnaires)?

Conflicts:
This requirement covers Bloom’s taxonomy, but also other taxonomies of the cognitive domain, e.g. Anderson’s taxonomy [Anderson & Krathwohl, 2001] could be used.

Dependencies:
4.2, 4.5, 1.1.1 - 1.1.3, 1.1.5 – 1.1.6

Requirement name: Assessment of synthesis level

Requirement #: 1.1.5

Use case #: 3.2

Description:
Assessment of synthesis level (of the cognitive domain).

Rationale:
Bloom’s taxonomy of the cognitive domain consists of six levels: knowledge, comprehension, application, analysis, synthesis and evaluation.

The system should provide the opportunity to assess the synthesis level according to Blooms taxonomy of cognitive domain.

Examples of verbs to evaluate the synthesis level are: Categorize, Combine, create, design, modify, reconstruct, develop, plan, build, create, design, organise, revise, formulate, propose, establish, assemble, integrate, re-arrange.

Source:
Anderson, L.W., & Krathwohl (Eds.). (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.

Bloom, Benjamin (Ed.) (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York; Toronto: Longmans, Green.

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system (e.g. multiple choice questionnaires, blog etc)?

Conflicts:
This requirement covers Bloom’s taxonomy, but also other taxonomies of the cognitive domain, e.g. Anderson’s taxonomy [Anderson & Krathwohl, 2001] could be used.

Dependencies:
4.2, 4.5, 1.1.1 - 1.1.4, 1.1.6

Requirement name: Assessment of evaluation level

Requirement #: 1.1.6

Use case #: 3.2

Description:
Assessment of evaluation level (of the cognitive domain).

Rationale:
Bloom's taxonomy of the cognitive domain consists of six levels: knowledge, comprehension, application, analysis, synthesis and evaluation.

The system should provide the opportunity to assess the evaluation level according to Blooms taxonomy of cognitive domain.

Examples of verbs to evaluate the evaluation level are: Conclude, criticize, defend, discriminate, evaluate, review, justify, assess, present a case for, defend, report on, investigate, direct, appraise, argue, project-manage.

Source:
Anderson, L.W., & Krathwohl (Eds.). (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman.

Bloom, Benjamin (Ed.) (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York; Toronto: Longmans, Green.

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system (e.g. digital portfolio)?

Conflicts:
This requirement covers Bloom's taxonomy, but also other taxonomies of the cognitive domain, e.g. Anderson's taxonomy [Anderson & Krathwohl, 2001] could be used.

Dependencies:
4.2, 4.5, 1.1.1– 1.1.5

Requirement name: Assessment of receive level

Requirement #: 1.2.1

Use case #: --

Description:
Assessment of receive level (of the affective domain).

Rationale:
Krathwohl’s taxonomy of the affective domain has five levels; receive, respond, value, organize/conceptualize values, internalize / characterize values.

The system should provide the opportunity to evaluate the receive level according to Krathwohl’s taxonomy of the affective domain.

Examples of verbs to assess the receive level are: ask, listen, focus, attend, take part, discuss, acknowledge, hear, be open to, retain, follow, concentrate, read, do, feel.

Source:
Krathwohl, D.R., Bloom, B. S., and Masia, B. B. (1964). Taxonomy of educational objectives, Handbook II: Affective domain. New York: David McKay Company, Inc. ISBN 0-679-30210-7, 0-582-32385-1

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system?

Conflicts:
This requirement covers Krathwohl’s taxonomy, but also other taxonomies of the affective domain could be used.

Dependencies:
1.2.2 -1.2.5, 4.2

Requirement name: Assessment of respond level

Requirement #: 1.2.2

Use case #: --

Description:
Assessment of respond level (of the affective domain).

Rationale:
Krathwohl’s taxonomy of the affective domain has five levels; receive, respond, value, organize/conceptualize values, internalize / characterize values.

The system should provide the opportunity to evaluate the respond level according to Krathwohl’s taxonomy for the affective domain.

Examples of verbs to assess the respond level are: react, respond, seek clarification, interpret, clarify, provide other references and examples, contribute, question, present, cite, become animated or excited, help team, write, and perform.

Source:
Krathwohl, D.R., Bloom, B. S., and Masia, B. B. (1964). Taxonomy of educational objectives, Handbook II: Affective domain. New York: David McKay Company, Inc. ISBN 0-679-30210-7, 0-582-32385-1

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system?

Conflicts:
This requirement covers Krathwohl’s taxonomy, but also other taxonomies of the affective domain could be used.

Dependencies:
1.2.1, 1.2.3-1.2.5

Requirement name: Assessment of value level

Requirement #: 1.2.3

Use case #: --

Description:
Assessment of value level (of the affective domain).

Rationale:
Krathwohl’s taxonomy of the affective domain has five levels; receive, respond, value, organize/conceptualize values, internalize / characterize values.

The system should provide the opportunity to evaluate the value level according to Krathwohl’s taxonomy of affective domain.

Examples of verbs to assess the value level are: argue, challenge, debate, refute, confront, justify, persuade, criticise.

Source:
Krathwohl, D.R., Bloom, B. S., and Masia, B. B. (1964). Taxonomy of educational objectives, Handbook II: Affective domain. New York: David McKay Company, Inc. ISBN 0-679-30210-7, 0-582-32385-1

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system (e.g. discussion forum, blog, chat-log etc)?

Conflicts:
This requirement covers Krathwohl’s taxonomy, but also other taxonomies of the affective domain could be used.

Dependencies:
1.2.1, 1.2.1, 1.2.4, 1.2.5

Requirement name: Assessment of “organize / conceptualize values” level

Requirement #: 1.2.4

Use case #: --

Description:
Assessment of “organize / conceptualize values” level (of the affective domain).

Rationale:
Krathwohl’s taxonomy of the affective domain has five levels; receive, respond, value, organize/conceptualize values, internalize / characterize values.

The system should provide the opportunity to evaluate the “organize / conceptualize values” level according to Krathwohl’s taxonomy of the affective domain.

Examples of verbs to assess the “organize / conceptualize values” level are: build, develop, formulate, defend, modify, relate, prioritise, reconcile, contrast, arrange, compare.

Source:
Krathwohl, D.R., Bloom, B. S., and Masia, B. B. (1964). Taxonomy of educational objectives, Handbook II: Affective domain. New York: David McKay Company, Inc. ISBN 0-679-30210-7, 0-582-32385-1

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system?

Conflicts:
This requirement covers Krathwohl’s taxonomy, but also other taxonomies of the affective domain could be used.

Dependencies:
1.2.1-1.2.3, 1.2.5

Requirement name: Assessment of “internalize / characterize values” level

Requirement #: 1.2.5

Use case #: 8.2

Description:
Assessment of “internalize / characterize values” level (of the affective domain).

Rationale:
Krathwohl’s taxonomy of the affective domain has five levels; receive, respond, value, organize/conceptualize values, internalize / characterize values.

The system should provide the opportunity to evaluate the “internalize / characterize values” level according to Krathwohl’s taxonomy of affective domain.

Examples of verbs to assess the “internalize / characterize values” level are: act, display, influence, solve, practice.

Source:
Krathwohl, D.R., Bloom, B. S., and Masia, B. B. (1964). Taxonomy of educational objectives, Handbook II: Affective domain. New York: David McKay Company, Inc. ISBN 0-679-30210-7, 0-582-32385-1

Fit Criterion:
Are tools to assess all the above mentioned verbs integrated into the system (e.g. pre / post survey tool)?

Conflicts:
This requirement covers Krathwohl’s taxonomy, but also other taxonomies of the affective domain could be used.

Dependencies:
1.2.1-1.2.4

Requirement name: Assessment of imitation level

Requirement #: 1.3.1

Use case #: --

Description:
Assessment of imitation level (of the psychomotor domain).

Rationale:
The system should provide the opportunity to evaluate the imitation level according to Dave's taxonomy of psychomotor domain [Dave, 1970].

Examples of verbs to evaluate the imitation level are: copy, follow, replicate, repeat, adhere.

Source:
Dave, R. H. (1970). Psychomotor levels. In Armstrong RJ, ed., Developing and Writing Behavioral Objectives. Tuscon, AZ: AZ:Educational Innovators Press.

Harrow, A. J. (1972). *A taxonomy of the psychomotor domain*. New York: David McKay Co.

Simpson, E. J. (1972). The *Classification of Educational Objectives in the Psychomotor Domain. The Psychomotor Domain*. Washington DC: Gryphon House.

Fit Criterion:
Are tools to evaluate all the above mentioned verbs integrated into the system (e.g. motion sensitive tools, audio sensitive tools)?

Conflicts:
This requirement covers Dave's taxonomy, but also other taxonomies of the affective domain e.g. Simpson's taxonomy [Simpson, 1972], Harrow's taxonomy [Harrow, 1972] could be used.

Dependencies:
1.3.2-1.3.5

Requirement name: Assessment of manipulation level

Requirement #: 1.3.2

Use case #: 4.2

Description:
Assessment of manipulation level (of the psychomotor domain).

Rationale:
The system should provide the opportunity to evaluate the manipulation level according to Dave's taxonomy of psychomotor domain [Dave, 1970].

Examples of verbs to evaluate the manipulation level are re-create, build, perform, execute, implement.

Source:
Dave, R. H. (1970). Psychomotor levels. In Armstrong RJ, ed., Developing and Writing Behavioral Objectives. Tuscon, AZ: AZ:Educational Innovators Press.

Harrow, A. J. (1972). *A taxonomy of the psychomotor domain*. New York: David McKay Co.

Simpson, E. J. (1972). The *Classification of Educational Objectives in the Psychomotor Domain. The Psychomotor Domain*. Washington DC: Gryphon House.

Fit Criterion:
Are tools to evaluate all the above mentioned verbs integrated into the system (e.g. motion sensitive tools, audio sensitive tools)?

Conflicts:
This requirement covers Dave's taxonomy, but also other taxonomies of the affective domain e.g. Simpson's taxonomy [Simpson, 1972], Harrow's taxonomy [Harrow, 1972] could be used.

Dependencies:
1.3.1, 1.3.3-1.3.5

Requirement name: Assessment of precision level

Requirement #: 1.3.3

Use case #: 7.3, 7.4

Description:
Assessment of precision level (of the psychomotor domain).

Rationale:
The system should provide the opportunity to evaluate the precision level according to Dave's taxonomy of psychomotor domain [Dave, 1970].

Examples of verbs to evaluate the precision level are: demonstrate, complete, show, perfect, calibrate, control.

Source:
Dave, R. H. (1970). Psychomotor levels. In Armstrong RJ, ed., Developing and Writing Behavioral Objectives. Tuscon, AZ: AZ:Educational Innovators Press.

Harrow, A. J. (1972). *A taxonomy of the psychomotor domain*. New York: David McKay Co.

Simpson, E. J. (1972). The *Classification of Educational Objectives in the Psychomotor Domain. The Psychomotor Domain*. Washington DC: Gryphon House.

Fit Criterion:
Are tools to evaluate all the above mentioned verbs integrated into the system (e.g. track tool, simulator)?

Conflicts:
This requirement covers Dave's taxonomy, but also other taxonomies of the affective domain e.g. Simpson's taxonomy [Simpson, 1972], Harrow's taxonomy [Harrow, 1972] could be used.

Dependencies:
1.3.1, 1.3.2, 1.3.4, 1.3.5

Requirement name: Assessment of articulation level

Requirement #: 1.3.4

Use case #: --

Description:
Assessment of articulation level (of the psychomotor domain).

Rationale:
The system should provide the opportunity to evaluate the articulation level according to Dave's taxonomy of psychomotor domain [Dave, 1970].

Examples of verbs to evaluate the articulation level are: construct, solve, combine, coordinate, integrate, adapt, develop, formulate, modify, master.

Source:
Dave, R. H. (1970). Psychomotor levels. In Armstrong RJ, ed., Developing and Writing Behavioral Objectives. Tuscon, AZ: AZ:Educational Innovators Press.,

Harrow, A. J. (1972). *A taxonomy of the psychomotor domain*. New York: David McKay Co.

Simpson, E. J. (1972). The *Classification of Educational Objectives in the Psychomotor Domain. The Psychomotor Domain*. Washington DC: Gryphon House.

Fit Criterion:
Are tools to evaluate all the above mentioned verbs integrated into the system (e.g. log, simulator)?

Conflicts:
This requirement covers Dave's taxonomy, but also other taxonomies of the affective domain e.g. Simpson's taxonomy [Simpson, 1972], Harrow's taxonomy [Harrow, 1972] could be used.

Dependencies:
1.3.1-1.3.3, 1.3.5

Requirement name: Assessment of naturalization level

Requirement #: 1.3.5

Use case #: --

Description:
Assessment of naturalization level (of the psychomotor domain).

Rationale:
The system should provide the opportunity to evaluate the naturalization level according to Dave's taxonomy of psychomotor domain [Dave, 1970].

Examples of verbs to evaluate the naturalization level are: design, specify, manage, invent, project-manage.

Source:
Dave, R. H. (1970). Psychomotor levels. In Armstrong RJ, ed., Developing and Writing Behavioral Objectives. Tuscon, AZ: AZ:Educational Innovators Press

Harrow, A. J. (1972). *A taxonomy of the psychomotor domain*. New York: David McKay Co.

Simpson, E. J. (1972). The *Classification of Educational Objectives in the Psychomotor Domain. The Psychomotor Domain*. Washington DC: Gryphon House.

Fit Criterion:
Are tools to evaluate all the above mentioned verbs integrated into the system (e.g. simulator)?

Conflicts:
This requirement covers Dave's taxonomy, but also other taxonomies of the affective domain e.g. Simpson's taxonomy [Simpson, 1972], Harrow's taxonomy [Harrow, 1972] could be used.

Dependencies:
1.3.1-1.3.4

Category 2: Content

Requirement name: Ranking of learning objects

Requirement #: 2.1

Use case #: 11.1, 11.2

Description:
Students rank learning objects in order to provide useful information to both teacher and fellow students.

Rationale:
Most students are eager to share in ”on campus” learning situations. They share lecture notes when one student was not able to attend the lecture, they exchange notes from the curriculum, they distribute URLs to interesting websites, they share mind maps and assignment answers. A student typically does this because there is “something in it for me” as well. They know that if they share their lecture notes this time, they will get something back from the receiving student later, so it will be useful for both the giver and the receiver.

In an online learning environment, however, the sharing is not as easy, because you do not necessarily know your fellow students very well and the answer of the question “What’s in it for me?” is not clear to neither students nor teachers. Today, sharing among online students is done through e.g. discussion forums. If online sharing is going to be successful, it must be obvious for the student that “giving now” will mean “receiving later”. If online students are going to share, it should not only be sacrifices and waste of time and energy, but the online students must know that the sharing will be useful for them later.

A small scale sharing in an online learning environment could be performed through a ranking system, where students e.g. rank a learning object, and the system could show the ranking results for other students. The ranking would be interesting feedback to the teacher as well, in the process of reviewing and improving the learning objects. The system could also use the ranking results to give suggestions of other learning objects to the student based on the behaviour of the fellow students, similar to Amazon.com, which has a suggestion list of other books that might be interesting to the buyer (“Costumers who bought this item also bought: … “). An e-learning example could be that the student ranks one learning object high, and the system provides a list of learning objects ranked high by fellow students who also had high ranking score on the same learning object.

Source:
Line Kolås (2006): “Topic maps in E-learning: An Ontology Ensuring an Active Student Role as Producer”, E-learn 2006 Proceedings.

Fit Criterion:
The system must allow students to rank learning objects / learning activities, and the system must use the ranking information to provide useful information for both teachers and fellow students.

Conflicts: None

Dependencies: None

Requirement name: Public option of presenting content

Requirement #: 2.2

Use case #: --

Description:
The possibility to publish some introductory lectures on the web for marketing, while the rest of the course demands authentication.

Rationale:
One way to market an online course, is to publish some of the introductory lectures on the web. The public part allows students the possibility of a informed choice selecting the courses they are interested in; this will allow many students to have a “look and feel” of the course and a possibility to understand if the course is covering what they want to learn, before applying for the course.

Source: QUIS

Fit Criterion:
The system must allow the teacher to publish parts of the course in a marketing space on the web.

Conflicts:
Copyright issues: There are other demands to copyright issues when used in marketing than used in education.
Protection of privacy: The system must not publish personal information (e.g. name, address, telephone number etc) of neither the student nor the teacher without approval.

Dependencies:
None

Requirement name: Convert students work into a new learning object

Requirement #: 2.3

Use case #: 1.1, 4.1, 5.1, 7.2, 7.4

Description:
Convert students work into a new learning object.

Rationale:
During a course students are making many contributions, like summaries, tests, games, demos etc.

Example 1; The student makes his/her own questions to the learning material. This requires that the student has to read more actively. The questions could of course be of the multiple choice type and can be collected to get a database of question to use for e.g. self-assessment later.

Example 2: The student wants to structure what s/he has read, and is making a mind map of the learning content.

The system must collect student contributions and present the student contributions in an open learning object repository or as a part of the course material. To be able to add it to the course material there must be a quality assuring process.

Source: QUIS

Fit Criterion:
The system must allow students to be producers of learning material, and give the student a choice if they want to keep the learning material private or if they want to share it by publishing it in an open learning object repository. When saving learning material the system should provide opportunity to both automatically and manually generated metadata.

Conflicts:
None

Dependencies:
2.4-2.6, 4.1-4.10.

Requirement name: Automatic generation of metadata

Requirement #: 2.4

Use case #: 3.2, 4.2, 4.4, 5.2

Description:
Many of the metadata descriptions are of a kind that could be automatic generated.

Rationale:
The system should in the process of producing a learning object or learning activity, automatically find as much metadata as possible, and present this to the author to minimize the workload. Examples of metadata that could be automatically generated are: size, date, author, title, level of taxonomy covered etc.

Source: QUIS

Fit Criterion:
The system must keep track of information that could be useful as metadata when learning objects / learning activities are to be saved in repositories.

Conflicts:
None

Dependencies:
2.5

Requirement name: Manual generation of metadata

Requirement #: 2.5

Use case #: --

Description:
Parts of the metadata are of a kind that could not be automated. That is learning goals, description of the content etc.

Rationale:
To be able to reuse learning objects and learning activities, they must be put into repositories with metadata. There are many different “standards” to use creating metadata to learning objects, e.g. SCORM, Dublin Core etc [Marsico et al., 2005] and design patterns [Rosvoll & Staupe, 2006].

Using design patterns to describe the metadata of a learning object, introduces the idea of creating the metadata n several steps. When the metadata is created in several steps, this also means that making a learning object with metadata will be one process instead of two separate parts where one first create the learning part and then create the metadata [Rosvoll et al, 2006].

Source:
Marsico, M. De, Temperini, M. and Bianco, A. (2005). *Standards for e-learning, QUIS report*. Available: http://www2.tisip.no/quis/public_files/wp5-standards-for-elearning.pdf (accessed 28 June 2006).

Rosvoll, S. et al. (2006). *Learning objects – Proposal for a new learning object standard using design patterns.* Appendix III of the QUIS Requirement Specification.

Fit Criterion:
The system must allow adding metadata manually to the learning objects and the learning activities produced in order to make them easily retrievable.

Conflicts:
There are too many “standards” available and it is problematic to state which standard the system should follow.

Dependencies:
2.4, 2.6.

Requirement name: Collaborative annotations of metadata

Requirement #: 2.6

Use cases # 11.1, 11.2

Description:
The system shall allow collaborative tagging of learning material and tag-based search.

Rationale:
The metadata definition is a demanding and time-consuming process. It would be better if the metadata definition was distributed to many parties (students and teachers).

The metadata definition has usually different meanings to different users, thus a distributed definition of metadata would be more representative of the topic understanding.

A collaborative annotation of metadata will allow a tag-based search of the learning material (semantic-based search based on the "implicit meaning" given by everyone to the tags).

Source:
See the MyTagsPlugin on www.twiki.org

Fit Criterion:
Are the following functionality implemented into the system:
- Tag-based search
- Collaborative annotation functionality

Conflicts:
What if e.g. students sabotage the metadata definition by writing nonsense?

Dependencies:
2.5

Requirement name: Teacher's feedback as learning object

Requirement #: 2.7

Use case #: --

Description:
To use teacher's written feedback to students as a learning object in the learning process.

Rationale:
The teacher uses a lot of time on giving written feedback to online students. This feedback should also be available to other students, not only in a FAQ, but be saved as retrievable learning objects in a learning object repository, and it must be possible to retrieve the objects in the system. The learning objects must be easily retrievable for students, e.g. searchable in a Help-system.

Source: QUIS

Fit Criterion:
The teacher's comments must be saved as a standardized learning object in a learning object repository, and be retrievable for the students in the system.

Conflicts:
None

Dependencies:
None

Requirement name: Proficiency stage - Novice

Requirement #: 2.10

Use case #: --

Description:
The system shall satisfy the needs of the students on a novice stage.

Rationale:
The student group is heterogeneous also when it comes to proficiency stages.

Dreyfus makes a division between different stages for students, and claims that students on different stages have different needs. The stages he has described are [Dreyfus 1998].:

1. Novice
2. Advanced beginner
3. Competence
4. Proficiency
5. Expertise.

Despite different professional competences, there are some characteristics identifying a specific progress [Vavik 2005]. The “novice” needs models, rules, prescriptions, while an “advanced beginner” starts to recognize based on experience. With “competence” the user chooses a plan of progress to reach the goal based on instruction and experience, while with “proficiency” the theory connected with the skill will gradually be replaced by situational discriminations accompanied by associated responses. With “expertise” the student not only sees what needs to be done, but also sees how to achieve his / her goal [Dreyfus 1998].

There must be possible for the teacher to create learning objects and learning activities for the novice student.

Source:
Dreyfus, H.L. (1998). *Intelligence without Representation*.
http://www.hfac.uh.edu/cogsci/dreyfus.html

Vavik, Lars (2004). *Perspektiver på samarbeid og veiledning i nettbaserte læringsomgivelser* in: Sigmundson, Hermundur & Finn Bostad (Red.), Læring. Grunnbok i læring, teknologi og samfunn. Universitetsforlaget. Kap 6, ISBN 8215006302.

Fit Criterion:
Are the following tools possible to create and use in the system: Wizards, road maps, templates, checklists, design patterns?

Conflicts:
None

Dependencies:
2.11-2.14

Requirement name: Proficiency stage – Advanced beginner

Requirement #: 2.11

Use case #: --

Description:
The system shall satisfy the needs of the students on a advanced beginner stage.

Rationale:
The student group is heterogeneous also when it comes to proficiency stages.

Dreyfus makes a division between different stages for students, and claims that students on different stages have different needs. The stages he has described are [Dreyfus 1998]:

1. Novice
2. Advanced beginner
3. Competence
4. Proficiency
5. Expertise.

Despite different professional competences, there are some characteristics identifying a specific progress [Vavik 2005]. The “novice” needs models, rules, prescriptions, while an “advanced beginner” starts to recognize based on experience. With “competence” the user chooses a plan of progress to reach the goal based on instruction and experience, while with “proficiency” the theory connected with the skill will gradually be replaced by situational discriminations accompanied by associated responses. With “expertise” the student not only sees what needs to be done, but also sees how to achieve his / her goal [Dreyfus 1998].

There must be possible for the teacher to create learning objects and learning activities for the “advanced beginner” student.

Source:
Dreyfus, H.L. (1998). *Intelligence without Representation*.
http://www.hfac.uh.edu/cogsci/dreyfus.html

Vavik, Lars (2004). *Perspektiver på samarbeid og veiledning i nettbaserte læringsomgivelser* in: Sigmundson, Hermundur & Finn Bostad (Red.), Læring. Grunnbok i læring, teknologi og samfunn. Universitetsforlaget. Kap 6, ISBN 8215006302.

Fit Criterion:
Are the following tools possible to create and use in the system?

- Help: search
- Toolkits

Conflicts: None

Dependencies: 2.10, 2.12-2.14

Requirement name: Proficiency stage - Competence

Requirement #: 2.12

Use case #: --

Description:
The system shall satisfy the needs of the students on a competence stage.

Rationale:
The student group is heterogeneous also when it comes to proficiency stages.

Dreyfus makes a division between different stages for students, and claims that students on different stages have different needs. The stages he has described are [Dreyfus 1998]:

1. Novice
2. Advanced beginner
3. Competence
4. Proficiency
5. Expertise.

Despite different professional competences, there are some characteristics identifying a specific progress [Vavik 2005]. The “novice” needs models, rules, prescriptions, while an “advanced beginner” starts to recognize based on experience. With “competence” the user chooses a plan of progress to reach the goal based on instruction and experience, while with “proficiency” the theory connected with the skill will gradually be replaced by situational discriminations accompanied by associated responses. With “expertise” the student not only sees what needs to be done, but also sees how to achieve his / her goal [Dreyfus 1998].

There must be possible for the teacher to create learning objects and learning activities for the “competence” student.

Source:
Dreyfus, H.L. (1998). *Intelligence without Representation*.
http://www.hfac.uh.edu/cogsci/dreyfus.html

Vavik, Lars (2004). *Perspektiver på samarbeid og veiledning i nettbaserte læringsomgivelser* in: Sigmundson, Hermundur & Finn Bostad (Red.), Læring. Grunnbok i læring, teknologi og samfunn. Universitetsforlaget. Kap 6, ISBN 8215006302.

Fit Criterion:
Are the following tools possible to create and use in the system?

- Frameworks
- Assignments without any help

Conflicts: None

Dependencies: 2.10, 2.11, 2.13, 2.14

Requirement name: Proficiency stage - Proficiency

Requirement #: 2.13

Use case #: --

Description:
The system shall satisfy the needs of the students on a proficiency stage.

Rationale:
The student group is heterogeneous also when it comes to proficiency stages.

Dreyfus makes a division between different stages for students, and claims that students on different stages have different needs. The stages he has described are [Dreyfus 1998]:

1. Novice
2. Advanced beginner
3. Competence
4. Proficiency
5. Expertise.

Despite different professional competences, there are some characteristics identifying a specific progress [Vavik 2005]. The “novice” needs models, rules, prescriptions, while an “advanced beginner” starts to recognize based on experience. With “competence” the user chooses a plan of progress to reach the goal based on instruction and experience, while with “proficiency” the theory connected with the skill will gradually be replaced by situational discriminations accompanied by associated responses. With “expertise” the student not only sees what needs to be done, but also sees how to achieve his / her goal [Dreyfus 1998].

There must be possible for the teacher to create learning objects and learning activities for the “proficient” student.

Source:
Dreyfus, H.L. (1998). *Intelligence without Representation*.
http://www.hfac.uh.edu/cogsci/dreyfus.html

Vavik, Lars (2004). *Perspektiver på samarbeid og veiledning i nettbaserte læringsomgivelser* in: Sigmundson, Hermundur & Finn Bostad (Red.), Læring. Grunnbok i læring, teknologi og samfunn. Universitetsforlaget. Kap 6, ISBN 8215006302.

Fit Criterion:
Are the following tools possible to create and use in the system?

- Topic directory

Conflicts: None

Dependencies: 2.10-2.12, 2.14

Requirement name: Proficiency stage - Expert

Requirement #: 2.14

Use case #: --

Description:
The system shall satisfy the needs of the students on an expert stage.

Rationale:
The student group is heterogeneous also when it comes to proficiency stages.

Dreyfus makes a division between different stages for students, and claims that students on different stages have different needs. The stages he has described are [Dreyfus 1998]:

1. Novice
2. Advanced beginner
3. Competence
4. Proficiency
5. Expertise.

Despite different professional competences, there are some characteristics identifying a specific progress [Vavik 2005]. The “novice” needs models, rules, prescriptions, while an “advanced beginner” starts to recognize based on experience. With “competence” the user chooses a plan of progress to reach the goal based on instruction and experience, while with “proficiency” the theory connected with the skill will gradually be replaced by situational discriminations accompanied by associated responses. With “expertise” the student not only sees what needs to be done, but also sees how to achieve his / her goal [Dreyfus 1998].

There must be possible for the teacher to create learning objects and learning activities for the “expert” student.

Source:
Dreyfus, H.L. (1998). *Intelligence without Representation*.
http://www.hfac.uh.edu/cogsci/dreyfus.html

Vavik, Lars (2004). *Perspektiver på samarbeid og veiledning i nettbaserte læringsomgivelser* in: Sigmundson, Hermundur & Finn Bostad (Red.), Læring. Grunnbok i læring, teknologi og samfunn. Universitetsforlaget. Kap 6, ISBN 8215006302.

Fit Criterion:
Are the following tools possible to create and use in the system?

- Search engine

Conflicts:
None

Dependencies:
2.10 - 2.13

Category 3: Collaboration

Requirement name: Workspace awareness

Requirement #: 3.1

Use case #: 9.1

Description:
To get a up-to-the-moment understanding of another persons interaction in the system.

Rationale:
Workspace awareness is “the up-to-the-moment understanding of another person’s interaction with a shared workspace. Workspace awareness involves knowledge about where others are working, what others are doing, and what they are going to do next. This information is useful for many of the activities of collaboration – for coordinating action, managing coupling, talking about the task, anticipating others’ actions and finding opportunities to assist one another.”[Gutwin & Greenberg, 2001].

According to Gutwin and Greenberg there must be possible to know something about who, what and where related to the present:
Who: Is anyone there? Who is that? Who is doing what?
What: Is anything happening? What is s/he doing / going to do? What object is s/he using?
Where: Where is s/he working? Where is s/he looking? What can s/he see? What can s/he manipulate?

Elements of workspace awareness related to the past:
How: How did that operation happen?
When: When did that event happen?
Who: Who was here, and when?
Where: Where has a person been?
What: What has a person been doing?

Source:
Gutwin, C. and Greenberg, S. (2001). “A descriptive framework of workspace Awareness for real-time groupware”, Computer Supported Cooperative work (CSCW). The Journal of Collaborative Computing, Kluwer Academic Press.

Fit Criterion:
The system must provide workspace awareness about the past, the present and as far as possible the future.

Conflicts:
None

Dependencies:
3.2, 4.6

Requirement name: Situation awareness

Requirement #: 3.2

Use case #: --

Description:
To get a up-to-the-moment cognizance required to operate or maintain a system.

Rationale:
Situation awareness is defined as "the up-to-the-moment cognizance required to operate or maintain a system" [in Gutwin & Greenberg, 2001].

Source:
Gutwin, C. and Greenberg, S. (2001). "A descriptive framework of workspace Awareness for real-time groupware", Computer Supported Cooperative work (CSCW). The Journal of Collaborative Computing, Kluwer Academic Press.

Fit Criterion:
The system must provide perceptual information from the learning / teaching environment and provide perceptual information that makes it possible for the user to be able to anticipate changes to the learning / teaching environment.

Conflicts:
None

Dependencies:
3.1

Requirement name: Interactive tutoring

Requirement #: 3.3

Use case #: 10.2

Description:
Synchronous tutoring of an exercise; the teacher, the tutor or students can point at e.g. errors and comment them in voice instead of sending back a text-based commented document.

Rationale:
Today it is normal for online teachers to write comments to e.g. student papers and send the commented paper back to the student. There should however be possible to add oral comments, and also possible for the student and teacher together to discuss e.g. a paper, exercise etc.

The oral tutoring allows to better deepen the comments and make them more friendly and clear; it is also possible to deepen further the explanation of particular aspects, as the need for this arise during the run of a program.

Source: QUIS

Fit Criterion:
The system must allow both teachers and students to add oral comments to documents, in addition to provide tools for synchronous tutoring like desktop sharing, application sharing, commenting tools etc.

Conflicts:
None

Dependencies:
4.10

Requirement name: Cooperative meta-learning process

Requirement #: 3.6

Use case #: --

Description:
The system shall provide a public space for expressing personal opinions about learning process.

Rationale:
To provide possibilities for personal reflections about the learning situation, that is presented to an audience, with possibilities to get feedback, questions, reflections etc that may be helpful in the meta-learning process.

Source:

Fit Criterion:
Are meta-learning tools e.g. blogs, journals implemented into the system?

Conflicts:
None

Dependencies:
4.18

Requirement name: Cooperative production of learning objects

Requirement #: 3.10

Use case #: --

Description:
"Open source" production of learning objects.

Rationale:
Using the open source mentality also when creating learning objects, it will be possible to lower cost, increase feedback, improve quality and have faster / continuous revision. In addition it will be possible to share ideas and experiences and have a wider cultural scope, and we avoid problems like we have in LMS of today, where the learning objects are not accessible from outside the LMS system, where one needs passwords as authentification.

The thought is to cooperate in the production of content, similar to a wiki, but with the advancement of creating a variety of content (not only hypertext with text and pictures like a wiki).

Source:
QUIS
Wikipedia.org

Fit Criterion:
The system must allow cooperative creation of learning objects.

Conflicts:
Copyright issues.

Dependencies:
3.11

Requirement name: Cooperative production of learning activities

Requirement #: 3.11

Use case #: --

Description:
"Open source" production of learning activities.

Rationale:
With an open tool for producing learning activities and sharing these, we will have a tool where it should be possible to produce new reusable learning methods. The learning activities produced should be systematized in categories e.g. the ten methods mentioned in the requirement specification [Heinich et al, 2002].

Source:
Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7
QUIS

Fit Criterion:
The system must allow cooperative creation of learning activities.

Conflicts:
Copyright issues.

Dependencies:
3.10

Requirement name: Cooperative production of assessment activities

Requirement #: 3.12

Use case #: --

Description:
"Open source" production of assessment activities.

Rationale:
Good online assessment is time-consuming to produce, and it should be possible to e.g. pick questions from a database of MCQ-questions written together with other teachers. This will lower cost, increase feedback, improve quality and ensure faster / continuous revision.

The assessment activities should be structured by using taxonomies for the cognitive, affective and psychomotor domains, e.g. Bloom's taxonomy for the cognitive domain [Bloom 1956], Dave's taxonomy for the psychomotor domain [Dave, 1970] and Krathwohl's taxonomy of the affective domain [Krathwohl, 1964].

Sources:
Dave, R. H. (1970). Psychomotor levels. In Armstrong RJ, ed., Developing and Writing Behavioral Objectives. Tuscon, AZ: AZ:Educational Innovators Press.

Krathwohl, D.R., Bloom, B. S., and Masia, B. B. (1964). Taxonomy of educational objectives, Handbook II: Affective domain. New York: David McKay Company, Inc. ISBN 0-679-30210-7, 0-582-32385-1

Bloom, Benjamin (Ed.) (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain*. New York; Toronto: Longmans, Green.

Fit Criterion:
The system must allow cooperative production of assessment activities, systematized using taxonomies for the cognitive, affective and psychomotor domains.

Conflicts:
None

Dependencies:
1.1.1-1.1.6, 1.2.1-1.2.5, 1.3.1-1.3.5

Category 4: Teaching

Requirement name: Method: Presentation

Requirement #: 4.1

Use case #: 2.1, 2.2

Description:
The system shall enable users to create and perform presentations.

Rationale:
"In the presentation method, a source tells, dramatizes or otherwise disseminates information to students. It is a one-way communication controlled by the source, with no immediate response from or interaction with students. The source may be a textbook, an audiotape, a videotape, a film an instructor etc." [Heinich et al., 2002].

Source:
Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7

Fit Criterion:
Is there a variety of presentation tools integrated (for both teacher and students) into the system?

- Wiki
- Mind map
- Concept map
- Maps
- Slide presentations
- Video / audio presentations

Conflicts:
None

Dependencies:
4.2

Requirement name: Method: Tutorials

Requirement #: 4.2

Use case #: 3.1, 3.2

Description:
The system shall enable knowledge acquisitions through tutorials (both tutoring the student but also allowing the student to produce tutorials).

Rationale:
“A tutor (in form of a person, computer, or special printed material) presents the content, poses a question or problem, requests a student's response, analyzes his / her response, supplies appropriate feedback, and provides practice until the student demonstrates a predetermined level of competency. Tutorial arrangements include instructor-to-student (e.g., Socratic dialog), student-to-student (e.g., tutoring or programmed tutoring), computer-to-student (e.g., computer-assisted tutorial software), and print-to-student (e.g., branching programmed instruction)” [Heinich et al., 2002].

“The pattern followed is that of branching programmed instruction, that is, information is presented in small units followed by a question or task. The computer analyzes the student’s response (compared with responses supplied by the designer) and gives appropriate feedback. A complicated network of branches can be programmed. The more alternatives available to the computer, the more adaptive the tutorial can be to individual differences” [Heinich et al., 2002].

Source:
Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7

Fit Criterion:
Are the following tools integrated into the system?
- Wizards
- FAQs
- Intelligent tutoring systems

Conflicts:
None

Dependencies:
4.1, 4.5.

Requirement name: Method: Demonstration

Requirement #: 4.3

Use case #: 5.1, 5.2

Description:
The system shall enable users to watch and develop demonstrations.

Rationale:
"In the demonstration method, students view a real or lifelike example of the skill or procedure to be learned. The objective may be for the student to imitate a physical performance or to adopt the attitudes or values exemplified by someone who serves as a role model." [Heinich et al., 2002].

Source:
Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7

Fit Criterion:
Are the following tools integrated into the system?
- Screen capture tools
- Animation tools

Conflicts:
None

Dependencies:
None

Requirement name: Method: Discussion

Requirement #: 4.4

Use case #: 8.1, 8.2

Description:
The system shall enable users to perform discussions.

Rationale:
"As a method, discussion involves the exchange of ideas and opinions among students or among students and teacher. It can be used at any stage of the instruction / learning process, and in small or large groups." [Heinich et al., 2002].

Source:
Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7.

Fit Criterion:
Are the following tools integrated into the system?

- Chat / instant messaging
- SMS / MMS
- E-mail
- Discussion forums
- Video conference
- Audio conference

Conflicts:
None

Dependencies:
4.6, 4.10

Requirement name: Method: Drill and Practice

Requirement #: 4.5

Use case #: 1.1, 1.2

Description:
The system shall enable users to perform drill and practice in the learning process (not only in the assessment process).

Rationale:
"In drill and practice students are led through a series of practice exercises designed to increase fluency in a new skill or to refresh an existing one. Use of the method assumes that students previously have received some instruction on the concept, principle or procedure that is to be practiced… The drill and practice exercises should include feedback to reinforce correct responses and to remediate errors…" [Heinich et al., 2002].

Source:
Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7

Fit Criterion:
Are the following tools integrated into the system?

- Multiple choice
- Drag and drop exercises
- Matching exercises
- Memory exercises
- Fill in blanks exercises.

Conflicts:
None

Dependencies:
1.1.1 -1.3.5, 4.2

Requirement name: Method: Cooperative learning

Requirement #: 4.6

Use case #: 9.1, 9.2

Description:
The system shall enable users to perform cooperative learning.

Rationale:
"Students can learn cooperatively not only by discussing texts and viewing media but also by producing media." [Heinich et al., 2002].

Source:
Gutwin C. and Greenberg S. (2002). *A descriptive framework of workspace awareness for real-time groupware*. Journal of Computer-Supported Cooperative Work, pages 411--446.

Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7

Fit Criterion:
Is the following functionality integrated into the system?

- Application sharing
- Collaborative virtual environments (CVEs)
- Shared archive
- Workspace awareness [Gutwin & Greenberg, 2002].

Conflicts:
None

Dependencies:
4.4, 4.10

Requirement name: Method: Game based learning

Requirement #: 4.7

Use case #: 4.1, 4.2

Description:
The system shall enable users to both play and produce games as part of learning and teaching situations.

Rationale:
"Gaming provides a playful environment in which students follow prescribed rules as they strive to attain a challenging goal. It is a highly motivating technique, especially for tedious and repetitive content. The game may involve one student or a group of students". [Heinich et al., 2002].

There exist different types of games: Adventure games, business games, board games, combat games, logical games, word games [Alessi & Trollip, 2001], and all the different types could be useful in a learning process.

Source:
Alessi, S.M. and Trollip, S.R (2001). *Multimedia for learning – Methods and development 3rd edition*. Allyn & Bacon – A Pearson Education Company. ISBN 0-205-27691-1.

Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7

Fit Criterion:
Are the following game tools integrated into the system (for the user to both play and produce games)?

- Adventure games
- Business games
- Board games
- Combat games
- Logical games
- Word games

Conflicts:
None

Dependencies:
None

Requirement name: Method: Simulation

Requirement #: 4.8

Use case #: 7.1, 7.2, 7.3, 7.4

Description:
The system shall enable users to both perform and produce simulations as part of a learning and teaching process.

Rationale:
"Simulation involves students confronting a scaled-down version of a real-life situation… The simulation may involve participant dialog, manipulation of materials and equipment, or interaction with a computer". [Heinich et al., 2002].

There exist different types of simulations: physical, iterative, procedural and situational simulations [Alessi & Trollip, 2001] and all the different types can be useful in a learning situation. The system should therefore cover all the types.

Source:
Alessi, S.M. and Trollip, S.R (2001). *Multimedia for learning – Methods and development 3rd edition*. Allyn & Bacon – A Pearson Education Company. ISBN 0-205-27691-1.

Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7

Fit Criterion:
Are the following simulations integrated into the system (for the user to both perform and produce simulations)?

- Physical simulations
- Iterative simulations
- Procedural simulations
- Situational simulations

Conflicts:
None

Dependencies:
None

Requirement name: Method: Discovery

Requirement #: 4.9

Use case #: 6.1, 6.2

Description:
The system shall enable discovery learning.

Rationale:
"The definition of discovery method: a teaching strategy that proceeds as follows:

- Immersion in a real or contrived problem situation
- Development of hypothesis
- Testing of hypothesis
- Arrival at conclusion" [Heinich et al., 2002]

"The discovery method uses an inductive, or inquiry, approach to learning; it presents problems to be solved through trial and error or systematic approaches". [Heinich et al., 2002].

Source:
Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7

Fit Criterion:
Are the following tools integrated into the system?

- Survey
- Vote tools
- Blog / journal
- Search tools (to search for information, e.g. in online libraries, encyclopaedias, statistical databases etc.
- Statistical tools
- Computer-based laboratories (e.g. in CVE)

Conflicts:
None

Dependencies:
None

Requirement name: Method: Problem solving

Requirement #: 4.10

Use case #: 10.1, 10.2

Description:
The system shall enable users to perform problem solving.

Rationale:
“Problem solving involves placing students in the active role of being confronted with a problem situated in the real world. Students start with limited knowledge, but through peer collaboration and consultation they develop, explain, and defend a solution or position on the problem” [Heinich et al., 2002].

“Students must examine the data or information presented, clearly define the problem, perhaps state hypotheses, perform experiments, ten re-examine the data and generate a solution. The computer may present the problem, process the data, maintain a database, and provide feedback when appropriate” [Heinich et al., 2002].

Source:
Heinich, R., Molenda, M., Russell, J.D. and Smaldino, S.E. (2002). Instructional media and technologies for learning 7th edition. Merrill Prentice Hall. ISBN 0-13-030536-7.

Fit Criterion:
Are the following tools integrated into the system?
- Tools to present the problem
- Tools to consult the teacher
- Collaboration tools
- Processing tools to process data
- Databases for the data
- Presentation tools to present the solution

Conflicts:
None

Dependencies:
3.1, 4.6

Requirement name: Visual intelligence

Requirement #: 4.12

Use case #: 3.2

Description:
The system shall satisfy the needs of students with a strong visual intelligence.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects and learning activities supporting different intelligences. H. Gardner has in his Multi-intelligence theory [Gardner, 1985] described eight intelligences; visual, verbal, logical / mathematical, bodily, musical, interpersonal, intrapersonal and naturalistic intelligence.

Visual intelligence is defined as “the ability to visualize and make mental maps” [Gardner, 1985]. Persons using e.g. mind maps are using this intelligence.

To satisfy the needs of the visual intelligence there is need of an interface where the student may interact by using the eyes (e.g. pictures, video, animation, drawings).

Source:
Gardner, H. (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Fit Criterion:
Are the following tools integrated into the system?
- Presentation tools,
- Mind map tools,
- Concept map tools
- Graphics tools (animation, video, screen capture tools)
- Eye sensors to provide in-data via the eyes.

Conflicts:
None

Dependencies:
4.1, 4.2, 4.3, 4.7, 4.8

Requirement name: Verbal intelligence

Requirement #: 4.13

Use case #: 3.2

Description:
The system shall satisfy the needs of students with a strong verbal intelligence.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects and learning activities supporting different intelligences. H. Gardner has in his Multi-intelligence theory [Gardner, 1985] described eight intelligences; visual, verbal, logical / mathematical, bodily, musical, interpersonal, intrapersonal and naturalistic intelligence.

Verbal intelligence is defined as “the ability of reading, writing and communicating with words” [Gardner, 1985]. This intelligence is well developed among writers, journalists, speakers etc.

To satisfy the needs of the verbal intelligence there is need of an interface where the student may interact by using the ears and speech or to use audio to control the system (like in Eyetoy, Play station 2), and to get feedback from the system (synthetic speech and speech recognition).

Source:
Gardner, H. (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Fit Criterion:
Are the following tools integrated into the system?

- Tools for written formulations: word editor, web editor etc
- speech recognition
- synthetic speech
- Audio recordings (audio in/out)

Conflicts:
None

Dependencies:
4.1, 4.4, 4.6, 4.10

Requirement name: Logical / mathematical intelligence

Requirement #: 4.14

Use case #: 3.2

Description:
The system shall satisfy the needs of students with a strong logical / mathematical intelligence.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects and learning activities supporting different intelligences. H. Gardner has in his Multi-intelligence theory [Gardner, 1985] described eight intelligences; visual, verbal, logical / mathematical, bodily, musical, interpersonal, intrapersonal and naturalistic intelligence.

Logical / mathematical intelligence is defined as “the ability of logical thinking and performing calculations, and for abstract thinking” [Gardner, 1985]. Mathematicians, engineers and lawyers often have a well-developed logical intelligence.

To satisfy the needs of the logical / mathematical intelligence there is need of an interface where the student may structure information and perform programming.

Source:
Gardner, H. (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Fit Criterion:
Are the following tools integrated into the system?

- spread sheet
- database
- topic maps
- concept maps
- programming software

Conflicts:
None

Dependencies:
4.8, 4.9, 4.10

Requirement name: Bodily / kinaesthetic intelligence

Requirement #: 4.15

Use case #: 3.2

Description:
The system shall satisfy the needs of students with a strong kinaesthetic intelligence.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects and learning activities supporting different intelligences. H. Gardner has in his Multi-intelligence theory [Gardner, 1985] described eight intelligences; visual, verbal, logical / mathematical, bodily, musical, interpersonal, intrapersonal and naturalistic intelligence.

Kinaesthetic intelligence is defined as "the ability of body coordination and conscious use of own body and hands" [Gardner, 1985], ability typically well developed among athletes, dancers, actors and craftsman.

To satisfy the needs of the kinaesthetic intelligence there is need of an interface where the user may interact by using the body (e.g. flight simulator, Eye Toy for Play station 2) or an interface where the system interacts with the student by simulating touching the student's body (e.g. joystick vibrating when a wheel hits a stone).

Source:
Gardner, H. (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Fit Criterion:
Are simulation tools, motion sensitive tools and haptic devices integrated into the system?

Conflicts:
None

Dependencies:
4.7, 4.8.

Requirement name: Musical / rhythmic intelligence

Requirement #: 4.16

Use case #: 3.2

Description:
The system shall satisfy the needs of students with a strong musical / rhythmic intelligence.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects and learning activities supporting different intelligences. H. Gardner has in his Multi-intelligence theory [Gardner, 1985] described eight intelligences; visual, verbal, logical / mathematical, bodily, musical, interpersonal, intrapersonal and naturalistic intelligence.

Musical / rhythmic intelligence is defined as “the ability of singing, playing, composing and having a good musical ear” [Gardner, 1985], usually found among composers, conductors and musicians etc.

To satisfy the needs of the musical / rhythmic intelligence there is need of an interface where you may hear, play and compose music.

Source:
Gardner, H. (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Fit Criterion:
Are the following tools integrated into the system?
- MIDI (Musical Instrument Digital Interface)
- record audio
- play audio recordings.

Conflicts:
None

Dependencies:
None

Requirement name: Interpersonal intelligence

Requirement #: 4.17

Use case #: 3.2

Description:
The system shall satisfy the needs of students with a strong interpersonal intelligence.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects and learning activities supporting different intelligences. H. Gardner has in his Multi-intelligence theory [Gardner, 1985] described eight intelligences; visual, verbal, logical / mathematical, bodily, musical, interpersonal, intrapersonal and naturalistic intelligence.

Interpersonal intelligence is defined as “the ability of understanding people and communicating” [Gardner, 1985], usually well developed among competent diplomats, charismatic leaders and among “persons that people like”.

To satisfy the needs of the interpersonal intelligence there is need of an interface where you may communicate, coordinate cooperation and cooperate with other users.

Source:
Gardner, H. (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Fit Criterion:
Is the workspace and situation awareness well implemented and are communication, coordination and cooperation tools integrated into the system?

Conflicts:
None

Dependencies:
4.6, 4.10

Requirement name: Intrapersonal intelligence

Requirement #: 4.18

Use case #: 3.2, 13.1, 13.2

Description:
The system shall satisfy the needs of students with a strong intrapersonal intelligence.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects supporting different intelligences. H. Gardner has in his Multi-intelligence theory [Gardner, 1985] described eight intelligences; visual, verbal, logical / mathematical, bodily, musical, interpersonal, intrapersonal and naturalistic intelligence.

Intrapersonal intelligence is defined as “the ability of understanding our “self” [Gardner, 1985].

To satisfy the needs of the intrapersonal intelligence there is need of an interface where the user may reflect upon own situation.

Source:
Gardner, H. (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Fit Criterion:
The system must allow integrating meta-learning tools into the learning activities.

Are reflection tools (e.g. blog) integrated into the system?

Conflicts:
None

Dependencies:
3.6

Requirement name: Naturalistic intelligence

Requirement #: 4.19

Use case #: 3.2

Description:
The system shall satisfy the needs of students with a strong naturalistic intelligence.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects supporting different intelligences. H. Gardner has in his Multi-intelligence theory [Gardner, 1985] described eight intelligences; visual, verbal, logical / mathematical, bodily, musical, interpersonal, intrapersonal and naturalistic intelligence.

Naturalistic intelligence is defined as “the ability to recognize and classify elements / patterns of the natural world” [Gardner, 1985].

To satisfy the needs of the naturalistic intelligence there is need of an interface where you may classify information.

Source:
Gardner, H. (1985). *Frames of Mind: The Theory of Multiple Intelligences*. New York; Basic Books.

Fit Criterion:
Are the following tools integrated into the system?
- Database
- Map tool
- Hypertext editor.

Conflicts:
None

Dependencies:
None

Requirement name: Solo learning style

Requirement #: 4.16

Use case #: 3.1

Description:
The system shall enable a solo learning style.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects supporting different learning styles. Solo learning style is defined as interacting with the system only or with the teacher through the system, synchronously or asynchronously.

Often the same course is given to different groups of students, for example campus students and off-campus-students. The needs are different, for example the schedule plan, the guidance etc. Therefore the system must be flexible and allow different runs for the same course

Source:
Betz, M.K. (2006). *Solo and Social Learning in Online Courses: Implications for Information Processing Theory*. International Journal of Instructional Technology and Distance Learning, vol 3, no 2. http://itdl.org/Journal/Feb_06/Feb_06.pdf

Fit Criterion:
The system must allow students to study alone.

Conflicts:
None

Dependencies:
None

Requirement name: Social learning style

Requirement #: 4.17

Use case #: 9.1, 9.2

Description:
The system shall enable a social learning style.

Rationale:
The student group is heterogeneous, and it must be possible to produce learning objects supporting different learning styles. Social learning style is defined as interacting with peer students only or interacting with the teacher(s) and peer students.

Source:
Betz, M.K. (2006). *Solo and Social Learning in Online Courses: Implications for Information Processing Theory*. International Journal of Instructional Technology and Distance Learning, vol 3, no 2. http://itdl.org/Journal/Feb_06/Feb_06.pdf

Fit Criterion:
The system must allow students to cooperate in the learning process.

Conflicts:
None

Dependencies:
4.6

Category 5: Student environment / Learning environment

Requirement name: Personalized learning environment

Requirement #: 5.1

Use case #: --

Description:
The e-learning system must be possible to personalize by the user.

Rationale:
Current learning technology is criticized for being course-centric rather that student-centric [Johnson et al, 2006]. A personalized learning environment allows the student to tailor his / her learning preferences.

“The personal learning environment (PLE) problem include:
- The desire for greater personal ownership of technology.
- The desire for more effective ways of managing technological services.
- The desire for the integration of technological activity across all aspects of life, not just institution-based learning.
- The removal of barriers to the use of tools and services.
- The desire to facilitate peer-based working” [Johnson et al., 2006].

Source:
Johnson, M., Liber, O., Wilson, S., Sharples, P., Milligan, C., Beauvoir, P. (2006). “Mapping the future: The personal learning environment reference model and emerging technology”. ALT-C 2006 The next generation Research proceedings. ISBN 0-9545870-5-7.

Fit Criterion:
Are the following criteria implemented into the system?
- Personal ownership of technology.
- Integration to other systems (not institution-based learning systems).
- Effective managing of technological services (context, conversation, network, resource, social, team, temporal, workflow, activity) [Johnson et al. 2006].
- Personalized user interface (look and feel, in addition to pedagogical approaches).

Conflicts:
None

Dependencies:
4.1 - 4.17

Requirement name: Compilation of learning modules to target platforms.

Requirement #: 5.2

Use case #:

Description:
Compilation of learning modules to target platforms.

Rationale:
In the future e-learning might be used as e-books are used today for entertainment, e.g. during transportation between your home and school. To make e-learning in different environments possible we may use platforms with different modalities. E.g. a personal computer is suitable for text, audio and video but a PDA will be feasible for some text, audio and images.

Numbers of hot spots / wireless connection areas are expanding quickly, but are still not yet available everywhere.

Source: QUIS

Fit Criterion:
There must be possible to compile learning modules to a variety of target platforms.

Conflicts:
None

Dependencies:
None

Requirement name: Intelligent search of FAQ

Requirement #: 5.3

Use case #: --

Description:
The system should support the easy collection and management of FAQ (frequently asked questions) with last-generation search engines.

Rationale:
Collecting frequently asked questions (FAQ) and the corresponding answers reduces the time spent answering the same questions, and the teacher has more time available. The corpus of questions and answers becomes an asset of the course.

When the student ask the teacher a question there should be possible for both the student and the teacher to search among earlier answers in a FAQ.

The system should also allow semantically annotated FAQs enabling semantic searches.

Source: QUIS

Fit Criterion:
Does the system support collection and management of a semantic-based FAQ?
Does the system support semantic searches of a FAQ?

Conflicts:
None

Dependencies:
None

Requirement name: Private and public communication in learning situations

Requirement #: 5.4

Use case #: --

Description:
In learning situations e.g. during synchronous lectures, students must have access to both private and public communication channels.

Rationale:
The teacher gives the lecture which is seen by all students together; students can interact making broadcast questions and receiving broadcast answer. The system should also provide the possibility of hidden interactions for modest students. Our experience is that many students avoid asking questions in public, but prefers private communication channels to ask questions (see appendix V and VI).

Source:
QUIS

Fit Criterion:
Does the system allow both private and public communication in the learning environment?

Conflicts:
None

Dependencies:
4.1, 4.6.

Requirement name: Adaptive to the student's learning styles

Requirement #: 5.5

Use case #: --

Description:
The system modifies the content selection and/or presentation to adapt to the learning style / strategy of the student.

The learning style used for a course can be changed during the course. The reason might be that the student has changed her / his opinion about what is the most convenient learning style. The system may also propose change of learning style because parts of the learning object is more suited to be learned using a certain learning style.

Rationale:
Several studies have shown that students are different from each other and that applying different pedagogical strategies obtain better learning results.

During execution of a learning object different learning styles may be preferred to improve performance.

Source:
QUIS

Fit Criterion:

Conflicts:
None

Dependencies:
None

Requirement name: Adaptive to the student's previous knowledge

Requirement #: 5.6

Use case #: 3.1, 3.2

Description:
The system should present the learning activities based on the student's previous knowledge of the subject.

Rationale:
An e-learning system adapting to previous knowledge could present to the student courses that are shorter, more focused, and faster to study.
The system must assess the students’ knowledge and the system must keep track of each student’s results and preferences.

Source:
QUIS

Fit Criterion:
Does the system keep track of each student’s previous results and does the system adapt to these results by presenting suitable learning activities to the individual students?

Conflicts:
None

Dependencies:
None

Requirement name: Differentiation

Requirement #: 5.7

Use case #: --

Description:
The system must allow differentiation.

Rationale:
Students may have different goals taking the course. Some wants to get basic knowledge only to be able to carry out some tasks but others wants to have a deeper understanding in order to continue with other courses building upon the current course.

Dale has defined 7 categories where differentiation in education is possible and useful, and where use of information technology should be an instrument / means in each category:

1. The students' abilities and learning premises / conditions (should diagnose the learning potential of each student, not only diagnose what the students are not able to perform).
2. Curriculum and work plans: Differentiation of the curriculum should be planed with each student, and the learning goals must feel realistic.
3. Level and pace
4. Organization of the day
5. Learning arenas and learning content
6. Learning processes and methods: Differentiation means that the educational institutions systematically use different methods.
7. Assessment [Dale, 2004].

Source:
Dale, L. E. (2004): *Kultur for tilpasning og differensiering*, Utdanningsdirektoratet, http://www.utdanningsdirektoratet.no/upload/Rapporter/Kultur_for_tilpasning_differensiering.pdf

Fit Criterion:
The system must allow differentiation of all the seven categories described above.

Conflicts:
None

Dependencies:
4.1-4.10

Requirement name: Variation

Requirement #: 5.8

Use case #: --

Description:
The system must allow variation.

Rationale:
Variation has been an important pedagogical principle in traditional classroom education, and is equally important in an online learning environment.

Kolås has defined the concept of variation in e-learning in several categories:
· Varied pedagogical methods - Varied teaching styles
· Varied learning styles - Varied levels of intellectual behaviour
· Varied content - Varied media
· Varied goals - Varied assessment [Kolås, 2005].

Source:
Kolås, L. (2005). *Variation and Reusability in E-learning: not Compatible*? E-learn 2005 Proceedings. AACE.

Fit Criterion:
The system must allow variation in all the different categories described above.

Conflicts:
None

Dependencies:
1.1.1 -1.3.5, 2.10-2.14, 4.1 – 4.20

Requirement name: Cultural adaptation of the learning context

Requirement #: 5.9

Use case #: --

Description:
In a multicultural context, the system should be aware of the cultural diversity. This awareness should be expressed by the possibilities for the student to use different interfaces and to interact in the most appropriate manners.

Rationale:
The system should be aware of the problem of cultural diversity. The interaction between the student and the system should be modifiable according to student's cultural peculiarities.

Hofstede has identified 5 dimensions important when describing cultural differences:
1. Power Distance Index: The extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally.
2. Individualism vs. Collectivism: The degree to which individuals are integrated into groups.
3. Masculinity vs. Femininity: The distribution of roles between the genders.
4. Uncertainty Avoidance Index: A society's tolerance for uncertainty and ambiguity.
5. Long-term vs. Short-term Orientation: Thrift and perseverance versus respect for tradition, fulfilling social obligations, and protecting ones "face" [Hofstede, 2001].

The style of questions should be switchable from more direct to less direct expression. The interaction in a forum should be allowed to be exerted in different styles: In different cultural context feedback can be obtained through different ways; a student could be requested for an opinion and produce it in a free format; on the other hand the student could be not at ease with such a procedure; in this case forms could be used to make data collection (through a less free way of expression for the student - this would be more "numeric" and less spontaneous, yet less committing for the contributors, i.e. with more contributors); for instance the system (teacher) could propose topics and make sample contributions (good questions, bad questions, off topics) so to present the students with the opportunity to comment existing contributions.

Example 1: The student is of Islamic religion. White colour may be taken by the student as a representation of death. The web interface through which the student interacts with the system should be aware of the problem: for instance, a white frame around a picture should be avoided...

Example 2: The student is from Japan. Usually the interactions between Japanese persons are less "direct" and more cautious; for instance the direct request of an opinion could be the less effective way to have a contribution in a forum; as a second example, a very explicit blame, after an error, might be considered insulting by a western country student, while it could be considered appropriate by the above Japanese student. The system should be aware of the problem: the style of questions, or of request for contribution in a forum, should be switchable from more direct to less direct expression.

Source:
Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviours, institutions and organizations across nations (2nd edition*). Saga Publications, Inc. ISBN 0-8039-7323-3

Fit Criterion:
Does the system manage an attribute of the student, expressing the "cultural context"?
Does the system make the teacher aware of the necessity of different approaches to learning in the course, as consequence of the presence of students from different cultural context?
Does the system cover Hofstede's cultural dimensions?

Conflicts:
None

Dependencies:
5.10

Requirement name: Internationalization

Requirement #: 5.10

Use case #: --

Description:
The system must focus on internationalization issues.

Rationale:
Based on the Bologna process it will be easier for both students and faculty to study /work in other institutions / other European countries. There is a need for the e-learning system to be able to present the interface and help files in several languages.

Other international issues are:
- International contacts
- Opportunities for international cooperation
- Opportunities for educational stays abroad
- International office
- Online students from different countries.

Source:
QUIS

Fit Criterion:
Is it possible to present the system's user interface and the help system in several languages?

Conflicts:
None

Dependencies:
5.9

Requirement name: Text writing support

Requirement #: 5.11

Use case #: --

Description:
The system must support the student writing a text, e.g. a summary, a scientific article, a lab report etc.

Rationale:
The system should support the student writing texts to help the student focus on the content and knowledge rather than the design and structure of the text.

Source:
QUIS

Fit Criterion:
Is text writing support implemented for the writing of different types of texts:

- summary
- novel
- interview
- scientific article
- lab report
- hyper document
- book review
- biographies
- poem
- essay
- causerie
- report / minutes
- fairy-tale
- play
- etc.

Conflicts:
None

Dependencies:
None

Category 6: Quality assurance at the course level

Requirement name: Quality assurance: Planning phase

Requirement #: 6.1

Use case #: --

Description:
Quality assurance in the planning phase of an online course.

Rationale:
The planning phase of an online course covers:

- HCI-solutions:
  Personalized views: The HCI-solution of the e-learning system should provide opportunities to choose personalized views. The user should not have to adapt to the system, but the system should adapt to the user.

  Universal design: "Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design." [Mace, accessed 2006].

  Language: The system should allow the user to display the menus etc. in the chosen language. One of the goals of the Bologna process is to promote mobility by overcoming obstacles to the free movement of students, teachers, researchers and administrative staff. The future e-learning systems must be built to help reach this goal as well, and one obstacle today is the language barriers. The user must therefore have the opportunity to change language of the e-learning system.

- Pedagogical preparation:
  Learning objectives: Specify the learning objectives of the course.

  Assessment: Plan summative assessment based on learning objectives of the course.

  Evaluation: The course evaluation plan should be prepared and introduced to the student in the beginning of the course.

  Course timetable: A course timetable with all important dates and dues should be prepared and presented to the students in the beginning of the course.

  Type of e-learning: E-learning comes in many forms e.g. self-paced, blended, web-based [MecaODL, 2002]. There must be decided in the planning phase of the course what type of e-learning the course should cover.

  Syllabus: The syllabus list should be prepared before the courses starts. The must also be decided what learning objects that need to be developed.

  Differentiation: An e-learning course shall provide differentiation, when it comes to the online learning environment, the learning process and the learning material. Differentiation in an online course should cover:
    - The learning process: There is a need to vary the pedagogical methods

    - The learning material: There is a need to vary the media types and the proficiency stages of learning objects / activities. Create content or use available content?
    - The assessment process

- Marketing of courses:
  Public/private area in the e-learning system: Future students must have the opportunity to look inside a "classroom" in the e-learning system. The student can have a look at some of the learning material and a bit of the learning activity.

  The course in a wider perspective: It must be clear how the specific course could be used as a “building brick” in an educational program (e.g. bachelor, master or PhD programs) and description of possible career paths the course could be used to reach.

  Multimedia-presentations: The future students are bombarded with information every day, and to reach to the students there is necessary to shape the marketing material using a variety of media types (audio, video, animation, illustrations, text).

- Pre-admission information:
  Course description: A course description providing the future student with information about, student fee, ECTS (European Credit Transfer System), admission requirements, organization of course, duration of course, contact information, application form, application deadline, course content, learning objectives, assessment, mandatory parts / exercises / lectures etc, access to tutor, access to technical support services, URL-address to course website, suggested courses for further studies, possible career description etc.

  Description of necessary technical equipment and software: The student must get a description of necessary technical equipment and software before signing up to the course. Many e-learning courses demand specific technical equipment (like speakers, microphone, web camera etc) and specific software (e.g. pdf reader, zip-software, media players etc). This must be clearly described to the student in the marketing phase of the course.

- Qualification:
  Qualified tutoring staff: Tutoring staff must know and understand the e-learning system and the course conditions. To quality assure the course there must be a training session of tutoring staff [Meca-ODL]. It is also necessary that the tutoring staff knows what they need to know about the course conditions (e.g. time limit for feedback of student questions, papers etc.).

  Responsibility: The responsibility of the different tasks in all phases of the course must be clarified, and access rights to different parts of the system must be set according to responsibility.

Source:
MECA-ODL, 2002. *Methodological Guide for the Analysis of Quality in Open and Distance Learning delivered via internet*. http://www.adeit.uv.es/mecaodl

Fit Criterion:
Does the system allow planning of HCI-solution, marketing, qualifications and pedagogical preparation?

Conflicts:
None

Dependencies:
None

Requirement name: Quality assurance: Running phase

Requirement #: 6.2

Use case #: --

Description:
Quality assurance in the running phase of an online course.

Rationale:
The running phase of an online course can be divided into;

Student perspective:

Admission information: The student must get a lot of information as s/he is admitted into a course, e.g. log on information (user name, password), syllabus list, course timetable, e-learning system tutorial, fellow students' contact information etc.

Student as consumer and producer: The system should allow the student to be both consumer and producer of e-learning objects and activities. To meet the demands of variation, differentiation and individualisation there must be possible for the student to have both roles. The producer role is as important as the consumer role for a student in a learning process.

Administration resources for online students: Online students need to have online access to administrative resources in their learning process.
- Exams via internet
- Access to library resources
- Access to administrative resources (e.g. study program consultancy, exam registration, ICT Service Centre (to get user name / password, access to software, ICT help, discount contracts etc.)

User involvement: The student group should get some opportunities to participate in the planning of the course, e.g. planning online class meeting, the content of class meetings and the content development. To ensure that all students participate, the system must provide student participation tools where the students can participate both individually, in groups and as one large group.

Teacher perspective:

Research-based education: The system shall enable users to perform research-based education, which includes everything from presenting own or others' research results to actively engage students in own research projects e.g. the student may do a small part of a larger research project. Higher education institutions in e.g. Norway are committed to perform research-based education.

Inactive student alerts: The system should provide alerts to the teacher telling him / her if some students are inactive, what learning objects / learning activities are not used etc. A problem in e-learning courses is often that students drop out of the course. If the teacher receives alerts telling him / her that a student has been inactive for x number of days, he could contact the student and provide extra help / encouragement etc.

Alerts: A system with many learning objects and learning activities will also have some learning objects / activities that are not used. The teacher should get alerts e.g. telling him / her that a specific learning object is not in use. The teacher could improve the learning object or remove it from the system.

Legal perspective:

Source reliability: The date and creator of learning objects and the learning activities must be known. The author / producer / creator of each learning object / learning activity must be identified, and there must be possible to see the production date of the learning object / activity.

Copyrights: The quality assurance system must detect if the material in the course is legally used. In the infant period of internet in education the difference between sharing and stealing has been vague; pictures, illustrations, texts and learning activities has been copied from the internet without crediting the owner. The system must require that identified persons confirm that the uploaded material is not stolen and that created material must be marked with e.g. copyright or creative commons licence.

Source:

Fit Criterion:
Are quality assurance means for the running phase of an online course implemented into the system, covering:

- The student perspective
- The teacher perspective
- The legal perspective

Conflicts:
None

Dependencies:
None

Requirement name: Quality assurance: Assessment phase

Requirement #: 6.3

Use case #: 12.1, 12.2, 13.1, 13.2

Description:
Quality assuring the formative and the summative assessment of an online course.

Rationale:
Formative assessment [Lauvås, 2003]:
(Formative assessment means assessment for learning and is used to improve a student's learning process and learning outcome.)

- Assessment of students pre-qualifications: The result of a pre-test should diagnose the students' pre-qualifications in the subject and serve as information for the teacher preparing a differentiated learning environment, but also for "reality information" to the student, telling him / her where pre-requirements are lacking. In the future it will because of the Bologna process be easier for the students to take courses at other institutions / in other countries. This may cause that the student group's pre-qualifications in the subject will differ in a larger extent than earlier. To ensure that the learning environment will cover what the students need, an online pre-test in the subject could be helpful.

- Mutual student assessment: Giving feedback to fellow students and receiving feedback from fellow students can be valuable in a learning process.

- Self assessment: For individual self-monitoring and checking progress and to promote meta-learning skills. Self-assessment is hard to do, and the system must be able to provide help to the student in the self assessment process, e.g. provide keywords, methods etc

- Formative tests: Tests where students uses tests as part of the learning process. The teacher does not get access to the results of the individual student but get access to the average results.

- Visualize demands and criteria: It is important to try to describe the demands and the criteria of summative assessment, but this only has limited value. Other methods could be to hand out last years student reports / exam answers etc and ask the students to assess these results. Then the students get access to the grade the report /exam answers got.

- Visualize progression: It is motivating and valuable in the learning process to see your own progression. There is possible to plan for this, by keeping the first deliverable in the course, use video to film first try in professional training etc. [Lauvås, 2003].

Summative assessment:
(Summative assessment means assessment of learning.)

    - Student verification: In case of online exams, there must be a system to verify the student.

- Matching learning objectives and assessment: The assessment activities must be matched with the learning objectives, because the goal of assessment is to find if the student learned what was intended in the course.

- Guidance document to external examiner: In the case of exams, exercises, portfolios etc that are being assessed by external examiners the teacher of the class should provide guidelines for the external examiner to follow in the assessment process.

- Transfer of assessment results to administrative systems: In the approving of exercises, group work etc student get grades, points etc. These data should be easy accessible and easy to collect in order to transfer from the e-learning system to the administrative system. Some students don't finish the course in one semester, and continue the course in a later semester. Transfer of already approved work from an earlier semester to current semester is needed.

Source:
Lauvås, P. (2003). *Vurdering for læring - viktigere enn eksamen (vurdering av læring).* Fredrikstad : Høgskolen i Østfold. http://klaff.hiof.no/~pla/Formativ-vurdering-hiof.htm (accessed 02 October 2006).

Fit Criterion:
The system must allow the most important methods of formative and summative assessment:
- Assessment of students pre-qualifications
- Mutual student assessment
- Self assessment
- Formative tests
- Visualize demands and criteria
- Visualize progression
- Student verification
- Matching learning objectives and assessment
- Guidance document to external examiner
- Transfer of assessment results to administrative systems.

Conflicts: None

Dependencies:
1.1.1-1.3.5, 3.6, 4.2, 4.18

Requirement name: Quality assurance: Evaluation phase

Requirement #: 6.4

Use case #: --

Description:
Quality assurance in the evaluation phase of an online course.

Rationale:
Evaluation is performed as a mean to improve the online course.

Feedback:

- Complaints:
  Online students must have access to process tools that make course complaints possible. A complaint is an expression of displeasure. Often students will find a discrepancy between what s/he was promised of activities and materials in the course and what s/he really got during the running of the course.

  A discrepancy / complaint process should therefore be clear to the online students and should be included in every e-learning system. This process should be very flexible and the teacher could connect e.g. a form to the course and as a result the students could report back (or complain) about the course and the activities at every moment. The teacher can choose to adjust the course in the proposed direction or all reports could be accumulated and analysed at the end of the course.

  Using a complaints system like this one the teacher can dynamically adjust the course at every moment depending of the feedback from the students.

- Surveys:
  The system shall provide surveys to evaluate the quality of the online course. A course evaluation survey is traditionally a collection of question frequently asked to the students, for example mid-semester and at the end of the semester. Teachers have used that kind of surveys earlier as well, but including these in the online learning environment makes it easier for the teacher to create, to carry out and to get result from surveys. It must be easy for the teacher to publish the survey, and several tools must be available for post processing the data gathered during the survey.

  Surveys must not only be an issue for the individual teacher. In addition it must be easy for the administrator to publish surveys for all students and in each course. The intention must be to measure the status in the course and to uncover low quality courses.

  Course evaluation will be similar in different coursers, and the educational institution should provide a bank of evaluation survey questions.

Evaluation timetable [HiNT – SNN, 2006]:

- Course introduction:
  - The students' expectations should be gathered through the system.
  - The teachers' expectations to the students must be presented.

    - The organization of the course must be presented.
    - Information about the evaluation system must be introduced to the students.
    - A student representative election must be carried through.
- Middle of course:
    - A mid-course evaluation survey must be carried through. Examples of parts that should be covered in such a survey;
        - The student role
        - The student's own contributions
        - The teacher role
        - The teacher's contributions
        - Content of the course
        - Workload of the course
        - The progression and propulsion of the course
        - The online learning environment
        - The quality of the syllabus.
    - The teacher must address the eventual changes that will be carried through in the rest of the course, based on the mid-course evaluation survey results.
- End of course:
    - It is possible to reuse the content from the mid-course evaluation survey. In addition should the following parts be covered in the final evaluation:
        - The follow-ups of the mid-course evaluation
        - The summative assessment
        - Are the students' expectations reached? The students' expectations gathered in the introductory phase of the course are used to measure if expectations are reached.

Reports:
The evaluation results must be collected into an evaluation report, which also specify who are responsible to follow up the different evaluation results.

Source:
HiNT – SNN (2006): "Evalueringsplan" (Internal document at the University College of Nord-Trøndelag).

Fit Criterion:
Are quality assurance means for the evaluation phase of an online course implemented?
- Feedback

Conflicts: None

Dependencies: 6.1

For complete reference list, see main document; The QUIS requirement specification of a next generation e-learning system.

Appendix III:

QUIS - Quality, Interoperability and Standards in e-learning

2004-3538/001-001 ELE - ELEB14

Learning objects

Proposal for a new learning object metadata standard using design patterns

Version 1.0

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Authored by the QUIS team.

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Quality, Interoperability and Standards in e-learning

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Introduction

The current standards and specifications of learning object metadata have been criticized for being too comprehensive and failing to describe the pedagogical content of the learning object. Studies have shown that only 50%-67% of the potential elements in the standards are populated, and especially the pedagogical elements are not used. Only a few of the potential elements are used, and many of them not correctly used.

The work documented in this report has developed a proposal for new standard for describing the pedagogical elements. This standard describes the learning object with design patterns, and contains fewer elements than the current standards. As a result of describing the learning objects with design patterns, there has been proposed a change in the process of how a learning object is created. This process consists of four main steps; create one part of the metadata; create the learning part; create the second part of the metadata; approve automatically created metadata. The report has also described and partly developed a prototype of an editor that allow to use this steps of creating metadata.[1]

A problem that Sarah Currier[2] [Currier, 2004] has mentioned is the general attitude in their conversations with e-learning colleagues around the world: that for both technology and pedagogy experts, metadata creation is seen as a tedious chore rather than as a complex set of skills, essential for unlocking access to resources. Probably, most of the users consider themselves done with the learning object when they have created the learning part. The problems with the standards today, are that they are too comprehensive, and some of the elements are not easy to understand. One could sometimes risk that creating the metadata takes more time than the creation of the learning part. For a user that consider the learning part as the most important part of the learning object, the tedious meta-data creation seems unnecessary.

Duval and Hodgins [Duval, Hodgins, 2004] say that the metadata should not be visible to the user, and it should be generated automatically. But the pedagogical information in the metadata is not easy to create automatically, and is not possible at the present time.

1. For more see; Silje Rossvoll‘s , “Learning objects”, The Norwegian University of Science and Technology (NTNU)
2. Sara Currier has worked as a librarian and at the influential learning object repostory project SeSDL with constructing a subject taxonomy for their repository. She has also worked in CETIS, and is currently working in Stor Curam a Scottish project that works with learning object repositories.

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Using design patterns to describe the learning parts allows the user to focus on the pedagogical information. Design patterns also introduce the idea of creating the metadata in several steps. If this is done thoroughly, it is probable that it would be a factor in assuring the quality of the learning part. When the user starts describing the context, the learner, starting knowledge and target knowledge in the “Problem” of the design patterns, this can make him aware of the learners´ needs, and will hopefully lead to an improved learning part.

When the metadata is created in several steps, this also means that making a learning object with metadata will be one process, instead of two separate parts where one first creating the learning part and then create the metadata.

The benefits of the metadata editor is that it eases creation of metadata, and the user can continue to create the learning parts in his content creation tools. The challenge is to get the user to think of the metadata as an important part of the learning object. When the user wants to create a learning object, he does not start opening the tool for the learning part, but sees the metadata and the learning part as a whole, and starts creating the metadata. If the users will adopt this method to create a learning object would depend on how easy it would be to create a learning object, the compatibility with existing methods and techniques, and the relative advantage in comparison with these established methods and techniques.

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Chapter 1: Learning Objects

For some time now, the learning community has been excited at the prospect of developing learner-centered solutions. In the past, training methods have used large, monolithic, inflexible training courses, which demand a lot of resources. The solution to this problem is to divide the courses into smaller components that again can be put together into new courses. The idea is that with proper descriptions, these smaller components can be stored, retrieved, and then again reused in new courses. These components are what we call learning objects, and the descriptions of the learning objects are the learning object's metadata. The potential of learning objects is immense, but there are several obstacles on the way. These challenges will be presented in this chapter, and discussed later in the article.

Definition

At the present time there is no single, determined definition of what a learning object is. The definitions that have been used until today have varied in size, terminology and focus, and have often been defined after each organisation's need. As an intuitive definition, several have mentioned the LEGO analogy, for example Wayne Hodgins and Marcia Conner:

LEGO analogy

"A simple example of valuable standards that I came to appreciate in life, and my children still enjoy, comes in the LEGO product-line. All LEGO blocks adhere to one absolute standard for pin size. Every LEGO piece, no matter what shape, colour, size, age, or purpose can always be snapped together with any others piece because of their uniformly shaped pins. This allows children of all ages to create, deconstruct, and reconstruct LEGO structures easily and into most any form they can imagine. If we map this to the world of learning content, we start to see the opportunities that would result if we were able to have the same standards and capabilities to reuse and assemble or disassemble content drawn from any source at any time" [Wayne Hodgins & Marcia Conner, 2000].

IEEE LTSC's definition

A more formal definition is the IEEE LTSC's definition:

A learning object is defined as any entity, digital or non-digital, that may be used for learning, education or training [LTSC IEEE March, 2002].

This definition has been criticised for it's wideness. With this definition, it is almost nothing that can not be a learning object. A more useful definition is Wiley's definition: "Any digital resource that can be

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reused to support learning...The main idea of “learning objects” is to break educational content down into small chunks that can be reused in various learning environments, in the spirit of object-oriented programming.” [David A. Wiley]

General Consensus

However, the general consensus seems to be that a learning object is:

“The smallest element of stand-alone information (including but not limited to, online instruction or a performance support tool) required for an individual to achieve an enabling performance objective or outcome.” [Ellen D. Wagner, April 2001]

An characteristic with all of these definition is the lack of one aspect; the metadata that describes the content of the learning object. In this report a learning object will be digital, and consist of two parts; a learning part that is “The smallest element of stand-alone information required for an individual to achieve an enabling performance objective or outcome.”, and a metadata part.

Challenges

The eLearning technology still is in an early phase, and there are several challenges to solve. Some of them are listed below:

Standards

When one creates a learning object it has to be done based on a given standard for learning objects. This makes the learning object easier to reuse, but results in extra work for the creator.

Time

To create a learning object takes time, and the more complex it is, the more time it takes. Learning objects created has also to be based on a standard which may require additional time.

Accessibility

It can be difficult to make the learning object fit into the learning context. For example it can be difficult for students with a slow Internet connection and/or slow hardware to access a digital animation. Then the learning object will not be accessible for all the students.

Pedagogical design

Good learning objects should be designed after pedagogical design principles and guidelines. This demands that the creators have a knowledge and understanding of pedagogy, and that they can use it. In addition the system must allow pedagogical design. To find someone that have this knowledge can take time, and be expensive. Another possibil-

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ity is a person with knowledge about pedagogical design principles, but does not have any information about the learners. This means that the creator is working "blind".

Learning Management Systems

In some cases one uses Learning Management Systems to sequence and administer learning objects. This is a cost of time, effort, and resources which could act as a barrier.

Tools for editing

To create a learning object one may need a new tool to complete the job. This added cost could be a barrier if there is a lack of funds, if there is no time to learn the new software, and/or other resource-based challenges.

Standards[1]

In the article "Three Objections to Learning Objects and E-learning Standards" [Friesen, 2003] Friesen[2] presents three problems with learning objects and standards. Several nations around the world are now using large sums on initiatives that are going to secure the development of learning objects, metadata and storages to store these learning objects and metadata. Friesen writes that there has not been any in-depth studies of the pedagogical consequences of these systems and ways of thinking, and no examinations of their epistemological and ideological implications. He thinks this has resulted in that fewer have started using the new technologies, both the users and the vendors.

Friesen starts with objecting to the actual term learning object. In the first place there is no clear, unambiguous definition of what a learning object is, and IEEE's definition is so wide that there are few things that can not be a learning object.

The result of this is that the development by the different actors are going off in all directions.

"...the term "learning object" juxtaposes two words that are in many ways incongruous and ultimately, incommensurable: The "object," is a thoroughly and very specific technological paradigm as specialized terms such as "concurrency," "polymorphism" and "typing" indicate. It

1. Standards see also QUIS, WP5 [De Marsico et al, 2006].

2.Norm Friesen are the director of the CanCore Initiative, and connected to the IMS Global Consortium Metadata Working Group, IEEE Learning Technology Standards CommitteeDogotal Rights Expression Group and ISO/IEC JTC1 SC36.

is part of an approach whose basic principles are so specialized to be difficult to express in everyday language. And the “learning,” is equally extreme in its vagueness, generality and broadly non-technical nature. In clear contrast to the dominance of the object-oriented paradigm in programming and software design, there is no consensus among educational experts as to how learning occurs or how it can best be understood.” [Friesen, 2003].

In Friesens opinion the divergence in these two terms is the underlying reason to the difficulties of giving one good, common definition of a learning object, and this is also why the process of starting to use the learning object technology has been slow.

Friesen quotes a research study from 1962. This research shows that the rate of adoption increases significantly when innovations possess some of the following characteristics:

1 simplicity,

2 compatibility with existing methods and techniques, and

3 relative advantage in comparison with these established methods and techniques [Rogers, 1962].

“The term “learning object” suggests neither simplicity, compatibility nor any obvious relative advantage over prevailing teaching practice” [Friesen, 2003].

The second objection is the statement that standards are pedagogical neutral. Standards shall secure compatibility, portability and reusability for content and systems. This implicate that specifications and standards are not connected to any approach or paradigm associated to learning. ELearning standards and specifications are expected to support several forms and practices for learning, and from this it follows that they are “pedagogical neutral”. One prominent specification effort that emphasizes this type of neutrality is the “SCORM” initiative (Shareable Courseware Object Reference Model): It describes itself as providing “pedagogically neutral means for designers and implementers of instruction to aggregate learning resources for the purpose of delivering a desired learning experience” [Friesen, 2003] . Friesen´s argument is that the active engagement that lies implicit in pedagogy and learning does not allow pedagogical neutrality. Specifications and applications that are truly pedagogically neutral cannot also be pedagogically relevant.

A lot of the eLearning standardization and learning objects today show signs of the ideology and need of the American aviation industry. This is Friesens third objection. The aims in the public education are

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very different from the aims in the American defence. Now the students are drilled in some tasks they are going to know how to solve, but they should be able to explore more on their own.

Another person that share this view is Dan Rehak[1]. He is one of the main architects behind SCORM, and he says that SCORM is not the right approach for institutions in higher education or in the elementary schools. SCORM is suited for an individual, self learning and self steered student. It is a limited pedagogical model, unsuitable for some communities [Rehak, Dan - CETIS, 2002]. Mark Oehlert, the communications officer in ADL answers to this claim in an article and explains that SCORM's main focus is interoperability within content that can be reused, and this can be used in the elementary schools as well as in higher education.

Metadata

Sarah Currier[2] writes in the article, "Metadata Quality in e-Learning: Garbage In -Garbage Out?" [Currier, Sarah, 2004], about the problem with poor metadata. When a matadata standard is implemented in a system, specific fields have to be filled in with real data about real resources. This causes problems. For the ones who search for learning objects, these problems are made clear by that it is difficult to retrieve resources, and that it is inconsistences in the search results.

"If you cannot search for an educational resource because it does not have metadata, or a search returns several hundred or thousand results; cannot reuse the resource because you cannot locate it or decide which resource is relevant to your needs because of the time required to assess the results of the search." [Ryan & Walmsley, 2003]

It is a common thought that metadata is easy to create for most of the creators of learning objects, because all they have to do is to fill out a form with the suitable metadata. Sarah Currier writes that this is not very well thought-through, and has in cooperation with Jane Barton presented some underlying assumptions for this way of thinking.

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1. Dan Rehak in the Carnegie Mellon -Learning Systems Architecture Lab
2. Sara Currier has worked as a librarian and at the influential learning object repostory project SeSDL with constructing a subject taxonomy for their repository. She has also worked in CETIS, and is currently working in Stor Curam a Scottish project that works with learning object repositories.

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• That, in the context of the culture of the Internet, mediation by controlling authorities is detrimental and undesirable;

• That rigorous metadata creation is too time-consuming and costly, a barrier in an arena where the supposed benefits include savings in time, effort and cost;

• That only authors and/or users of learning materials have the necessary knowledge or expertise to create metadata that will be meaningful to their colleagues;

• That, given a standard metadata structure, metadata content can be generated or resolved by machine.

These assumptions are in Currier & Barton's opinion wrong, and they present what they think is an improvement to the creation of metadata; the Collaborative model. In this model the work is divided into two steps:

1 The educational practitioner is responsible for entering the basic metadata, including title, description, contribution and any technical information they may be aware of.

2 The information scientist is responsible for reviewing the basic metadata and providing additional metadata for subject classification, educational attributes etc.

The collaborative model has also been proposed for the creation of metadata in semantic web. Even if there are some challenges with the collaborative model that delay the process with creating learning objects, more people should be involved etc, this model is also recommended by the JORUM[1] project. JORUM is a major UK-wide funded project developing a cross-sectorial, multi-disciplinary repository for sharing learning objects.

Not everyone shares this view. Duval et al argue in their article "Metadata Matters" [Duval et al, 2004] that metadata should as much as possible be created automatically. Duval et al. think that it is wrong that it is only people, and preferable people with a background in indexing, that can create good metadata. In their opinion the developers today are to preoccupied by continuing to pursue the present practice, than designing and developing something new and more effective. Standards are going to make it possible for developers to realize compatible technical components, and are not meant to be visible for the end users. Terms such as "Catalogue Entry", "Contribute" and "Semantic Density" are suitable for the standard document itself, but are not necessarily well known to the creator of the metadata. Duval et al´s opinion is that

1. JISC Online Repository for [Learning and Teaching] Materials, http://www.jorum.ac.uk/

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in the same way as the browsers hide the details of HTML or HTTP, the different tools must as much as possible hide the detailed metadata of learning objects. In fact the ARIADNE learning object repository - “Knowledge Pool System” has in cooperation with Blackboard Learning Management System already managed to generate a detailed set of metadata automatically.

Duval et al ate a number of suggestions of how the metadata can be generated automatically, and are of that opinion that it is easier for the user to get a proposed metadata, and see if it is correct, than create the metadata himself. They also write that it is a myth that good metadata only can be created by professionals. Several studies have showed that “amateurs” can do this just as well, and this is why it is important to get them interested in creating good metadata.

But even though Duval et al think that metadata should be invisible for the end users, they write “... we believe there is a serious need for large communities of practice; professions etc. to take on the responsibility of providing the critical elements of relevance and applicability to their disciplines and constituents. This includes the hard, but necessary work of defining vocabularies, taxonomies, ontologies, etc.”Duval et al describe an example with a video machine in their article. Every time one watches a TV program one has recorded, one can give it a character by pushing a “thumb up”-or “thumb down”-button. Gradually the video machine will know which type of programs one likes to watch, and will record these when something interesting comes. This functionality with recognition of certain attributes the user likes, they think that also can be important within the field of eLearning.

In the metadata survey presented in section 2.4, “International LOM Survey: Report” [Friesen, 2004], Friesen concludes that LOM are going to be an important basis in the further work with standards. There he mentions Duval et al´s article, where Duval et al argue that it is wrong to base further development on the present technology. Friesen on the other hand writes that the success of the video machine and its idea, can not serve the basis for development of standards for education, learning and training. This is because: “1) The practices and contexts of education and training differ in substance from those of other domains, such as entertainment or television watching. 2) More importantly, speculations on future developments in technologies and the social practices that develop with them are notoriously prone to error, and especially subject to ideological and other distortions‘” [Duval, 2004]

Pedagogy

In the article “Modelling Units of study from a pedagogical perspective - the pedagogical meta-model behind EML” [Koper, 2003], Koper[1] asks “Where is the learning in eLearing?”. It is a widespread idea that it is the media (Internet) that is the main factor to the success of eLearning, but it is not Internet itself that is the reason for this success -it is the pedagogical design used in connection with the characteristics of the media. Another common idea is that learning is the same as transfer of knowledge, and further that it is enough to make the knowledge available for the student, within some pedagogical structure. To make the proper knowledge available is not enough, the content has to be learned. Studies shows that learning does not come with available knowledge alone, and that it is the activities that the student perform in the learning environment, that are the main factors for the learning.

As mentioned earlier, Friesens writes that something that is pedagogical neutral can not be pedagogical relevant. Rob Koper writes in his article “Combining reusable learning resources and services to pedagogical units of learning” [Koper, 2003] that even if several standards and specifications claim to be pedagogical neutral, they are in practice not. If learning technology is going be pedagogical neutral, it has to support ways to learn in both ends of the spectrum of approaches to learning (from knowledge transfer to active learning) and any model in between:

1 Technology designed to search, order and package resources in a way that fits into the traditional view of teaching. The basic components in this approach are the “resources” or “learning objects”.

2 Technology designed to stimulate learning activities, discussions and advanced assessment at the other end of the spectrum. The basic components in this approach are the “services” which support the learning process (such as e-mail and discussion forum).

IMS Content Packaging Specification, ADL SCORM and IEEE LTSC LOM are some specifications that use the traditional approach to learning, even though most of them claim to be pedagogical neutral. What this means is that in reality that given a traditional pedagogical model, the learners can use what learning strategy they want.

1. Rob Koper is professor of Educational Technology at the Educational Technology Expertise Centre (OTEC) of the Open University of the Netherlands. He is director of learning technologies research & development. He was, among other things, responsible for the development of Educational Modelling Language (EML), currently known as the IMS Learning Design specification.

"In our view, a modern e-learning environment, including the underlying learning technology specifications and standards, should support both sides of the spectrum. Not by being ignorant of the pedagogy, not by being prescriptive in any of the hundreds of different pedagogical models around [Koper, 2001], but to allow the pedagogical model to be explicit."

A learning object can be viewed in several ways. The usual perspective is that learning objects are entities that may be referred to with metadata. The metadata itself are separate from the learning part it refers to. The metadata, and sometimes the learning parts itself, may be stored in databases. The metadata specification is described in the IEEE LOM standard specification. In Kopers opinion it is clear that the learning object model adapts to the principles in object orientation. Content packaging specifications organize and transfer series of learning objects. From this, Koper asks: ".. does this model of learning objects and packages provide us sufficient means to build complete, flexible and valid units of learning to be delivered through learning management systems?" [Koper, 2003]

The answer to this question must be "no". From a pedagogical point of view, it is not enough to organize the learning objects and metadata in this way. Several types of learning objects, for example a text or a test, have different functions when it comes to learning. The learning object model gives a general, superior structure of objects when it comes to learning, but lacks a model that express the semantic connection between different types of objects in a learning context. Mohan et al also mention this problem [Mohan et al, 2003]. To make pedagogical decisions when it comes to learning objects demands good pedagogical information in the metadata. The metadata say nothing about how the learning objects can be put together, and neither if such a composition in fact is suitable for the purpose. Other objections Mohan et al have when it comes to the pedagogical matters, is that the metadata do not say anything about the learning outcome, which students the learning object is suitable for, or which learning strategy it uses.

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Chapter 2: Standards[1]

Learning technologies have been evolving over the last decades, and have gone through many phases and approaches. In the early phases the learning software development has often been the result of individual ideas and initiative, and little regard has been paid to ensuring that learning software can survive the rapid change in technology [CETIS, 2004]. The libraries have developed ways for categorising and describing text, but no such system has existed for computer-based learning materials. This lead to a somewhat chaotic learning content world, and it is difficult to retrieve and reuse learning materials. To prevent this situation arising again, interoperability standards are needed. Administrative systems, like Learning Management systems, need to agree on what information they should contain and how they save it so that it can be transferred to other suppliers' systems, and between systems that want to use this information.

There are two key difficulties in achieving the standards described earlier [CETIS, 2004]. These are:

1. User´s needs and supplier´s needs are very different. Implementing standards represent a cost for suppliers, and stops them from protecting their user base from other suppliers, whereas for users, standards gives them flexibility and choice. Consequently, suppliers want the smallest possible specification of standards, and users want a broad and well defined set of standards.
2. It is very difficult to define interchange standards that do not have some effect on functionality. It is not the job of specification bodies to define what systems do, but rather the format they save their data in. But the priorities that different specification make can represent a bias towards one educational approach amongst others.

In spite of these difficulties, achieving interoperability standards for learning technology will be such a great benefit, that it has to be developed. For learning content, not only technical standards like graphics interchange formats are needed, but also formats for the way in which the packaging, sequencing, and other management of the software is handled, so that it can be transferred between platforms and environments. Likewise standard ways of describing educational materials are needed so that they can be easily searched for and located. This report focuses on standards for describing educational content .

1. Standards, see also QUIS WP5 [De Marsico et al, 2006].

The involved bodies in learning object standardization

Since 1998 there has been rapid growth in the number of bodies working to develop specifications and standards for learning technology interoperability [CETIS, 2004]. Before the different bodies are presented, the process of how standards are developed is described.

- The process start with user needs and/or input from a research community active in a related area (Example: CETIS Special Interest Groups).
- This leads to specification work, defining how interoperability can be achieved in the field under consideration (Example: IMS).
- These specifications are tested for their validity by user organisations (Example: JCIEL projects, CETIS groups and AICC).
- Finally, if a specification is deemed to be valid and widely accepted, it is submitted to a formal standards body (Example: IEEE, a volunteer organisation, and ISO).

IMS - Global Learning Consortium, Inc

The IMS Global Learning Consortium was formed as an Educom project in 1997, and is one of the most advanced groups in advanced learning technology interoperability specifications. It is an independent, subscription-based non-profit organisation, and has developed a membership that includes almost all the leading technology system suppliers, publishers and many user organizations. IMS is working on the development and promotion of open specifications for facilitating online distributed learning activities, and has two main goals [Hodgins et al, 2000]:

- Defining the technical standards for interoperability for applications and services in distributed learning.
- Supporting the incorporation of IMS specifications into products and services worldwide. IMS promotes widespread adoption of specifications that will allow distributed environments and content from multiple authors to work together. Source: http://www.imsproject.org/

DCMI

The Dublin Core Metadata Initiative (DCMI) is an organization dedicated to promoting the widespread adoption of interoperable metadata standards and developing specialized metadata vocabularies for describing resources that enable more intelligent information discovery systems. The Dublin Core is a metadata element set that contains 15 elements, and is intended to facilitate discovery of electronic resources. These elements can be refined to add richness of description.

The mission of DCMI is to make it easier to find resources using the Internet through the following activities:

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1 Developing metadata standards for discovery across domains,

2 Defining frameworks for the interaction of metadata sets, and

3 Facilitating the development of community-or disciplinary-specific metadata sets that are consistent with items 1 and 2.

The range of activities of DCMI includes:

• Standards development and maintenance, such as organizing international workshops and working group meetings directed toward developing and maintaining DCMI recommendations.

• Tools, services, and infrastructure, including the DCMI metadata registry to support the management and maintenance of DCMI metadata in multiple languages.

• Educational outreach and community liaison, including developing and distributing educational and training resources, consulting, and coordinating activities within and between other metadata communities. More about the Dublin Core Metadata Set in section 2.3.6. Source: http://dublincore.org/

AICC

The Aviation Industry CBT (Computer-Based Training) Committee was formed in 1988 and is an international association that develops guidelines for the aviation industry. However, the scope of AICC specifications goes further than aviation, and the AICC work with IEEE, IMS and ADL. AICC produce "AGRs" (AICC Guidelines and Recommendations) in a number of areas, from hardware to interoperability.

The objectives of the AICC are as follows:

• Assist airplane operators in development of guidelines which promote the economic and effective implementation of computer-based training (CBT).

• Develop guidelines to enable interoperability.

• Provide an open forum for the discussion of CBT (and other) training technologies.

Source: http://www.aicc.org/

IEEE LTSC

The Institute of Electrical and Electronics Engineers, Inc. Learning Technology Standards Committee is a leading authority in technical areas, including computer engineering, and the IEEE LTSC consists of working groups that develop technical standards in about 20 different areas in information technology for learning, education and training. Their aim is to facilitate the development, use, maintenance and interoperation of educational resources. The LTSC is most well known for the work on the Learning Object Metadata Standard (LOM) and the standardisation

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of the AICC CMI. The scope of this LOM standard is described like this on the IEEE LTSC web page:

"This Standard is a multi-part standard that specifies Learning Object Metadata. This part specifies a conceptual data schema that defines the structure of a metadata instance for a learning object. For this Standard, a learning object is defined as any entity–digital or non-digital– that may be used for learning, education or training."

IEEE LTSC LOM is now collaborating with DCMI to design a meta-data architecture for web based learning education and training.

Source: http://ltsc.ieee.org/and http://www.ieee.org/

BSI

British Standards Institute is a British company that was formed in 1901, and participate in international activities concerning standards. The BSI IST/43 -Information technology for Learning, Education and Training standards in the UK has been set up as a response to the establishment of the ISO/IEC JTC1 sub committee for standards in the areas of Learning, Education, and Training. BSI IST/43 aims to promote standardisation, and is contributing to the ISO/IEC work as well as beginning to develop British standards. The group also intends to develop added value products to assist users of standards with their practical applications.

BSI IST/43 are becoming involved in the following fields of interest:

- Agreeing standards for metadata in learning technology
- Defining interoperability for computer managed instruction and between content software and learning management software
- Work in the area of assessment or questions in IT
- Agreeing a standard for student identifiers
- Work on the UK lifelong learning profile -UKLeaP

Source: http://www.bsi-global.com/index.xalter

ISO

The International Standards Organisation (ISO) is a network of national standards institutes form 140 countries and works in partnership with international organisations, governments, industry, business and consumer representatives. ISO has a Central Secretariat that is placed in Geneva, Switzerland, that coordinates the system.

The ISO/IEC JTC1 SC36 develops international standards in the field of Learning, Education, and Training, with an aim to enable interoperability and reusability of resources and tools. The IEC, also known as the International Electrotechnical Commission, is the international standards and conformity assessment body for electrotechnology and is working with the ISO on this sub committee. JTC1 is an acronym for "Joint Technical Committee 1" which has a scope of standardisation in the field of information technology as a whole. SC36 just means "sub committee 36".

ISO standards emerge from the work of these specification bodies.

Source: http://www.iso.org

ISO/IEC JTC1 SC36 http://jtc1sc36.org/

IEC http://www.iec.ch/

JTC1 http://www.jtc1.org/

CEN/ISSS

The Centre de European Normalsation/The Information Society Standardisation System (CEN/ISSS) was created in mid-1997 by CEN as the focus for its ICT (Information and Communications Technologies) activities, and in 1999, the European Commission gave a mandate to CEN/ISSS to identify a work-plan for Europe in the area of learning technology interoperability. This body claims to combine the rapid process of information specification with the security offered by the formal open consensus of traditional standardisation.

The CEN/ISSS Learning Technologies Workshop has contributed to work on the localisation of the IEEE LTSC Learning Object Metadata (LOM). The Workshop also has project teams focused around the following areas:

- Educational modelling languages
- Repository of taxonomies/vocabularies for a European Learning Society
- Educational Copyright Licence Conditions
- A Quarterly Electronic Newsletter
- A business plan source: (http://www.cenorm.be/isss/Workshop/lt/BP/ busplanwslt0402.pdf)

contains a detailed description of the work of the CEN/ISSS Learning Technologies Workshop.

ADL

Advanced Distributed Learning (ADL) was formed in 1997 by the US federal government to promote sharing of learning material between the state, the industry and educational institutions. ADL´s main goals [CLOE, Stories, 2005]:

- Develop guidelines for development and implementation of efficient, cost-effective distributed learning on a large scale.

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- Identify and promote business models and economic incentives for consumers and vendors of distributed learning content, tools and systems.
- Establish a rapidly growing network community of education and training consumers.
- Stimulate large-scale collaborative developments by organizations that share learning requirements.
- Identify technical challenges that exceed the current state-of-the-art and initiate collaborative research and development (R&D) programs to meet those challenges.

ADL has developed the standard SCORM (Sharable Content Object Reference Model). ADL has coordinated and built upon the work of groups like IEEE/LTSC, ARIADNE, IMS in attempts to create a unified set of standards, specifications, and guidelines for learning objects. Source: http://www.adlnet.org/

ARIADNE

Association of Remote Instrutional Authoring and Distribution Networks for Europe (ARIADNE) is a research and technology development project sponsored by EU. The project focuses on the development of tools and methodologies for the production, management and reusing of computer based learning material.

The ARIADNE Foundation is involved with the standardization efforts of the IEEE LTSC, and is working with the Educase IMS Project to assist in developing the metadata standards (LOM -learning objects metadata). The ARIADNE Foundation is also working with the ADL Initiative, and the SCORM standards [CLOE, Stories, 2005]. Source: http://www.ariadne-eu.org/

eStandard-prosjektet

eStandard-prosjektet is involved in defining the Norwegian LOM-profile: NORLOM. It was founded in January 2003, and are working in all of the areas in the education sector. The main goal is to build a network of professional exchange and debate with a wide participation. Source: http://www.estandard.no

Standards, the Element Categories

In this section some of the most important standards and application profiles are presented. The Norwegian application profile of LOM, NORLOM, has recently been published, but is not included in this comparison. The Norwegian LOM profile contains a minimum of elements because it is going to be easy to implement, and that instances of NORLOM not shall be rejected because one does not have access to or wants

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to provide the learning object with that amount of metadata. It is also emphasized to create interoperability with samples that are based on the European CELEBRATE-profile. The CELEBRATE-profile and the UK LOM Core have been of important inspiration to the work with the Norwegian LOM profile [eStandard.no, 2005]. Actually, the element set of the NORLOM profile only differs from UK LOM Core with one element in the Life Cycle Category (2.1:Version), and two elements in the Technical Category (4.1:Format, 4.3:Location).

IEEE LOM

The IEEE standard, 1484.12.1 -2002 or IEEE LOM [Hodgins el al, 2002], is the basis of several standards, and a number of the standards today are further specifications, guidelines and selected elements from this document. IEEE LOM is composed by the IEEE Learning Technology Standards Committee (LTSC) and was based on the early work of the IMS Global Learning Consortium. The purpose of this standard was to provide a structured way to describe reusable, digital learning objects. The standard is very comprehensive, and it has since it's publication been discussed if it is too complex to implement all of it. IEEE LOM defines 68 metadata elements that are divided into nine categories[1]:

Table 2-1: The Element categories in IEEE LOM

Nr	Name	Explanation
1	General	This category groups the general information that describes this learning object as a whole.
2	LifeCycle	This category describes the history and current state of this learning object and those entities that have effected this learning object during its evolution.
3	Meta- Metadata	This category describes this metadata record itself (rather than the learning object that this record describes). This category describes how the metadata instance can be identified, who created this metadata instance, how, when and with what references.
4	Technical	This category describes the technical requirements and characteristics of the learning object.
5	Educational	This category describes the key educational or pedagogical characteristics of the learning object.

1. The descriptions in the table is taken from IEEE 1484.12.1-2002, "Draft Standard for Learning Object Metadata"

Table 2-1: The Element categories in IEEE LOM (Continued)

Nr	Name	Explanation
6	Rights	This category describes the intellectual property rights and conditions of use for this learning object.
7	Relation	This category defines the relationship between this learning object and other learning objects, if any. To define multiple relationships, there may be multiple instances of this category. If there is more that one target learning object, then each target shall have a new relationship instance.
8	Annotation	This category provides comments in the educational use of the learning object, and information on when and by whom the comments where created. This category enables educators to share their assessments of learning objects, suggestions for use, etc.
9	Classification	This category describes where this learning object falls within a particular classification system. To define multiple classifications, there may be multiple instances of this category.

SCORM

Sharable Content Object Reference Model (SCORM) is a standard and a framework for creating, sharing and presentation of learning objects, and are developed by Advanced Distance Learning (ADL). SCORM's learning object model is based on IMS LOM, but calls it´s learning objects "Sharable Content Objects" (SCO). SCORM is an application profile that has taken part in the defining of the market for the vendors of Learning Management Systems, and is reckoned as one of the leading standards on the market. The focus of the developers has been on the infrastructure in the Learning Management Systems, that is delivering and packaging of the learning objects, and has adapted the IEEE LOM model for metadata.

CanCore

The CanCore Initiative was established in November 2000 to address common concerns regarding information management and resource discovery within a number of Canadian public-sector e-learning projects. The main objective of the CanCore Initiative was to coordinate the work with creating and sharing of data. One metadata standard that has been especially significant for CanCore is the Dublin Core Metadata Element Set (DCME is described in section 2.3.6). The CanCore metadata set

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consists of 46 elements, and all of the elements are optional. In CanCore‘s view as much as possible of the not intuitive metadata should be invisible to the common user, but also that the more advanced user should be able to describe the learning objects more precisely. The text below is taken from "CanCore Guidelines Version 2.0: Introductio". [Friesen el al, 2003].

"The Learning Object Metadata standard (IEEE 1484.12.1-2002 or LOM; also known as IMS Learning Resource Meta-data) is both complex and general in character, contains a broad range of elements, and leaves open many possibilities for interpretation. CanCore seeks to simplify and interpret this standard in order to help implementers and record creators with design, development, and indexing work. CanCore began this task by identifying a subset of the many elements in the LOM, selecting them on the basis of their simplicity and their utility for resource discovery and sharing. The current document, however, provides recommendations for the semantics and syntax of all LOM elements based on best practices in indexing and metadata communities."

From the subset of 61 elements (46 “Active"), CanCore operates with 4 different subsets; Possible Search Subset (13 elements), Possible Results Subset (21 elements), Automatically Supplied Values (21 elements) and Values Supplied by Record Creator (20 elements).

SingCORE

SingCore is a standard from Singapore and is described as "Singapore‘s Meta-data Schema for Labeling Digital Learning Resources." Its purpose is to customize the LOM standard for local Singapore needs. This standard also uses a subset of LOM, 52 elements, and all the elements are mandatory. The ideal has been a standard that is more specific than the Dublin Core, without defining a set of metadata where a number of the metadata do not have any practical use.

UK LOM Core

Like CanCore, the purpose of the UK LOM Core[1] is to "identify common practice and provide guidelines for metadata implementers, creators and users." [UK LOM Core, 2004]. The UK LOM Core is essentially an application profile of the IEEE 1484.12.1 -2002 Standard for Learning Object Metadata that has been optimised for use within the context of education in the United Kingdom. It uses all of the IEEE LOM elements, and identify them as Mandatory or Optional.

When the UK LOM Core profile was developed, a subsequent comparison was undertaken of twelve metadata schemas based on the IEEE

1. United Kingdom Learning Object Metadata Core; http://www.cetis.ac.uk/profiles/ uklomcore

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Learning Object Metadata Standard. Some of these schemas were the schemas produced by SCORM, CanCore, FAILTE, the National Learning Network and the University for Industry. As a result of this comparison, a set of guidelines has been drafted to inform UK practitioners on the implementation of a minimum common core of LOM elements and associated value spaces. The Norwegian LOM profile, NORLOM, is based on UK LOM Core.

Dublin Core

This element set "was created to provide a core set of elements that could be shared across disciplines or within any type of organization needing to organize and classify information" (Dublin Core Metadata Initiative, 2002b). The element set consist of 15 elements, that can be adapted to the IEEE LOM. All the elements are optional.

Use of Educational Category Elements

Table 2-2 contains an overview of which educational elements each of the standards define and which elements that are Mandatory or Optional[1].

Table 2-2: Use of Educational Category Elements in Profiles[a]

Element	SCORM	CanCore	Sing-Core	UK LOM Core	Dublin Core
5: Educational	O	Y	Y	O	
5.1: Interactivity Type	O	N	N	O	
5.2: Learning Resource Type	O	Y	Y	O	DC.Type
5.3: Interactivity Level	O	Y	N	O	
5.4: Sematic Density	O	N	N	O	
5.5: Intended End User Role	O	Y	Y	O	
5.6: Context	O	Y	Y	O	
5.7: Typical Age Range	O	Y	Y	O	
5.8: Difficulty	O	N	N	O	

1. For the other elements which are not included in this comparison, see Silje Rossvoll's , "Learning objects", The Norwegian University of Science and Technology (NTNU)

Table 2-2: Use of Educational Category Elements in Profiles[a]

Element	SCORM	CanCore	Sing-Core	UK LOM Core	Dublin Core
5.9: Typical Learning Time	O	Y	N	O	
5.10: Description	O	N	N	O	
5.11: Langugage	O	Y	N	O	

a. The numbering comes from element "5" in "The element categories in IEEE LOM"

LOM Survey

In July 2004 a LOM survey report was published [Friesen, 2004]. The intention of undertaking an international survey of LOM implementations was announced at the plenary meeting of the "Information Technology for Learning, Education and Training" ISO/IEC JTC1/SC36 subcommittee in March 2003. It has been CanCore in Canada and metadata experts in Finland who have written this report.

The survey focuses on two questions:

1. Which elements were selected for use or population?
2. How were these elements used, or what were the types of values assigned to them?

LOM samples received

To find answers to these questions, the survey analyses five record samples from widely varying regions. Sets of records from 75 to over 3000 was received from different projects, and a record set of 50 was chosen from each project. The nature and emphasis of the projects or collections that contributed metadata instances varies[1]:

ARIADNE (EU): The "Ariadne Knowledge Pool System" is a distributed repository built to enable better quality learning through the development of learning objects, tools and methodologies that enable a "share and reuse" approach for education and training. The metadata set has been ARIADNE Educational Metadata Recommendation -V3.2 and is available at http://www.ariadne-eu.org. This metadata set maps to the LOM. The metadata that are created and maintained in this project is not certain, but the metadata surveyed here shows distinct signs of hav-

1. Some of the descriptions of the projects are shortened and some are taken directly from the descriptions in the LOM Survey [ISO/IEC JTC1 SC36, Friesen, 2004].

ing been systematic work of a small number of individuals with expertise in metadata.

LTSN Economics (UK): The Learning and Teaching Support Network for Economics is hosted by the Economics Subject Centre of the UK's Higher Education Academy. This collection has usage guidelines based on the UK LOM Core[1] and the RDN Cataloguing Guidelines[2], which are used to assure the quality of the metadata. The metadata in this collection appears to have been based in some detail on this profile and these guidelines.

CELTS (China) : CELTS is an acronym for Chinese E-Learning Technology Standard, and is the title of a LOM application profile in use in China. Further information on the CELTS application profile is available at: http://mdlet. jtc1sc36.org/doc/SC36_WG4_N0059.pdf. Who has created and maintained the metadata in this project is not known, but conformance measures and a conformance test suite have been discussed in the context of CELTS.

CAREO (Canada) : CAREO is an acronym for Campus Alberta Repository of Educational Objects, and has as its primary goal "the creation of a searchable, web-based collection of multidisciplinary teaching materials for educators across the province [of Alberta, Canada] and beyond." The repository contains over 3500 metadata records, and is based fairly strictly on the LOM itself. The records studied here have been added under a variety of workflow processes and circumstances. End users with little or no metadata support and background are encouraged to create records. Trained and supervised indexers or record creators have not typically been used. No specific application profile was used in the development of the repository or the metadata records[3]

Metalab (France) : METALAB refers to the tool that has been used to assist in the creation of this set of metadata records. The design of the METALAB tool is based on the ManUeL application profile. The only available information associated with these records is the following: METALAB is an indexing tool assisting in the pedagogical and physical description of teaching resources. Further information at http://www.uel-pcsm.education.fr/metalab/.

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1. http://www.cetis.ac.uk/profiles/ uklomcore/uklomcore_v0p1.doc
2. http://www.rdn.ac.uk/publications/cat-guide/
3. http://www.careo.ca for other information related to the repository.

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Prliminary findings

The survey is done in two stages, first the preliminary findings were presented in September 2003, and final report was published in July 2004. The preliminary findings involved smaller samples records from different populations of metadata instances, and each record set was manually inspected.

The preliminary findings were as follows:

1 Some complex LOM structures are utilized very effectively and precisely.
2 A small number of the potential LOM elements are used.
3 Few of the element iterations and field lengths are put to use.
4 Problems with referencing and using vocabularies.
5 Many of the elements used are in the Dublin Core Element Set.
6 Use of Educational elements is not necessarily high.
7 Problems with vCard[1].

Generally, only about 1/2 to 2/3 of the "active" LOM elements were populated in a given record. That only a small number of the potential LOM elements were used indicates several things, and will be discussed further in section 7 Discussion.

Element use

We will here only present the Eductional Category Elements[2]

Table 2-3: LOM Survey, Educational Category Elements

Element	France	CELTS	UK LTSN	CAREO	ARI-ADNE	Total	%
5: Educational	50	50	50	21	50	221	88.4
5.1: Interactivity Type	47	0	0	20	50	117	46.8
5.2: Learning Resource Type	49	50	50	3	50	202	80.8

1. Card is a electronic business card, and carry vital directory information such as name, addresses (business, home, mailing, parcel), telephone numbers (home, business, fax, pager, cellular, ISDN, voice, data, video), e-mail addresses and Internet URLs (Universal Resource Locators).
2. For the other elements which are not included in this comparison, [Rosvoll, Silje, 2005].

Table 2-3: LOM Survey, Educational Category Elements (Continued)

Element	France	CELTS	UK LTSN	CAREO	ARIADNE	Total	%
5.3: Interactivty Level	43	0	0	0	0	43	17.2
5.4: Semantic Density	0	0	0	0	0	0	0
5.5: Intended End User Role	50	0	0	0	50	100	40
5.6: Context	49	0	0	0	0	49	19.6
5.7: Typical Age Range	50	0	0	3	0	53	21.2
5.8: Difficulty	38	0	0	0	0	38	15.2
5.9: Typical Learning Time	50	0	0	0	0	50	20
5.10: Description	47	0	0		0	47	18.8
5.11: Language		0	0	3	0	3	1.2

Many different local vocabularies were used. Many of these vocabularies had different values, but many of the values seem to have comparable meanings or functions. The values used with frequency refer broadly to the genre or intellectual type of resource (hypertext, notes, video), rather than to a specific educational application (assignment, exam, self-assessment).

Survey conclusion

Based on these findings, the survey draw four major conclusions, and many of these conclusions are consist with the findings in the preliminary stage of the survey.

Listed below are the four conclusions[1].

1. LOM structures make data portability difficult to realize using conventional and low cost technologies. These structures should be revised so that they are not so dependant on costly, native-XML storage and processing technologies.

1. The conclusions are quoted from the LOM Survey [ISO/IEC JTC1 SC36, Friesen, 2004].

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2 Any advantage that the inclusion of vCard might present in LOM records is far outweighed by the difficulties of implementation, and the under-utilization of vCard fields.

3 Elements describing the intellectual content (Keywords, Classification [with Purpose = Discipline]) and the characteristics of the resource as media and Internet files (Technical Format, Learning Resource Type) are well-utilized. Those which attempt to describe the resource as a software "object" or to associate with it an educational context or level are much less frequently used (e.g. Life-cycle.Version, Aggregation.Level, Semantic Density, Context). This extends to the vocabulary values for LifeCycle.Contribute.Role, where values consistent with traditional "authorship" and "publication" were consistently chosen over values descriptive of roles in software development or instructional design teams (e.g. "terminator", "validator"). (Differentiating data elemens that are "abstract" [e.g. semantic density] and "tangible" [e.g. learning resource type], [Kabel et al, 2003] report similar findings,: "different people annotate only 'tangible' data elements consistently. 'Abstract' data elements are not annotated consistently, certainly not when a single value is allowed."). As a result, WG4´s application of the term "learning resource" (rather than "learning object") to metadata seems prudent. It would seem further worthwhile to refine those elements describing the intellectual content and file characteristics of the resource, and to consider the deprecation of less-used elements and vocabulary values listed above.

4 Only a small number of the potential element iterations and vocabulary values were used. Given the difficulties that these nested iterations and vocabulary choices can present to systems developers and record creators, the complexity and frequency of their occurrence should be subject to examination. Also, given the higher semantic interoperability that could be realized with fewer and more narrowly defined vocabulary values, the identification and definition of such values should also be considered.

These findings are based on the assumption that the way the LOM is currently being implemented serves an important basis for defining future metadata requirements and approaches. And further that the examination of the way in which this metadata standard is currently utilized provides valuable and verifiable empirical evidence of the utility or inadequacy of its components and characteristics.

Chapter 3: Design Patterns and learning objects

Design Patterns were introduced in the work of architect Christopher Alexander in the late 1970s. "A Pattern Language" [Alexander el al, 1977] was published in 1977, and "A Pattern Language" and "The Timeless Way of Building" are two halves of a single work. "A Pattern Language" describes the detailed patterns for towns, neighbourhoods, houses, gardens and rooms. The language presented can be used to work with others, or to design something for oneself. It can also be used to guide one in the actual process of construction.

"The elements of this language are entities called patterns. Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem in such a way that you can use this solution a million times over, without ever doing it the same way twice." [Alexander el al, 1977]

The use of design patterns has been adapted into several other areas, such as object-oriented software, eLearning, pedagogy, etc. The format of the design patterns varies in each area, but they all share some common minimum characteristics [The E-LEN project, 2004]:

- A ***name*** of the pattern.
- A description of the ***problem***.
- The ***context***.
- The ***forces*** that play a role in coming to a solution.
- The ***solution*** itself.

Examples of design patterns

The following sections will present some examples of design patterns used in software, pedagogical and learning objets areas.

Software patterns

The software example is taken from the book "Design Patterns -Elements of Reusable Object-Oriented Software" [Gamma el al, 1995]. Erich Gamma et al. write that their object-oriented software patterns have four essential patterns:

1. The ***pattern name*** is a handle we can use to describe a design problem, its solutions, and consequences in a word or two. Naming a pattern immediately increases our design vocabulary. It lets us design a higher level of abstraction. Having a vocabulary for patterns lets us talk about them with our colleagues, in our documentation, and even to ourselves. It makes it easier to think about design and to communicate them and their trade-offs to others. Finding good names has been one of the hardest parts of developing our catalog.
2. The ***problem*** describes when to apply the pattern. It explains the problem and its context. It might describe specific design problems such as how to represent algorithms as objects. It might describe class or object structures that are symptomatic of an inflexible

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design. Sometimes the problem will include a list of conditions that must be met before it makes sense to apply them to the pattern.

3 The ***solution*** describes the elements that make up the design, their relationships, responsibilities, and collaborations. The solution does not describe a concrete design or implementation, because a pattern is like a template that can be applied in many different situations. Instead, the pattern provides an abstract description of a design problem and how a general arrangement of elements (classes and objects in our case) solve it.

4 The ***consequences*** are the result and the trade-offs of applying the pattern. Though consequences are often invoiced when we describe design decisions, they are critical for evaluating design alternatives and for understanding the costs and benefits of applying the pattern. The consequences for software often concern space and time trade-offs. They may address language and implementation issues as well. Since reuse is often a factor in object-oriented design, the consequences of a pattern include its impact on a system's flexibility, extensibility, or portability. Listing these consequences helps you understand and evaluate them. [Gamma el al, 1995]

The software patterns are too comprehensive to be included here, but the elements in the template are: ***Pattern Name and Classification, Intent, Also Known As, Motivation, Applicability, Structure, Participants, Collaborations, Consequences, Implementation, Sample Code, Known Uses, Related Patterns.*** This template lends a uniform structure to the information, making design patterns easier to learn, compare and use, and is used in all of the design patterns in the book.

Pedagogical patterns

The example of a pedagogical pattern is taken from the European project E-Len Project. The E-LEN project was a project under the Socrates Programme with the aim to create a Network of E-Learning Centres and leading organisations in the learning technologies. One of their main objectives was to identify and gather best practices presented as a collection of design patterns and research roadmaps on e-learning [The E-LEN project, 2004].

The following E-LEN design pattern structure was developed in the project. The comprehensive structure is chosen to enable them to capture all relevant aspects of a design pattern.

- ***Name*** Give a name that:
  -covers the content (problem and solution)
  -is meaningful and easy to remember
  -gives rise to associations that are related to the described problem and solution.
- ***Category*** Choose from: pedagogical/organizational/technical. Combinations are possible.
- ***Abstract*** A short paragraph outlining key elements in the pattern.
- ***Problem*** A detailed description of the problem.

• ***Analysis*** An explanation of what makes this problem a problem, and why a solution is needed.

• ***Known solutions*** This section should set out what constitutes a "good practice" solution to the problem. It can be based on existing practice, or drawn from theory.

• ***Research questions*** A description of any research questions that are still to be solved, and ideas about possible research settings and methods. Other remarks.

• ***Context*** A description of the type of context the solution is applicable to.

• ***Conditions*** A general description of critical success indicators / factors that influence use / implementation of the solution (e.g. required roles, type of resources), resources needed to solve the problem.

• ***Discussion/consequences*** The consequences of use, implementation issues and other remarks.

• ***References*** References for the pattern.

• ***Related patterns*** Related design patterns and research patterns.

• ***Author(s)***

• ***Date*** Date of completion of the pattern.

• ***Acknowledgements*** Acknowledge any other people or sources of help, information etc.

This example is taken from the E-LEN project webpage[1] even if the elements differ slightly from the design pattern structure given above.

• ***Name*** Information about the pattern Hypertext Learning

• ***Belongs to SIG*** Lifelong learning

• ***Maturity level*** *

• ***Category*** Not available yet

• ***Problem*** How can the process of hypertext learning be supported?

• ***Analysis*** Hypertext learning has the advantage, that you have access to many chunks of information. You can use the information at any time. Most research in the area of hypertext refers to context, nodes and networking. There is a rich literature on this field. There are 6 learning steps that describe how hypertext learning takes place. The pattern can be used if the learning goal is to work with information in quite a deep way of processing.

• ***Solution***

1. A topic is searched and chosen; it should be processed in a nonintentional, but complex way
2. An overview is sought and control is intended. The subject tries to create a frame for the information flow (index, titles, synopsis, etc.) using back and forward browsing. The development of expectations relative to learning possibilities occurs.
3. The desired results of the work are decided upon -a product, a game with out any further function, a discovery by change, etc.
4. A free or controlled ("guided tour") way of learning is chosen.

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1. http://www2.tisip. no/E-LEN/index.php

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5. A free or guided path is realized. For both possibilities, deviations are always possible.
6. Relevant parts are stored; unimportant parts eliminated. Valid arrange ments are expressed and, thus, results are presented.

- ***Known uses*** Up to now there are no known uses in the area of e-learning.
- ***Context*** The pattern is in use in the area of computerbased-learning. The use of the pattern requires a higher level of knowledge on information-processing and facts about software- applications.
- ***References*** Oser, F., & Baeriswyl, F. J. (2001). Choreographies of Teaching: Bridging Instruction to Learning. In V. Richardson (Ed.), Handbook of Research on Teaching, 4th edition (pp. 1031-1065). Washington, DC: American Educational Research Association.
- ***Related patterns***
- ***More information on relations***
- ***Author(s)*** Pattern proposed by Wildner, S., Niegemann, H. M. & Domagk, S.
- ***Type*** Generic
- ***Submitted date*** 2004-09-17

A learning object patterns

The last example uses design patterns to describe a learning object. The example is taken from the article "Designing Adaptable Learning Resources with Learning Object Patterns" [Jones, 2004]. It is important to notice that this design pattern describes how a learning object should be -how to decouple links from the text. Design patterns are not used to describe the content of each learning object, but as the title of the article says; "Designing Adaptable Learning Resources with Learning Object Patterns",

- ***Name*** Decoupled Links
- ***Context*** A topic is common across a number of domains of knowledge and so a common learning resource could be used. However, in any particular knowledge domain, it would be pedagogically advantageous to provide contextual details from the domain being studied.
- ***Problem*** It is desirable to be able to reuse learning resources across different learning contexts, and in order that the resource supports each of the contexts in which it is to be used, it should be designed to be free of any one of them. On the other hand, within any particular context, it may be helpful from a pedagogical point of view to include context-specific material such as case studies or domain specific examples. There is, therefore, a tension between the desire to enhance reusability by making the resource context-free and the desirability of making it relevant to the learner within a specific context.
- ***Solution*** Design the main part of the learning resource to be completely context-free, but identify the places within the resource where useful contextual information could be provided. Include within the resource the ability to link to external expansion resources and, for each context in which the main resource is to be used, implement these expansion resources. The complete resource, therefore, consists of a main context-free part along with optional expansions that provide context-specific content. These expansions can be included with the main

resource when it is built for a particular context, or dynamically linked in at runtime.

• ***Example usage*** Mathematical techniques are used in a number of different fields. For example, trigonometry can be studied as a pure subject but is also necessary in the understanding of navigation (through space or on the sea) or in the use of a surveyor's theodolite. A learning resource giving a theoretical explanation of trigonometry could be entirely context-free and might be suitable for use in a pure maths course. However, those learning to navigate, or to be surveyors, might benefit from examples that are specific to their particular discipline. To cater for each of these cases a main context-free resource could be developed along with two sets of expansions that contain examples or further material. One of these would be designed to be suitable for navigators and the other for surveyors.

Discussion

The present situation and discussion in the eLearning research field have been presented. The LOM survey showed that not all of the elements are populated, and the standards have been criticised for not to describe the pedagogical model and content good enough. It seems to be a common thought that it is enough to make the information available for the learner, but it is importent to remember that "learning is reached based on the activities that the student perform in the learning environment."

SCORM is a widely used standard that uses the same elements as LOM. SCORM has been described as mainly been written for vendors and developers of learning management systems and authoring tools. SCORM is an important technical reference model for these products. Dan Rehak is one of the main architects behind SCORM, and he says that SCORM is not the right approach for institutions of higher education or the elementary schools [Rehak, 2002]. Mark Oehlert has responded to this statement by saying that SCORM emphasizes interoperability and reuse, which are important in all kinds of education [Oehlert, Mark - CETIS, www, 2006]. Even though they do not agree upon the learning model in SCORM, Rehak and Oehlert share the opinion that this discussion should continue and result in better future solutions.

In the LOM survey only a few of the element iterations and field lengths were put to use, and especially the descriptive information was very easily accommodated by the size or capacity of the elements specified by the LOM. From these findings one should think that writing descriptions are too time consuming, and that the elements that uses a vocabulary[1] was used in a larger extent. But the survey also showed problems with referencing to and using vocabularies. The records displayed inconsistencies or difficulties with the way in which they referenced (or failed to reference) local or custom vocabularies, and these vocabularies appeared to provide little potential for semantic interoperability.

1. a set with alternatives

The use of the educational elements was low, despite that LOM has been designed specifically for educational learning resources (or learning objects). It seems that the educational elements in LOM are not described good enough, or should be replaced with another, more intuitive way to describe the educational content. For example is the Educational element 5.4 in table 2, “Semantic Density”, not used in any of the record samples in the survey. This indicates that even if such terms can be suitable for the standard document itself, they are not necessarily well known for the creator of the metadata. It is therefore important that the standards make allowance for the pedagogical model to be visible, and that the educational elements are described properly.

Duval el al argue in their article [Duval & Hodgins, 2004] that as much metadata as possible should be created automatically. The only thing the user will have to do, is to read through the suggested metadata, and choose if he wants to change it or approve it. It would surely be a great advantage to make the metadata invisible for the users, but the educational elements, which this report emphasizes, are not elements that can easily be created automatically.

Sarah Currier presents the collaborative model as a method to create better metadata [Currier, Sarah, 2004]. In this model the creator of the learning object is responsible for entering the basic metadata, and an information scientist is responsible for reviewing the basic metadata and providing additional metadata for subject classification, educational attributes etc. This model will raise the quality of the metadata, but involves more people and resources. Even if this is more time consuming and expensive, it will be such a great benefit, that it is a good alternative. Poor metadata is equal to no metadata. The concern about this model, is that one can risk that only a few, qualified persons are capable to create good metadata.

It is desirable that the creator of the learning object also is capable to create the metadata, since he probably is the one that knows the learning object best. It will take time for the information scientist to learn the learning object and recognize the pedagogical model. It is likely that the creator of the learning object, which has experience in teaching and knowledge of the pedagogical model, is the one that is best suited to create the pedagogical metadata.

A big problem is to make the creators of learning objects want to create good metadata. Currier & Barton [Currier & Burton, 2004] discovered a general attitude in their conversations with e-learning colleagues around the world: that for both technology and pedagogy experts, metadata creation is seen as a tedious chore rather than as a complex set of skills, essential for unlocking access to resources. This attitude is probably not easy to change, but it is possible to facilitate the creation of metadata.

Sarah Currier writes: "How will users search for materials within learning object repositories and networks? For example, how important is it to have authority control over the names of authors and contributing institutions? What educational attributes will users search for, and how? Answers to these questions will have a profound impact on decisions about metadata creation." [Currier, 2004].

It is likely that a user rather would search for the content and the pedagogical model in a learning object, than for e.g. Rights elements or Life Cycle elements. If the learning objects were described with design patterns, there will be fewer elements, and the elements that are used, will contain the information that most of the users search for. The elements will be written in free-text, and learning objects can be searched for in free-text.

To strengthen the pedagogical part of the metadata, the goals of describing learning objects with design patterns will be to:

1 **Raise the level on the pedagogical information in the metadata** -Because the elements emphasize to describe the learning object thoroughly, with a description of learning object type, the learners and the pedagogical model.

2 **Facilitate the creating of metadata** -Because there are fewer elements to fill in, it is easier to understand what information the different elements should contain and the elements are written in free-text.

3 **Facilitate the retrieval and reuse of learning objects** -Because the information that the elements emphasizes on are the information that most users search for.

Hopefully this will help the creators to make better metadata, and how to describe learning objects with design patterns are further explained in the following chapters.

Design patterns and learning objects

It has earlier been discussed that an easier and more intuitive way to describe learning objects is needed. The educational and descriptive elements are not utilized good enough and the vocabularies are not used properly. To solve these problems it has been suggested to describe learning objects with design patterns. This chapter presents a draft of how this can be done.

Design patterns

Design patterns for learning objects differ from other types of design patterns because the solution in a design pattern for a learning object is a description of the learning object while the solution in for example a software pattern is an algorithm or a method to do something. In that way one can say that a learning object pattern is more like the original Alexandrian design pattern, where the pattern described a building or area, than newer patterns. However, one could argue that also the Alexandrian pattern describes a method to do something -that is a stepwise explanation of how to build or create a house, area, garden, bus-stop etc. In this context, Ray Jones‘s [Jones, 2004] way to use design patterns on learning objects corresponds better to the present use of design patterns. Jones uses design patterns to describe how a learning object should be constructed -not describe the content of every learning object, as is tried to do in this report.

Design patterns for learning objects also differ from other design patterns because learning objects have considerable more elements that describes the learning object, than for instance the elements that describes where to place a bus-stop in an Alexandrian pattern. The IEEE LOM standard defines 76 elements[1]

1. There are 11 educational elements in the IEEE LOM

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that describes the learning object, which means that it is not likely that the few elements in the learning object pattern can serve as a complete standard for the metadata. However, it is the objective that these elements should be enough to describe the content and pedagogical information of a learning object, and be the only necessary elements for retrieval and reuse.

Elements in a learning object pattern

Patterns are usually discovered in existing practice. A problem is solved over and over again, until the best solution is found. If each pattern is going to describe a problem which occurs over and over again, we can say that what the learner is going to learn is the problem. This is a problem which occurs over and over again because this information is something that different learners will need over and over again. For instance a learner could want to know more about the hardware's influence on the operating system -this is information that other learners will need after him. In addition to what the learner should learn, the problem also can contain information about the learner and which level he is in. The solution to this problem is a learning object that describes the hardware's influence on the operating system. The solution element describes the learning object, and if the learning object is made after a specific pedagogical model, this should be described in the solution.

The elements for learning object patterns in table 3-1 are based on the elements in [Jones, 2004] ;

Name, Context, Problem, Solution and Example usage. In addition to these elements two more were added; Learning object type and Limitations.

A draft of how the elements should be used are described in table 3-1:

Table 3-1: Elements in a learning object pattern

Nr	Element Name	Explanation
1	Name	The name of the pattern Give a name that: • covers the content (problem and solution) • is meaningful and easy to remember • gives rise to associations that are related to the described problem and solution
2	Learning object type	The type of learning object. Use Kopers classification of learning objects, and specify further if it is desirable.
3	Context	The principal environment within which the learning and use of this learning object is intended to take place. (Element 5.6 IEEE LOM)
4	Problem	A description and the background of the problem that the learning object is going to solve.
5	Solution	A description of the learning object - the solution to the problem.

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Table 3-1: Elements in a learning object pattern (Continued)

Nr	Element Name	Explanation
6	Limitation	Limitation or comments to the learning object.
7	Example usage	An example of how the learning object can be used - in this or other contexts.

- All of the elements should be written in free text.
- Name, Learning object type, Context, Problem and Solution is mandatory elements.
- Limitations and Example usage are optional elements.

The IEEE LOM has defined 15 learning resource types in the vocabulary for element "5.2 Learning Resource Type".[1] This was considered to be too detailed, and there are also a possibility that some learning objects do not fit in to these definitions. Therefore the five learning object types defined by Rob Koper in the article "Combining reusable learning resources and services to pedagogical purposeful units of learning" [Koper, 2003] were chosen. These learning object types are more extensive, and it should be possible to place the learning objects within one of the types. An explanation of the five types of learning objects are given below:

Knowledge objects are learning objects which contain information for people to learn from or to use while supporting the learning activities of others (for example teachers with students). An example is a web page with a series of information objects to learn, (e.g. about sensory systems); or a teacher‘s manual.

Tool objects are learning objects to learn with or to use while supporting the learning activities of others. Examples include electronic tools (java applets for statistics) or simulations.

Monitor objects are objects which provide information about the learning progress and tracking of ones own learning or that of others.

Test objects are learning objects used to assess learning results, learning progression or prerequisites -for example a complete test or a test item.

Resource organization objects are learning objects at a lower level that enable the resources to be organized in a particular way. Examples include aggregating pictures and text to a paragraph and paragraphs to sections and sections to chapters. These arrangements of objects, or "organizations", are used as the information reference containers in higher level objects such as knowledge objects, test objects and activity descriptions.

1. Exercise, Simulation, Questionnaire, Diagram, Figure, Graph, Index, Slide, Table, Narrative text, Exam, Experiment, Problem statement, Self assessment and Lecture

Descriptions of learning objects - example

Following is a collection of descriptions of some learning objects from a slide set and one from a hypermedia course. The learning objects are described with design patterns, according to the draft given.

Descriptions of a slide set

The slide set "Strukturering av lærematerielI" [Staupe, 2003] was the first learning objects that was described with design patterns. It consists of 30 slides 1 and 3 of the descriptions of these slides are presented below.

Every slide is described as one learning object. The slides are written in Norwegian, but are described in English. The figures ahead of the descriptions show the slides.

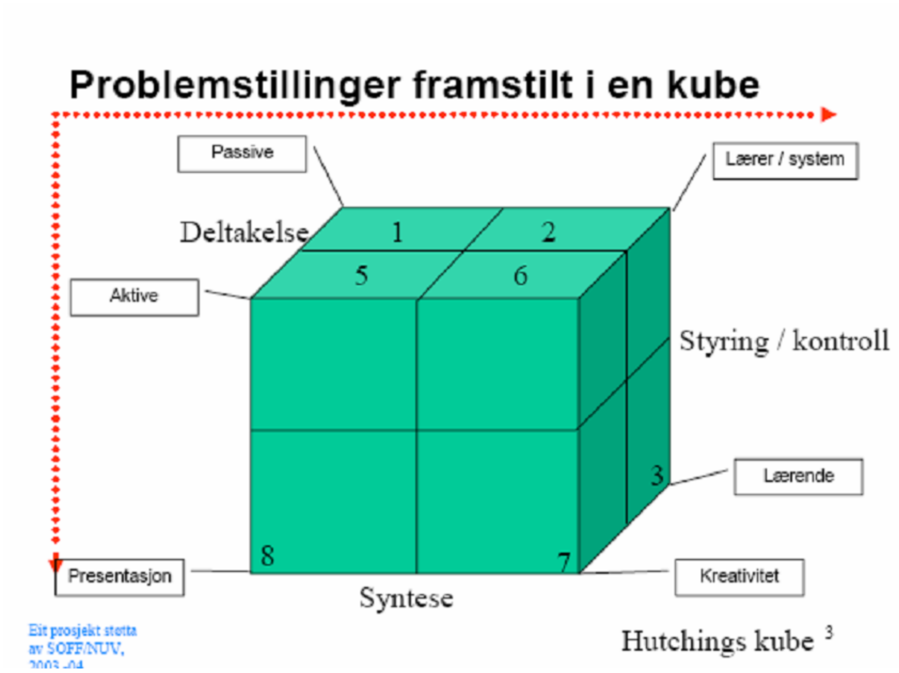

Figure 1; Slide; Problems represented in a cube

Problems represented in a cube.

Name

Problems represented in a cube

Learning object type

Knowledge object

Context

Education in pedagogical problems, use of ICT (Information and Communication Technologies) in education.

Language

Norwegian

Problem

When one talks about learning it is desirable to have a framework to refer to when one describes the different types of learning.

Solution

This is a slide that shows a pedagogical model called Hutching´s cube. The cube has three axes; participation, synthesis and steering/control with the range of passive to active, presentation to creativity and teacher/system to learner. In this model we can classify the learner from the passive learner where only the teacher/ system presents the information (corner no 1), to the active learner who is creative and has control over his/her learning (corner no 7).

Limitations

This model requires that the learners can understand a co-ordinate system with axes. The model is not described in detail, and should be supplemented by the teacher or by reading about the topic.

Example usage

The slide can be used in a course where one wants to get a visual and three-dimensional view of different learners and learning methods.

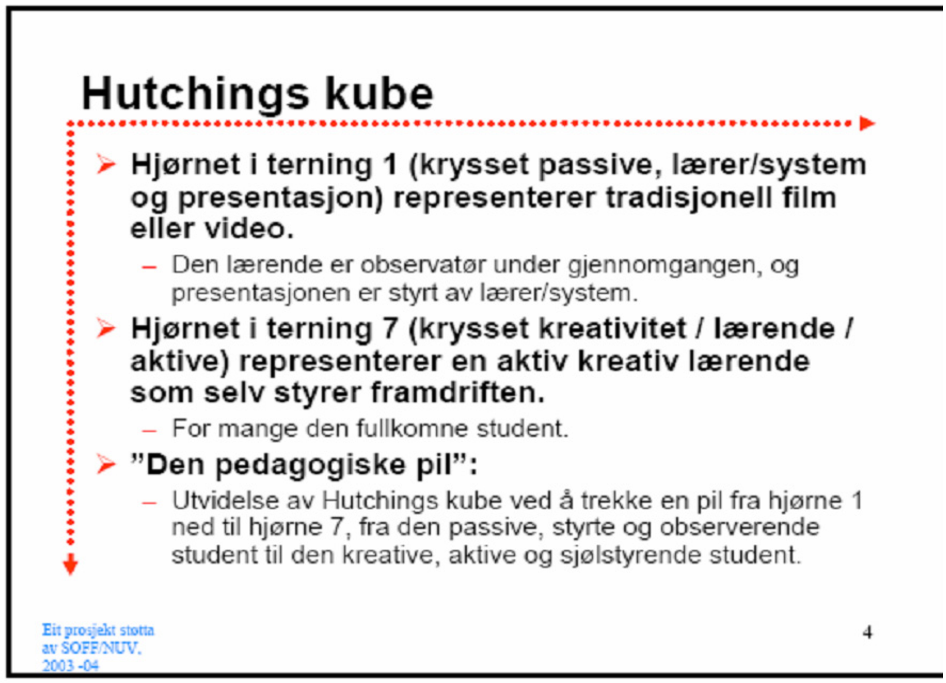

Figure 2; Slide; Description of “Problems represented in a cube”

Hutchings cube.

Name

Hutching´s cube

Learning object type

Knowledge object

Context

Education in pedagogical problems, use of ICT (Information and Communication Technologies) in education.

Language

Norwegian

Problem

One has a figure or model of a cube (Hutching´s cube) that describes different learners and learning methods, but this model is not described in detail.

Solution

This slide is a further explanation of the figure of Hutching´s cube shown in "Problemstillinger framstilt i en kube", but can also be used to describe other representations of Hutching´s cube. With regards to Hutching´s cube, some examples of different kinds of students and presentation media are presented. Where in Hutching´s cube we find the desirable form for learning and learners is

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explained. The most desirable learner is the active, creative learner who takes control over her/his own learning. "The Pedagogical arrow" is presented.

Limitations

It can be hard to understand if one has not seen the figure of Hutching´s cube before. The slide contains only keywords and should be supplemented by a teacher or by reading about the topic.

Example usage

This slide could be used as a further explanation of a representation of Hutching´s cube.

“

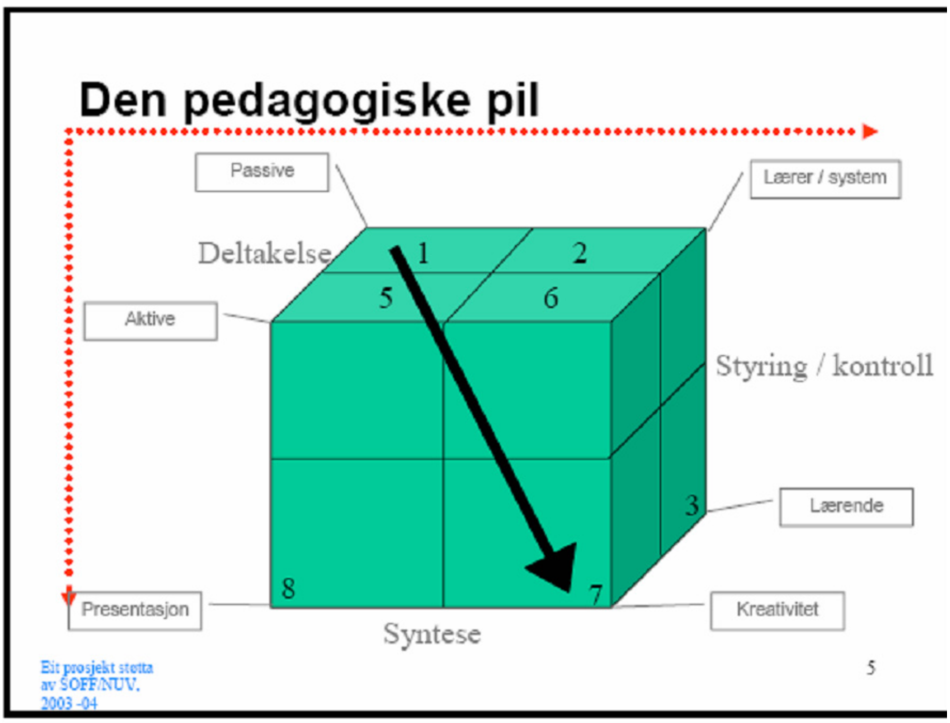

Figure 3; Slide; Hutching´s cube with “The pedagogical arrow”

The pedagogical arrow.

Name

The pedagogical arrow

Learning object type

Knowledge object

Context

Education in pedagogical problems, use of ICT (Information and Communication Technologies) in education.

Language

Norwegian

Problem

It is desirable to have a framework to refer to when one describes the different types of learning. One wants to see the transition from the passive learner who gets the information presented by a system or a teacher, to the active, creative learner who controls her/his own learning.

Solution

This is a slide that shows a pedagogical model called Hutchings cube. The cube has three axes; participation, synthesis and steering/control with the range of passive to active, presentation to creativity and teacher/ system to be learning. In this model we can classify the learner from the passive learner where the teacher/system presents the information to the active learner who is creative and has control over his/her learning. “The pedagogical arrow” is drawn from the corner where the learner is passive and get the information presented of the system/teacher, to the active, creative learner who controls his/her own learning.

Limitations

This model requires that the learners can understand a co-ordinate system with axes. The model is not described in detail, and should be supplemented by the teacher or by reading about the topic.

Example usage

The slide can be used in a course where one wants to get a visual and three-dimensional view of different learners and learning methods, and one wants to see the transition from the most desirable learner/ learning methods to the least desirable learner/learning methods.

Descriptions of a learning object from hypermedia

In this section one of the hyper documents in the course ***"IT2202 -Operating systems"*** [Staupe, Arvid, 2004] is described. Each of the hyper documents is described as one learning object, but is also divided if this seemed suitable. The figures and text below the descriptions are examples of the learning objects, and are not a part of the metadata. In the “Operating system hypermedia course” there are more than 1100 learning objects. Many of the hyper documents are described in [1], but only one in this report.

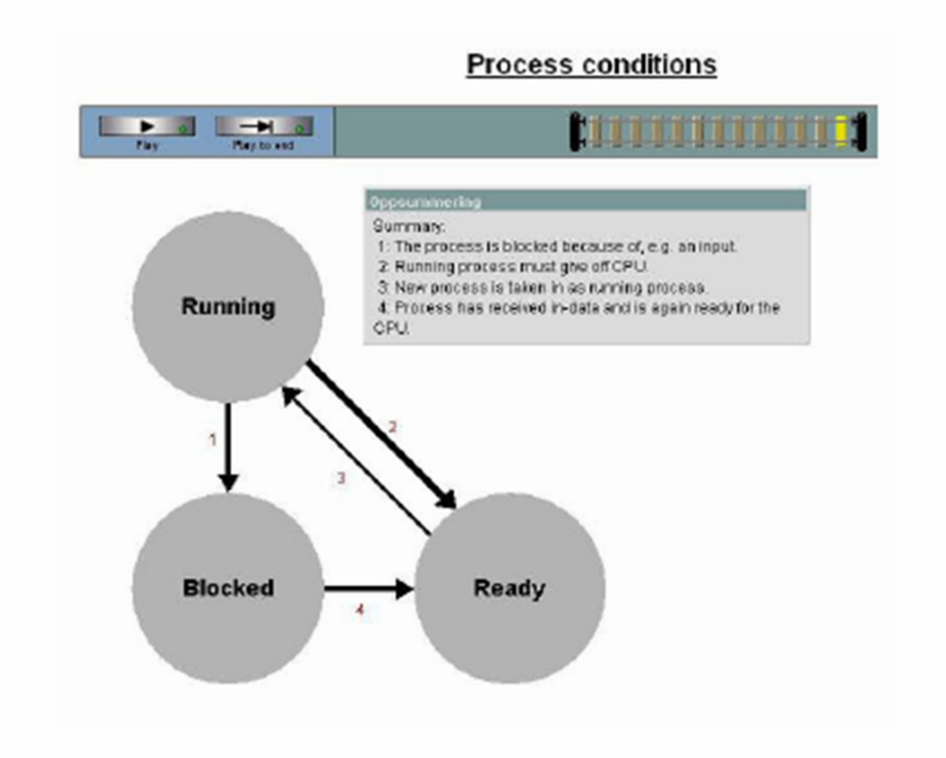

Figure 4; Slide; “Process conditions”

1. Silje Rossvoll‘s , “Learning objects”, The Norwegian University of Science and Technology (NTNU)

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Process conditions.

Name

Process conditions

Learning object type

Knowledge object, animation

Context

A hypermedia course in operating systems.

Language

Norwegian and English

Problem

One has created a hypermedia course about operating systems, and is describing the different conditions of a process. For a better understanding it is desirable to visualize the different conditions, and what makes a process change its condition.

Solution

This learning object is an animation that shows the different conditions a process can be in, and why. At the top of the animation, there is a kind of tool bar. This contains two buttons and a status line. The first button is “Play” and brings the student one step forward in the animation. The second button is “Play to end” and plays through the whole animation. The status line shows the progress of the animation.

In a simplified setup, processes exist in three conditions; running, blocked and ready. These conditions are drawn as circles one by one, and a text box beside them tells the student what happens. When the conditions are drawn, arrows shows that the process can go from one condition to another. This is well explained in the text box. For every transition it is first explained that it is possible to go from one condition to another, and then given an example.

For example an arrow is drawn from “Running” to “Ready” and the box says: “A process can also change condition from running to ready”. Push the “play” button once, and in the next step the text box says: “A running process may be forced by the operating system to give off the CPU. In a multiple task system, each process will have a set of period of running time before the next process takes over.” The animation ends with a summary in the text box. The summary consists of 4 numbered points that refers to numbered arrows between the different conditions.

Limitations

Normaly in a animation it is not possible to go one or more step backward in the animation. You have to start over again. But with this animation you can go one or more steps backward and forward again. You can go back and forth. You can go one and one step, or you can run the animation to the end.

Example usage

The slide can be used in a course where one wants to visualise how a prosess switches between different states when the prosess is activated/running.

Findings and discussion

The design patterns presented has been used to describe learning objects. The learning objects are taken from a slide set about different ways to structure information, and a hypermedia course about operating systems. Some of these descriptions have been showed above. It is only knowledge objects and animation objects that have been described, but they give a good picture of advantages and disadvantages when learning objects are described with design patterns. The result from this work is presented and discussed here.

Findings

There was originally two ideas how to describe learning objects. One of them was to describe the learning object with only a text. The text should be a free-text in about 500 to 800 words, and contain all the relevant information about the learning object. This approach was tried on some of the learning objects in the slide set[1]. When there are no elements to guide the user, it is difficult for the creator to remember to mention all the information that the metadata should contain, and this approach was abandoned early.

The second idea was to describe the learning objects with design patterns. This idea was pursued, and the first question that was asked when the work started was: "how will users search for learning objects?" It was desirable that it should be possible for the user to search in free-text, and write questions like: "I am making a course in operating systems, and have made a part about the hardware‘s influence on the operating system. I need a figure that shows the systems structure, and a text that describes the components."

The wording in the descriptions of the learning objects shows signs of this. What information the different elements should contain is described in the table 3-2 "Elements in a learning object pattern” page. Problems or comments to the different elements during the work are listed below:

Name

Generally the learning objects already had a name, and this was used and is possible to retrieve automatically. When a learning object was divided into several knowledge objects and one resource organizing object, the objects were given the same name as the original with an extension that told what type of learning object it was. The resource organizing object kept the original name. The knowledge objects should probably have been given better names.

Learning object type

Resource organizing objects and knowledge objects were the only types of objects that were described. Often the more specific type of learning object was used as an extension to the type of object defined by Rob Koper [Koper, 2001]. The more detailed description of the learning object was often repeated in the solution element, and therefore it could be better to make Learning Object Type a vocabulary of the learning object types defined by Rob Koper. This will make it easier for a user to search for a general type of object, for example a knowledge object or a test object. The type of object should still be further described in Solution, and should be possible to search for in free-text.

Context

The learning objects described were only from two different courses, and the context for the different learning objects were often the same. The context was also often repeated or described further in the Problem element. If one could find a relatively small set of wider contexts, maybe also this element could be a vocabulary, and be described further in the Problem element.

1. Silje Rossvoll‘s , “Learning objects”, The Norwegian University of Science and Technology (NTNU)

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Problem

This element often started with a further description of the context. As not being the one who created the learning object, it felt unnatural to construct the problem, when the solution already was given. It was also difficult to write something about the learner, the level and the time it would take to go through the learning object. The wording in this element sometimes seemed unnatural -the word "one" was often used.

Solution

In this element the learning object was described, and the biggest problem was to write more about the subject of the learning object than the information that was given in the learning object. When figures were described, one had to read about the subject to describe the figure thoroughly enough. As not being the one who created the learning object, it was also difficult to recognize and write something about the pedagogical model.

Limitations

There were no special problems with this element, but it would probably be easier to finish this element after the learning object has been used by one or several learners. The element was often used to describe the required knowledge the user should have before studying the learning object.

Example usage

This element was often only a repetition or rewriting of the problem. It was difficult to find other areas or contexts the learning objects could fit in.

Dividing the learning objects

In addition to these problems regarding the elements, it was also difficult to know if one should divide some of the learning objects into smaller learning objects. In the slide set, every slide was described as one learning object, even if several slides could cover parts of the same content, and it would probably have been more suitable to describe them as one. In the operating system course, the hyper documents often were divided into a text or a figure/table. This was done because it might be desirable to use only the figure or the text.

Revised element set

The changes of each element are explained in the sections below.

Name

The Name element is not changed.

Learning object type

This would be easier for the user to fill in, and it would be easier to search for a type of learning object. Now a user could search for all kinds of knowledge objects, test objects, monitor objects etc. The learning object type should be described in more detail in the Solution element.

Context

The context was often further described in the Problem element. Therefore Context also could be a vocabulary with a few, wider contexts that the user could choose from. Then the context could be described in more detail in the Problem element.

Solution

To prevent that important information not is left out, the educational elements in the IEEE LOM were gone through and added if necessary. Originally, one wanted to add the three educational elements, 5.1, 5.3 and 5.4 into the Solution element.

- 5.1 Interactivity type: Predominant mode of learning supported by this learning object. “Active” learning (e.g. learning by doing) is supported by content that directly induces productive action by the learner. An active learning object prompts the learner for semantically meaningful input or for some other kind of productive action or decision, not necessarily performed within the learning object‘s framework. Active documents include simulations, questionnaires, and exercises. "Expositive" learning (e.g., passive learning) occurs when the learner‘s job mainly consists of absorbing the content exposed to him (generally through text, images or sound). An expositive learning object displays information but does not prompt the learner for any semantically meaningful input. Expositive documents include essays, video clips, all kinds of graphical material, and hypertext documents.
When a learning object blends the active and expositive interactivity types, then its interactivity type is "mixed".

- 5.3 Interactivity level: The degree of interactivity characterizing this learning object. Interactivity in this context refers to the degree to which the learner can influence the aspect or the behaviour of the learning object.

- 5.4 Semantic density: The degree of conciseness of a learning object. The semantic density of a learning object may be estimated in terms of its size, span, or - in the case of self-timed resources such as audio or video-duration. The semantic density of a learning object is independent of its difficulty. It is best illustrated with examples of expositive material, although it can be used with active resources as well.

These elements were less used in the LOM Survey, and therefore it was decided to try another approach. Three sub elements of Solution were created, and they were inspired by the three categories in Hutchings cube, Steering/Control, Participation and Synthesis. The name Synthesis are replaced with the name Construction because the term "synthesis" is not well known, and the term "construction" would probably be easier for a user to understand.

Three factors have particularly large importance in *education:* ***construction, steering/control*** and ***participation***. The problem area is visualized as a cube that is placed in a three dimensional system of axis, figure 1 and figure 3. We call one of the axis, ***construction***, and it ranges from presentation in one outer point to creativity in the other outer point. The next axe is called ***steering/control*** and ranges from learner to teacher/system, and the last axe is called ***participation*** and ranges from active to passive. The cube is further divided into 8 smaller cubes, which are numbered from 1 to 8. The cube numbered 1, where passive, teacher/system and presentation meet one can say presents the traditional film or video. The learner is an observer through the session, and the presentation is steered by a teacher or a system. The cube numbered 7, where creative, learner and active meet, represents the active, creative learner that steers the progress himself. This student is by many seen as the perfect student. The arrow from the corner of cube 1 to the corner of cube 7, is called the pedagogical arrow.

Another way to illustrate this approach is a system with three axes, shown in figure

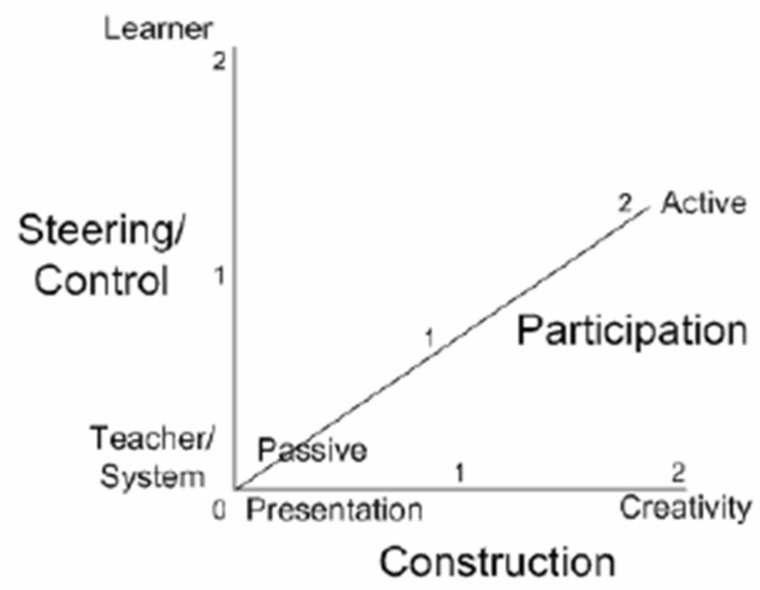

Figure 5; Solution represented with three axes, see figure 1

The elements 5.1 Steering/Control, 5.2 Participation and 5.3 Construction in the learning object pattern are given the value space 0,1,2, but this will probably have to be changed. For once it would probably be more understandable for the user to select from a vocabulary consisting of ***active, mixed, passive than 0,1,2 in the Participation***[1] element. The second objection is that there exist learning objects, for example simulations, where the user can be more or less active. It should therefore also be an option in the vocabulary that said that the learning object could have several of the options. The vocabulary 0,1,2 therefore has to be seen only as an example.

Limitations

The Limitation element is not changed, but the required knowledge is specified to be described in the Solution element.

Example usage

The Example usage element is not changed.

1. For comparison the LOM elements 5.1 Interactivity type has the value space active, expositive, mixed, 5.3 Interactivity level has the value space low, medium, high, very high and 5.4 Semantic density has the value space very low, low, medium, high, very high.

Table 3-2: Revised Element Set

Nr	Element Name	Explanation
1	Name	The name of the pattern Give a name that: • covers the content (problem and solution) • is meaningful and easy to remember • gives rise to association that are related to the described problem and solution.
2	Learning object type	Vocabulary Value space: • Knowledge object • Tool object • Monitor object • Test object • Resource organizing object
3	Context	The principal environment within which the learning and use of this learning object is intended to take place. Vocabulary Value space is not defined.
4	Problem	A description and the background of the problem that the learning object is going to solve. The problem is written in free-text, and should contain information about: • The context (additional information) • The learner, principal user(s) for which this learning object was designed • The typical age or level of the intended user • The Learner´s starting knowledge • The target knowledge, the intended knowledge of the learner after he has studied the learning object.
5	Solution	A description of the learning object - the solution to the problem. Solution is written in free-text, and: • Specifies the learning object type • Describes the requried knowledge and stying this learning object, and • Describes the learning object in detail

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Table 3-2: Revised Element Set (Continued)

Nr	Element Name	Explanation
	5.1 Steering/Control	Vocabulary Value space: 0, 1, 2 where “0” is “Teacher/System” and “2” is “Learner”
	5.2 Participation	Vocabulary Value space: 0, 1, 2 where “0” is “Passive” and “2” is “Active”
	5.3 Construction	Vocabulary Value space: 0, 1, 2 where “0” is “Presentation” and “2” is “Active”
6	Limitation	Limitation or comments to the learning object.
7	Example usage	An example of how the learning object can be used - in this or other contexts.

The table shows a new draft of what information the different elements should contain. These elements have to be seen as a first possible subset, that can be extended. For example there could also be elements that described which learning objects the resource organizing objects consist of, or which resource organizing object a learning object is a part of.

Table 3-3: Possible subsets

Nr	Element Name	Data type	Possible search subset	Possible results subset	Mandantory
1	Name	Free-text	Yes	Yes	M
2	Learning object type	Vocabulary	Yes	Yes	M
3	Context	Vocabulary	Yes	Yes	M
4	Problem	Free-text	Yes	Yes	M
5	Solution	Free-text	Yes	Yes	M
	5.1 Steering/Control	Vocabulary	Yes	Yes	O[a]
	5.2 Participation	Vocabulary	Yes	Yes	O[b]
	5.3 Construction	Vocabulary	Yes	Yes	O[c]
6	Limitation	Free-text	No	Yes	O
7	Example usage	Free-text	No	Yes	O

a. Should be mandatory for knowledge objects
b. Should be mandatory for knowledge objects
c. Should be mandatory for knowledge objects

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This table 3-2 shows some additional information to the elements in the previous table. It shows which elements that are written in free-text, and which elements that are selected from a vocabulary. The possible search subset are all the elements that it is possible to search in. The elements that are written in free-text can be searched for in free-text. The possible result set shows which elements the user will see after the search. As one can see the elements Limitations and Example usage can not be searched for, but they are a part of results subset the user gets about the learning object after the search. The last column shows which elements that are mandatory to fill in, and which elements that are optional.

Chapter 4: A metadata editor

In chapter 1 a learning object was defined to be digital, and consist of to parts; a learning part that is "The smallest element of stand-alone information required for an individual to achieve an enabling performance objective or outcome", and a metadata part. To avoid misunderstandings, the term "Learning part" will from now on be used to refer to the learning part of the learning object, even if this normally, and somewhat imprecise, is called the learning object. The learning part can be produced when needed or fetched from a database of "learning parts" (raw data).

We assume that the creators of the learning objects will continue to create the learning parts in the same tools as earlier, usually "Off-the-shelf software". Therefore we here focus on requirements for a new metadata editor to create the metadata belonging to the learning objects. The metadata editor should enable creating and modification of the metadata, display the learning part, and link these parts together.

The process

Originally, the users have created the learning part first, and then created the metadata. This approach is not well suited for creating learning objects that are described with design patterns. It is not natural to construct the problem after one has solved the problem -i.e. created the learning part. The creation of the metadata, should also be an integrated part of creating the learning part. If not, it is easy for the user to consider himself done with the learning object after he has finished the learning part. Sometimes creating the metadata could take more time, than creating the learning part itself. To get a user to still want to create the metadata is a challenge. Hopefully, this work will be easier, and less time consuming, when it is an integrated part of the work of the learning part, and the user already is engaged in the creation.

The metadata elements that can be created before one starts with the learning part, is Name, Learning object type, Context and Problem. After one has created the learning part, one can change the first elements if necessary, and create the rest of the elements; Solution, Teacher/System, Participation, Construction, Limitations, Example usage. The main steps in the process of creating a learning object are described below.

1. Fill in the first elements, **Name**, **Learning object type**, **Context and Problem** in the learning object editor.
2. Create the learning part in a context creation tool, e.g. a slide editor.
3. Change the first elements if necessary, and fill in the rest of the elements, **Solution**, **Teacher/System**, **Participation**, **Construction**, **Limitations**, **Example usage.**
4. Look through and approve the automatically generated metadata (metadata that are not covered by the elements in the design pattern.)

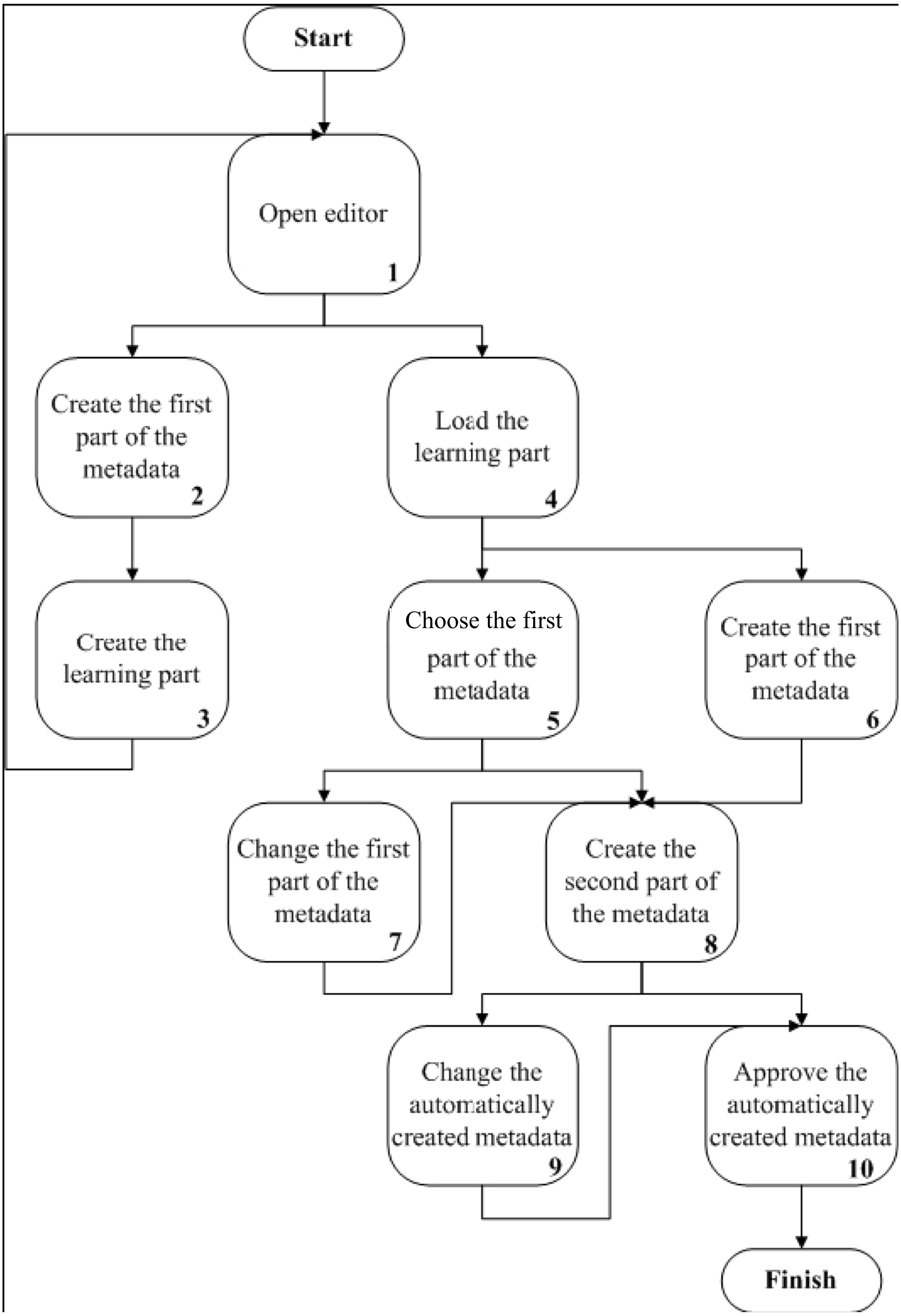

Figure 6: The process of creating a learning object

Because it is possible that the learning part is made before any of the metadata, step 6 is added.

Scenarios

When the user opens the editor, he choose if he wants to start creating the learning object by creating the first part of the metadata, or he can load a premade learning part. Then he can choose if he wants to change the first part of the metadata, or go directly to the creaton of the second part of the metadata. The idea is that the metadata that is not described with design patterns should be created automatically. The editor provides a suggestion with automatically created metadata, based on the learning part. The user can then change or approve this metadata. When this is done, the learning object is saved. The learning part and the metadata are stored separately, but both parts have a link that refers to the other part.

Scenario 1

No parts of the learning object are created.
The user will follow the path: 1 - 2 - 3 - 4 - (5) - 6 - (7) - 8. (se figure 6)
(It is assumed that if the user first has opened the editor, he creates the metadata before he creates the learning part.)

Scenario 2

The learning part and the first part of the metadata is created.
The user will follow the path: 1 - 4 - (5) - 6 - (7) - 8. (se figure 6)

Scenario 3

The learning part is created (not necessarily by the user), no metadata is created.
The user will follow the path: 1 - 4 - 5 - 6 - (7) - 8. (se figure 6)

The steps in the parenthesis are optional steps.

Requirements for a metadata editor

Above the process of creating a learning object is described. The requirements regarding this process are following. This is meant to be a list of the main functions of a metadata editor.

General requirements

- The user should be able to take a guided tour in the editor, before he creates the metadata.
- It should be possible to navigate between the different steps of the process.
- It should be possible to create different user profiles.
- One has to assume that a user often creates learning objects for the same type of learners. Therefore it should be possible to create different types of standard learners that the creator can choose from when he is going to describe the learners.
- It should be possible to specify how different learning objects are connected. For example if one describes a resource organizing object, one should specify

which objects it consists of, and it should be possible to retrieve the metadata of these learning objects.

- It should be possible to use the metadata editor in different modes (standard mode, expert mode etc.)
- It should be a help-function in the editor.
- Each element should have an explanation, either visible, or possible to view if one pushes a help button.
- Each element should have its own help button.
- When the learning part and the first part of the metadata is loaded, these parts should be linked together.
- It should be possible to import the learning part by copying it into the learning object or by creating a referance to it to reduce the size of the learning object and/or be imported in such a way that the learning part will be updated automatically whenever the stored learning part is changed.
- It should be possible to use the same first part of the metadata on several learning parts. (For example, it is possible that several slides in a slide set could have the same first part of metadata, and then be described individually).
- The system should contain a version control of the learning part and the metadata.

The metadata created with design patterns

When learning objects are described with design patterns, it is desirable to create the metadata in two steps. One part of the metadata before one has created the learning object, and one part after one has created the learning part. This implies that the first part of metadata has to be saved, and opened again when the learning part is finished. Requirements concerning creating the metadata is listed below.

If the learning part is already made, it should be possible to;

- load the learning part in the editor, view the learning part in the editor, and fetch the already created metadata (optional).
- change and/or create the first part of the metadata, and create the second part of the metadata,
- change and/or approve the automatically created metadata.

If the learning part is not made, it should be possible to;

- create the first part of the metadata.
- save the metadata.

Viewing the learning part;

- it should be possible to view the most common file types, such as .doc, .jpg, .pdf, .xls, .ppt, .html and so on.
- it should be possible to play a movie file or audio file in the editor (The learning object could be a movie.)
- It should be possible to load several learning objects in the metadata editor.

The automatically created metadata

The information that are not covered by the elements in the learning object pattern, should be created automatically. This is not described in detail, but there are several metadata that could be created automatically [Duval & Hodgins, 2004]. For example the language can be extracted from the text of the learning part. Other information that can be found is the technical information, such as size, version and format. The user profile will give all the necessary information about the author.

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The automatically created metadata should be;
- proposed to the user,
- possible for the user to change,
- possible for the user to approve.

Conclusion

The learning object technology is relative new, and the current learning object standards are criticized for being too comprehensive, and for not describing the pedagogical content good enough. Far from all of the possible elements of the learning object standards are used, and some of the elements are not used correctly.

The work documented in this report has developed an alternative standard for describing the pedagogical elements of a learning object. The proposed standard describes the learning object with design patterns, and contains fewer elements than the current standards. As a result of describing the learning objects with design patterns, we propose a change in the process of how a learning object is created. This process consists of four main steps; 1) create one part of the metadata, 2) create the learning part, 3) create the second part of the metadata and 4) approve automatically created metadata. The report has also described an editor that allows this way of creating learning object metadata.

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Bibliography

Advanced Distributed Learning (ADL) (2004) : Sharable Content Object Reference Model(SCORMr), 2nd Edition http://www.adlnet.org/index.cfm?fuseaction=DownFile&libid=648&bc=false

Alexander,C., Ishikawa,S., Silverstein,M. (1977) : A Pattern Language -Towns, Buildings, Contstruction ISBN: 0-19-501919-9 3.1

Carnegie Mellon -Learning Systems Architecture (2004) : SCORM Best Practices Guide for Content Developers. http://www.lsal.cmu.edu/lsal/expertise/projects/ developersguide/index.html

Cesarini,Mirko, Mazzoni,Paolo, Monga,Mattia (2004) : Learning Objects and Tests. http://homes.dico.unimi.it/~monga/lib/wbe04.pdf

CETIS, Centre For Educational Technology Interoperability Standards (2004): CETIS website; http://www.cetis.ac.uk
2.1, 2.2, 2.2.10

CLOE Stories (2005) : The Co-operative Learning Object Exchange (CLOE). website http://learnware.uwaterloo.ca/projects/CCCO/cloe_ stories.html
2.2.8, 2.2.9

Currier,S. (2004) : Metadata Quality in e-Learning: Garbage In -Garbage Out? http://www.cetis.ac.uk/content2/20040402013222/ printArticle
1.3.2,4

Cioni,G., Limongelli,C., Temperini,M. (2004): COURSE CONFIGURATION IN E-LEARNING VIA AUTOMATED PLANNING ISSN: 1128-3378

Doorten,M., Giesbers,B., Janssen,J., Daniels,J., Koper,R. (2002): Transforming existing content into reusable Learning Objects. http://citeseer.ist.psu.edu/cache/papers/cs/31565/http:zSzzSzdspace.learningnetworks.orgzSzretrievezSz41zSzDisaggregation.pdf/ transforming-existing-content-into.pdf

Douglas,I. (2001): Instructional design based on reusable learning objects: Applying lesons of object-oriented software engineering to learning system design. http://fie.engrng.pitt.edu/fie2001/papers/1118.pdf

Dublin Core Metadata Initiative (2004): Dublin Core Metadata Element Set, Version 1.1: Reference Description. http://dublincore.org/documents/dces/

Duval,E., Hodgins,W. (2004): Metadata Matters. http://www.cs.kuleuven.ac.be/~erikd/chronos/2004/ 20041011-14_DC_Shanghai/DuvalHodginsDC2004-preprint. pdf 1.3.2, 4, 9.4

The E-LEN project (2004) Design expertise for e-learning centres -Design patterns and how to produce them : The E-LEN projeckt -webpage. http://www2.tisip.no/E-LEN/ 3.2.2

eStandard.no (2005): NORLOM versjon 1.0 klar for utrulling. http://www.estandard.no/stories.php?story=05/04/08/ 1950689 2.3

Friesen,N. (2003): Three Objections to Learning Objects and E-learning Standards. http://www.learningspaces.org/n/ papers/objections. html 1.3.1

Friesen,N., Fisher,S. (2003): CanCore Guidelines Version 2.0: Introduction. http://www.cancore.ca/guidelines/ CanCore_Guidelines_ Introduction_2.0.pdf 2.3.3

Gamma,E., Helm,R., Johnson,R., Vlissides,J. (1995): Design Patterns -Ele 3.2.3

Heng,Simon (2002): Learning Objects -Where next? http://citeseer.ist.psu.edu/cache/papers/cs/27005/ http:zSzzSzmms.ecs.soton.ac.ukzSzpaperszSz26.pdf/ learning-objects-where-next.pdf

Hodgins,W., Duval,E., IEEE LTSC (2002): Draft Standard for Learning Object Metadata. http://ltsc.ieee.org/wg12/files/ LOM_1484_12_1_v1_ Final_Draft.pdf 2.3.1, 2.3.7

Hodgins,W. (2002): The Future of Learning Objects. http://www.academiccolab.org/resources/UFE%20Future%20of%20Learning%20Objects.doc

Hodgins,W., Conner,M. (2000): Everything you ever wanted to know about learning standards but where afraid to ask. http://www.linezine.com/2.1/features/wheyewtkls.htm 2.2.1

Hodgins,W. (2000): Into the Future -A Vision Paper. http://www.learnativity.com/download/MP7.PDF

Horrigmoe,S. (2004): Presens http://www.presens.nl.no

Internet Mail Consortium (2005): Internet Mail Consortium. http://www.imc.org/pdi/vcardoverview.html

Institute of Electrical and Electronics Engineers, Inc (2002): Draft Standard for Learning Object Metadata. http://ltsc.ieee.org/wg12/files/LOM_1484_12_1_v1_ Final_Draft.pdf

ISO/IEC JTC1 SC36, N. Friesen (2004): International LOM Survey: Report. http://mdlet.jtc1sc36.org/doc/SC36_WG4_N0109.pdf

Last Link Previous Next

1.3.2, 2.4, 3, 2.4.3, 5

Jones,R. (2004): Designing Adaptable Learning Resources with Learning Object Patterns. http://jodi.ecs.soton.ac.uk/ Articles/v06/i01/Jones/ ?printable=1 3.2.4, 5.2, 5.3

Koper,R. (2003): Combining reusable learning resources and services to pedagogical purposeful units of learning. http://dspace.learningnetworks.org/retrieve/39/ Combining-preprint.pdf 1.3.3, 5.3

Koper,R. (2001): Modeling units of study from a pedagogical perspective -the pedagogical metamodel behind EML. http://eml.ou.nl/introduction/docs/ped-metamodel.pdf 1.3.3, 4, 7.2.8

Kraan,W. (2004): Learning Object Metadata use survey: sticking the short and wide in the long and thin. http://www.cetis.ac.uk/members/pedagogy/lib/newsViewer?id=20041015015543

Kraan,W., CETIS staff (2002): Learning content. Theirs, yours, mine and ours. http://www.cetis.ac.uk/content/20020916013733

Bianco,A., De Marsico,M., Temperini,M. (2006): Standards for e-learning, Working Package 5, QUIS

Merill,M. Davis (2001): First Principles of Instruction http://www.id2.usu.edu/Papers/5FirstPrinciples.PDF

Mohan,P., Brooks,C. (2003): Engineering a Future for Web-based Learning Objects. http://www.cs.usask.ca/research/research_groups/ aries/papers/icwe2003_mohan_brooks.pdf 1.3.3

Oehlert,M. -CETIS SCORM is not for everyone -ADL responds http: //www.cetis.ac.uk/content/20021017153823 1.3.1, 4

Rehak,D. (2002): SCORM is not for everyone -CETIS. http://www.cetis.ac.uk/content/20021002000737 1.3.1, 4

Rosvoll,S. (2005): The learning object http://daim.idi.ntnu.no/masteroppgaver/IME/IDI/2005/1069/masteroppgave.pdf

Schmidt,A. (2003): Context-steered Learning: The Learning in Process Approach http://www.fzi.de/KCMS/kcms_file.php?action=link\&id= 306

Staupe,A. (2004): IT2202 -Operativsystemer (hypermedia). http://mserver.idi.ntnu.no (document), 6.3, 6.1, B, B.1, B.2, B.3

Staupe,A. (2003): Strukturering av lærematerielll. http://munin.hsh.no/lu/inf/NU/NettPed/NUV_Laeremateriell.pdf 6.2, 3, A

Last Link Previous Next

Taylor,Craig R. (2002): E-Learning: The Second Wave. http://www.learningcircuits.org/2002/oct2002/taylor. html

UK LOM Core (2004): UK Learning Object Metadata Core, Draft 0.2. http://www.cetis.ac.uk/profiles/uklomcore/uklomcore_v0p2_may04.doc 2.3.5

Wagner,E. O. (2002): The New Frontier of Learning Object Design. http://www.elearningguild.com/pdf/2/061802dst-h.pdf

Øverby,E. (2004): www.estandard.no -Få LOM-elementer blir brukt, viser undersøkelse. http://www.estandard.no/stories.php?story=04/09/13/9253018

Appendix IV:

The PLExus prototype: A PLE realized as topic maps

Table of contents:

Introduction

An HCI solution offering a customized interface within e-learning could be realized using the concept of topic maps, where the information can be shown in several views based on the choice of the user. Topic maps are an ISO standard - ISO/IEC 13250:2003. “A topic map is a technology for knowledge integration, describing concepts and their relations” [Garshol, 2006]. Organizing documents into a topic map, it is necessary to identify the topics, the topic types, the occurrences and the associations [Pepper, 2002].

Appendix IV of the QUIS Requirement Specification first describes topic maps within e-learning, and why topic maps may be a solution to achieve a personalized learning environment. An e-learning ontology is presented, followed by a technological description of important primary constructions in topic maps applicable in a PLE. Finally PLExus, the PLE prototype is presented with screenshots and a system description.

An e-learning topic map

The student interface based on a topic map will allow customized views of the learning objects and learning activities. Examples of the students’ views of the learning objects and learning activities could be views based on:

- Themes
- Time (the newest learning objects / learning activities)
- Pedagogical methods [Heinich et al., 2002]
- Media type / intelligence [Gardner, 1985]
- Proficiency stages [Dreyfus, 1998]
- Learning objective (knowledge / skill / attitude / meta learning)
- Student productions of learning object / learning activities
- Ranking score (the learning objects with the highest ranking scores)
- List of learning object recommended by the system based on behaviour of previous students (e.g. the students who liked the same learning object as you also liked the following learning objects…).
- Guided learning paths produced by teacher
- (Free text) search.

Why topic maps in e-learning?

A user-friendly, individualized and differentiated interface is an important feature of an e-learning system. Instead of presenting the learning objects and learning activities in one standard interface for all the students, an e-learning topic map could present “many roads to Rome”, addressing the needs of the heterogeneous student group [Kolås, 2005].

Dichev et al. [2003] mention many advantages using topic maps, e.g. efficient context-based retrieval, customized views, information visualizations and deeper understanding of the domain conceptual relations. The advantages of a topic map presenting information (e.g. learning objects) are that the user will experience a flexible learning environment and is able to make his / her choices on what perspective s/he wants to the learning material.

Information overload for the student is a problem which may occur when we are trying to arrange for an individualized and differentiated learning environment prepared for individual needs when it comes to methods, media, intellectual stages, cultural needs, assessment, and different intelligences in the existing online learning environments. If nothing else is done other than organizing many different learning objects into folders, the students will not know which learning object to start and which to continue with. “One problem with web portals is how to locate the information you are interested in” [Hjeltnes, 2006]. This problem also applies to the situation when both the students and teachers produce learning resources, these must be easy retrievable. There is therefore a need for good HCI-solutions, and topic maps are suggested as one solution of this problem [Dichev et al., 2003].

The e-learning ontology

A topic map ontology is “the set of privileged topics and their characteristics, including associations between them” [Grønmo, 2006]. The e-learning ontology (Tab. 1) [Kolås, 2006] covers the different needs of the heterogeneous student group when it comes to different pedagogical methods [Heinich et al., 2002], proficiency stages [Dreyfus, 1998], multiple intelligences [Gardner, 1985] and taxonomies for affective, cognitive and psychomotor domains [Kratwohl, 1964; Bloom, 1956; Dave, 1970]. The e-learning ontology is based on key topics, topic types, associations and occurrences:

Key topics:	Topic types:	Associations	Occurrences
Learning objectives	Knowledge	Is assessed through	MCQ, memory, matching, true/false, short answer, completion, blog, portfolio
	Attitude		Chat log, discussion forum, pre/post survey tool.
	Skill		Motion sensitive tool, simulator, track tool, log, audio sensitive tools.
	Meta-learning		Pre-test, post-test, reflection tool.
Pedagogical methods	Drill	Is taught through	Multiple choice, drag and drop, match, memory, fill in blanks.
	Presentation		Wiki, mind map, concept map, map, slide presentation, video / audio recordings.
	Tutorials		Wizards, FAQs, intelligent tutoring systems.
	Gaming		Adventure games, business games, board games, combat games, logical games, word games [Alessi & Trollip, 2001].
	Demonstration		Screen capture, animation.
	Discovery		Survey, Voting, blog / journal, search, statistical tools, computer based

			laboratories.
	Simulation		Physical, Iterative, procedural and situational simulations [Alessi & Trollip, 2001].
	Problem solving		Data processing tools, databases, collaboration tools, presentation tools.
	Discussion		Chat / IM, SMS, e-mail, forum, Video conference, audio conference.
	Cooperative learning		Application sharing, CVE, workspace awareness, shared archive.
Learning objects	***(Multiple intelligences:)***	Is produced through	
	Visual intelligence		Presentation tool, mind map, concept map, graphics tool, eye sensors.
	Verbal intelligence		Word processor, web editor, record audio, speech recognition, synthetic speech.
	Logical intelligence		Spread sheet, database, topic maps, concept maps, programming software.
	Kinaesthetic intelligence		Simulation, motion sensitive tool.
	Musical intelligence		Record audio, midi.
	Interpersonal intelligence		Communication, coordination and cooperation tools.
	Intrapersonal intelligence		Mind map, hypertext editor, blog.
	Naturalistic intelligence		Database, map, hypertext editor.
	(Proficiency stages:)		
	Novice		Checklist, template, road map, wizard, design pattern.
	Advanced beginner		Toolkit, help tools.
	Competence		Assignment without help, framework
	Proficiency		Topic directories.
	Expert		Search engines.

Table 1: The e-learning ontology

Structuring a personal learning environment (PLE)

Based on the development of the functional requirements [appendix II], one of the experiences was that a next-generation e-learning system must be a personal learning environment (PLE). The question so far is however; - What is really a PLE? Johnson et al. describes how different persons have different understandings of the concept “PLE”, from “empowering users of informal learning resources away from institutions” or “an extended portfolio” to “a superfluous accessory to the technologies of the desktop operating systems and the World Wide Web” [Johnson et al., 2006]. The variety of interpretation illustrates how diffuse the concept still is.

This report will present our interpretation of the concept “PLE” based on the experiment developing pedagogical-based topic maps.

In e-learning systems of today there is the institution / the teacher who decides how the learning material is presented to the student. In a pedagogical-based PLE the student will be able to customize the learning environment, and will be able to choose pedagogical strategy to reach the learning objective or get access to learning material based on e.g. media type or proficiency stage. This requires that learning objects, learning activities and assessment activities are saved and retrieved in such a manner that e.g. one student could reach the learning objective through a presentation, while others students reach the same learning objective through discovery, demonstrations or collaboration.

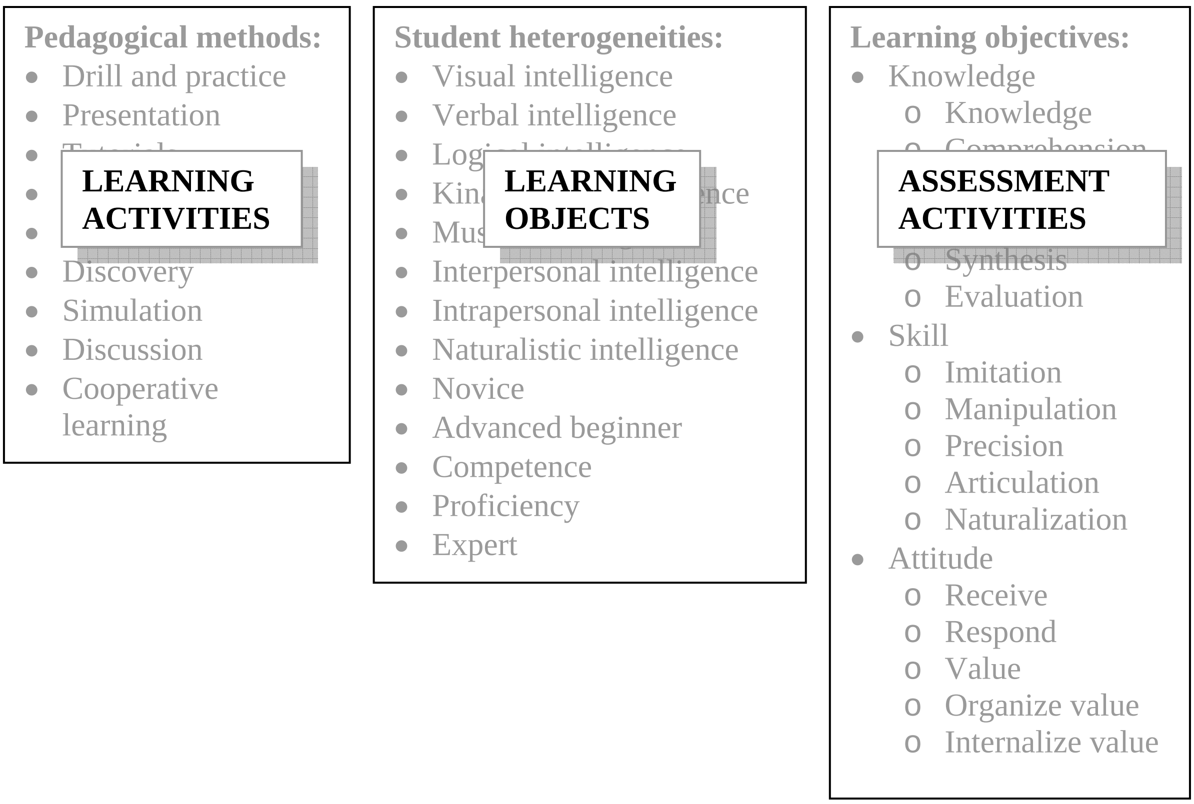

Figure 1: Important factors in a PLE

Why use Topic Maps as a Personal Learning Environment?

In order to meet the requirements of a Personal Learning Environment (PLE), a powerful computer architecture is needed, where it is easy to locate resources based on context and needs. There should also be a powerful search- and navigation system connected to the architecture. The architecture must ensure relevant, complete and consistent information. One example of this type of architecture is Topic Maps. Topic maps are an ISO standard [ISO/IEC 13250, 2003].

Topic Maps are today acknowledged computer architecture and it is expected that it will be further developed with new functions and qualities. A Topic Map System was developed in WP5 in the QUIS project. In this connection, an article describing topic maps more detailed was written. Thus we refer to the WP5 report for further details [Marsico et al., 2005].

For a PLE we need a system for administrating a certain amount of information which is in constant change, normally growing, and which also consists of a lot of different information that can be linked together in many different ways. That is, administration of complex information. In Topic Maps, metadata can be isolated and stored separately from the object, it will however still be closely connected to the object. Metadata will be central during information search.

In this presentation we will focus more on the strength of topic maps in order to create a PLE, and therefore, to some extent, describe the qualities of parts of the primary structure in topic maps. In appendix III (Learning objects, Proposal for a new learning object metadata standard using design patterns) we have described the use of learning objects. The learning objects may exist many places, in a local database, in a publisher’s database, available on the Internet, etc. In the first place, learning objects can be made of images, text files, animations, videos, etc. without necessarily being used / viewed as learning objects. To stick to the terminology of topic maps we therefore call these “subjects”.

The metadata connected to these subjects will only be those connected to ordinary files. Based on the subjects, it should be possible to create learning objects containing necessary additional metadata when the object is to be used for learning. In turn, there might be a wish to create new learning objects around one, two, or several basic learning objects. The new learning object will then get its metadata and can be made available. And we could go on like this; several learning objects forming parts of courses, course modules, or sometimes a complete course in a PLE.

The subjects can originate from many different sources, e.g. images, text files, web pages, videos, etc. The subjects may also be physical units which we can touch and feel, such as a tool machine within vocational training. Not all subjects can be put into a computer or be directly connected to it, the alternative will then be to describe it in the form of a substitute (proxy).

Other factors are, for example, rights/access to subjects. Furthermore, another factor is the possibility of variant names, e.g. that the printout is dependent on the type of medium used (computer monitor, PDA), use of the Braille system, pictogram, etc. Topic maps make this possible.

Important primary constructions in Topic Maps applicable in a PLE

Subject

A subject is the resource that we have in mind when we start developing a topic map. In a learning environment, these resources will be text, images, electronic workbooks, videos, mind maps, animations etc. Some of the subjects will be directly addressable for the computer (through a “Resource Reference”) while others will not. For the non-addressable subjects, we have to fake the subject, i.e. make use of a substitute (proxy) that can be addressed by using an URI. A hammer may be important within vocational training. The hammer cannot be addressed, and therefore needs a substitute. Through the substitute we need to provide an unambiguous description of the subject it represents. In topic maps the substitute’s address is called “Subject Identifier” and the substitute is called “Subject Indicator”. Together these make up a “Subject Identity”.

Definition of subject:
1. “Anything that can be spoken about or conceived of by a human being. In the most generic sense, a subject is anything whatsoever, regardless of whether it exists or has any other specific characteristics, about which anything whatsoever may be asserted by any means whatsoever.
2. Anything on which the author of a topic map chooses to discourse.
3. Anything that is reified by a topic in a topic map; the organizing principle of a topic. Humans are the ultimate authorities for determining the subjects of topics” [Pepper & Moore, 2001].

Definition of subject indicator:
A subject indicator is a resource that is intended by the topic map author to provide a positive, unambiguous indication of the identity of a subject. There are three ways of indicating a subject in a topic map:
1. Pointing via a <topicRef> element to a <topic> element that shares the same subject;
2. Pointing via a <subjectIndicatorRef> element to a resource that indicates the subject;
3. Pointing via a <resourceRef> element to a resource that is the subject.” [Pepper & Moore, 2001].

According to the Topic Map White paper “The author wants to guarantee that the subject indicator is accessible and unchanged at least as long as the created topic map will exist. Agreement; The author has to agree that the subject indicator describes really the same subject the author has in mind” [Pepper & Moore, 2001].

Topic

Topic is the very building block in topic maps. One topic represents a subject and can be connected to several occurrences. Normally, there is a name connected to a topic. For example, we may have a map of Europe as a resource to which metadata is connected. In this case, it would make up a learning object. Here, we could have a topic named “Map of Europe” with the occurrence “map” and the occurrence “metadata”. We could also have a map hierarchy with topic “Map of Europe” as the superior and then a subordinate topic for each country with their occurrences.

A topic is “the representative”, the presence of the subject in the computer. The topic represents the subject in the computer.

A topic has three characteristics:
1. Names (base names): descriptive names, a topic may have 0, 1 or several names (base names).
2. Occurrences: refers to resources that are relevant to connect with the topic. We say that a topic reifies a subject, and makes an abstract concept concrete.
3. Roles in associations

- A topic may have several occurrences.
- A topic may be part of a hierarchy of topics.
- A topic may be associated with other topics. A topic fills a role in an association, and it can be member of several associations.
- A topic may be member of 0, 1 or several types/classes. The types/classes are in turn topics.

Definition of reification:
”The act of creating a topic. When anything is reified it becomes the subject of the topic thus created; to reify something is therefore to create a topic of which that thing is the subject. Reification of a subject allows topic characteristics to be assigned to the topic that reifies it: In other words, it makes it possible to discourse about that subject within the terms of the topic map paradigm.” [Pepper & Moore, 2001].

Occurrences
An occurrence:
- Connects relevant resources to a topic.
- Can be occurrence of an occurrence type/class. For example, image as one type, text as another type.
- The same occurrence cannot be an occurrence in several occurrence types/classes. It cannot, for example, occur both in type image and type text.
- Technically, an occurrence is either a resource reference that connects the topic with the resource, or a data area (string value/resource data) that represents the resource. Type/class occurrence will then decide how to interpret the data area. One example of using the data area could be to use metadata as data area.

Associations
Topics can be connected by using associations. As mentioned above, a topic takes on a role in an association. In an association for a learning situation, one topic could fill the role as a teacher, another as a student and a third as the curriculum. However, a topic cannot have more than one role in each association, but it can be member of several associations. In ‘a student’ it can be a student in one association and assistant teacher in another. For example, one may link together those topics that are connected to production tools, those related to learning activities, etc. It is possible to build associations in a hierarchy, so that for learning activities, one may have an association for methods and therefore also association for learning theories.

One may have associations that link topics in a recommended order, e.g. a learning path etc. Through associations, it is possible to create relations in relational databases, one could use associations to create the relations of a synonym dictionary. There are many possibilities. Associations with only two members are called binary associations.

Scope

With scope, it is possible to see “the world” from different points of view. Different persons have different interests for subjects. It could be that;

- People prefer their own language, access to the subjects in Norwegian, English, French, etc.
- Access rights, different access rights can be given, depending on the user(s) (teacher/student).
- Meaning: Both associations and occurrences offer the opportunity to relate the information on a given topic to the current context. This means that scopes can determine which contexts the information is relevant. For example, 1) Intellectual stages (e.g. “Novice”, “Advanced beginner”, “Competence”, “Proficiency”, “”Expert”). This could in turn lead to further information on each level. 2) Relate to learning theories (e.g. “Behaviorism”, “Information processing”, “Constructivism”, “Socio-Constructivism”).

By using scope, we can imagine that we have semantic layers in a topic. There could be one layer for access as novice, another as expert, etc. If one prefers Norwegian, one can access one layer, for French another.

With merging, the basic rule is that all topics with the same base name should be replaced by one topic. “Topic having the same base name in the same scope implicitly refers to the same subject and therefore should be merged.” [Pepper & Moore, 2001]. Notice that the name similarity only applies within the same scope. Thus, scope could be used in solving ”problems” with using similar names.

It is up to the application program to take care of the interpretation of scope.

Variant names

Variant names are alternative names for base names used, for example, in displays of various units, such as a computer monitor and PDA, or used when arranging/sorting topics. These are only two examples, there are many areas of usage.

Variant names can be created in a structure with variant, sub-variant, sub-sub-variant, etc. For example, printer, type of printer (laser, ink), further which manufacturer etc.

Merging topic maps

With merging, it is possible to merge two topics, or two topic maps. Identical names or addresses are replaced by one. Names are compared byte-by-byte. Occurrences must be of the same kind and point to the same resource, associations must be of the same kind, and topics must have the same role if there is to be a replacement.

”Merging:
1. The process of merging two topic maps, either as a result of explicit <mergeMap> directives, or for any application-specific reasons.
2. The process of merging two topics.
The rules governing all forms of merging are given in Annex F: XTM Processing Requirements” [Pepper & Moore, 2001].

Realizing a Personal Learning Environment (PLE) using Topic Maps

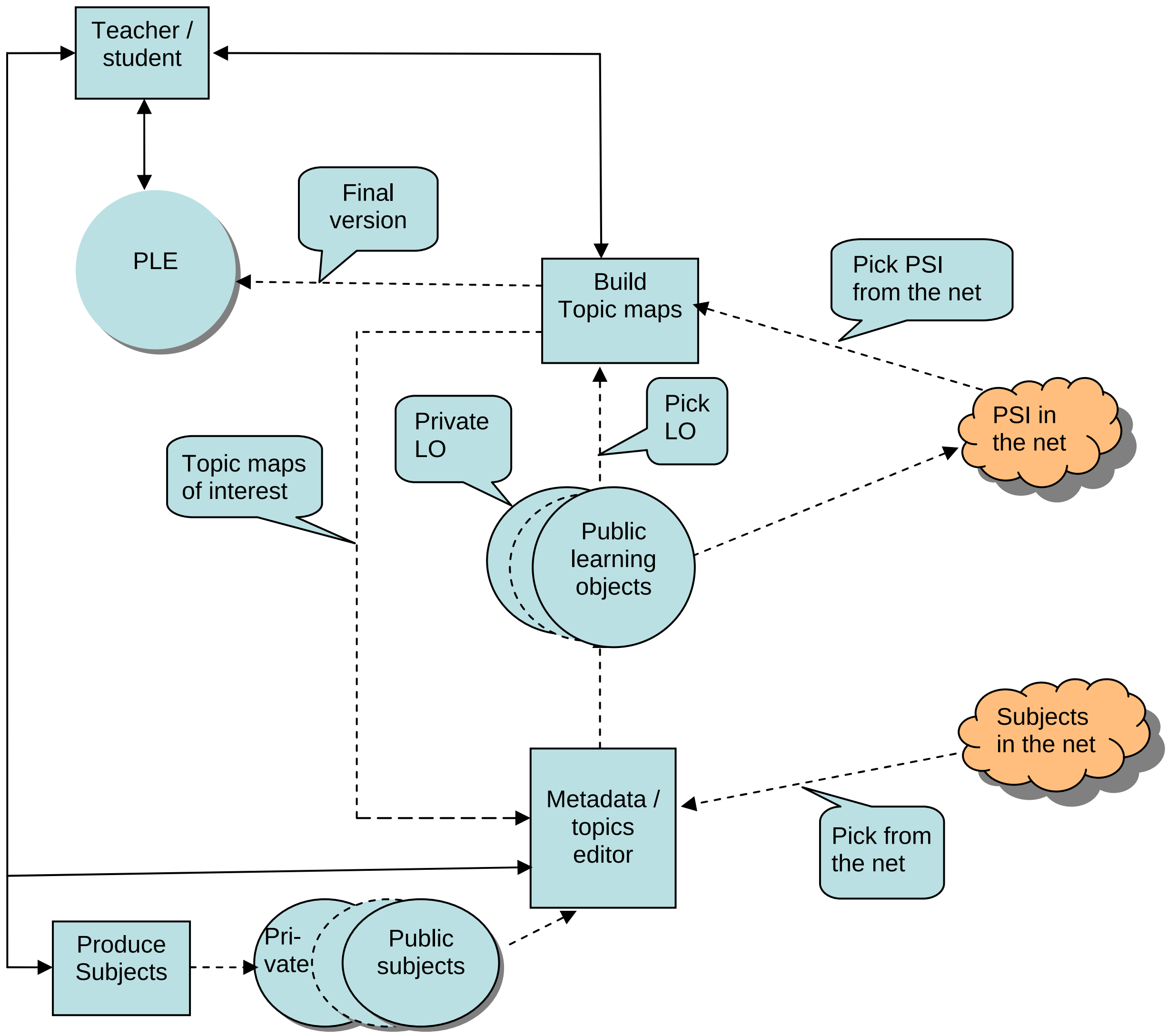

Figure 2: Conceptual model realizing a Personal Learning Environment (PLE) using Topic Maps

Explanation of figure 2
The model is built around the use of topic maps, since we believe that topic maps are suitable as the core of a powerful PLE with information administration, search and navigation as important components. According to Charles F. Goldfarb, the founder of SGML, Topic maps are ”the GPS of the information universe” [Goldfarb, 2003]. It tells us where we are and where to find the requested information. The terminology in the figure is related to topic maps terminology.

Teacher
The model is based on the assumption that both teachers and students can act as consumers and producers in an online learning environment. A typical situation would then be that a teacher is creating a course, or a course module. The teacher will then check if there already exist any learning objects (LO). S/he first searches and reuses learning objects from his / her

own library. S/he then searches and makes use of locally published learning objects or from an internet-based PSI (Published Subject Indicators). When using topic maps in connection with learning, it is natural that an educational Published Subject Indicators (PSI) is made available via Internet. Such environments already exist within several subject areas.

If no sufficient or preferred learning objects exist, the teacher can choose to develop his / her own. S/he may use already-existing subjects in the form of images, text, animations, videos, evaluation programs, arenas of cooperation, toolkits, etc. There are three sources for learning objects and subjects; private library, local library available or public libraries available on the Internet.

In the process of transforming subjects into learning objects (topics), it will be necessary to add metadata and PSI. “Learning objects - Proposal for a new learning object metadata standard using design patterns” [Appendix III], briefly discusses the requirements of such an editor. In addition, it is also necessary that the editor includes the building of topics with the necessary elements, such as one or several base names (possibly most common with at least one base name), possible variant names, occurrence(s), scope(s) and subject indicator.
The learning object is added to a private or a public database, or in both. If wanted, the learning object can now, with its PSI, be marketed on the Internet.

Based on learning objects that the teacher found, the next step will be to build a topic map, which is the information structure. That is, topic, association hierarchies and class hierarchies. When the final step of the topic map construction is completed, one will have a complete Personal Learning Environment (PLE). However, the road there could include several steps where expanding topic maps are created. Each of these steps may lead to topic maps that are interesting enough to make public, or to add to a private database of learning objects. It would be natural that the teacher aims at a private database before making these public. However, before they are added to a database, new relevant metadata must be added. It is also possible to publish via the new PSI that is created.

Eventually, learning objects that are private, locally public, or from the Internet, will be available even from topics with subjects in the form of a simple text, image, simple modules, course modules, modules for arenas of cooperation, evaluation programs etc., to objects with complete course.

Student
For students, the environment can be made available the same way as for a teacher.
In the QUIS requirement specification, it is from pedagogical models emphasized that the students themselves are to be producers of their own learning environments.

This is done by making the learning objects more or less available to the students.
However, it is possible to add the requested restrictions, the most extreme case is that the students have to do everything on their own, building the entire PLE. A more common example is that the students design their own electronic workbook, develop smaller course parts, course modules, etc. As for the teacher, it is natural that the students work in relation to private learning object bases. Also here, it will be natural with authorization before the objects are made publicly available.

PLExus – a prototype of a pedagogical-based PLE

A pedagogical-based PLE could be implemented using e.g. the topic map architecture, and we here introduce a prototype of a pedagogical-based PLE as a topic map. The student will experience a personalized user interface where s/he gets access to the learning objects from different points of view, based on e.g. pedagogical method (e.g. game, discussion, tutorial etc), learning objectives (knowledge, skill, attitude), proficiency stage (e.g. novice, competence, expert etc), intelligence (visual, verbal etc). The PLExus prototype presented is for the time being only covering some of these factors.

The PLExus prototype is based on the experiment with learning objects and writing metadata with design patterns, described in appendix III (Learning objects – Proposal of a new learning object metadata standard using design patterns).

The wizard

The teacher will prepare for a personal learning environment for the student by structuring the learning objects using a pedagogical topic map wizard.

The following screen shots are added to the report to help describe the prototype. The prototype is running, but there is not yet implemented a self-instructing user interface.

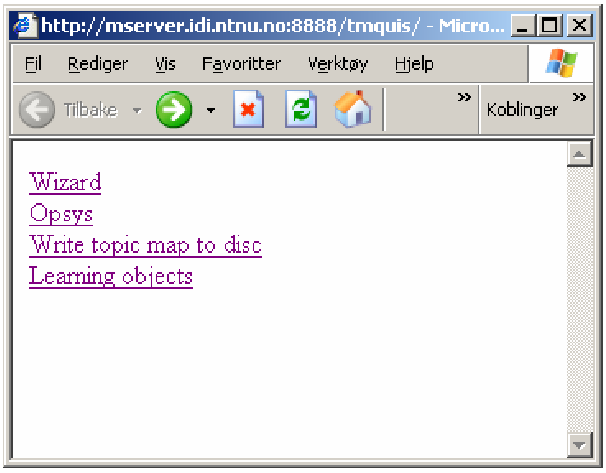

Figure 3: Screenshot 1

In screenshot 1 there are four choices:

- Wizard: Starts the wizard, which allows the teacher to put learning objects into the QUIS topic map.
- Opsys: A link that provides access to the hypermedia curriculum of the course “Operating systems”.
- Write topic map to disc: Utility function that for the time being store the in-memory topic map. A new version of the prototype should implement the functionality to store the topic map to disc.
- Learning objects: A link to the QUIS topic map, which will provide access to the learning objects from different perspectives like pedagogical method, level of learning objective etc.

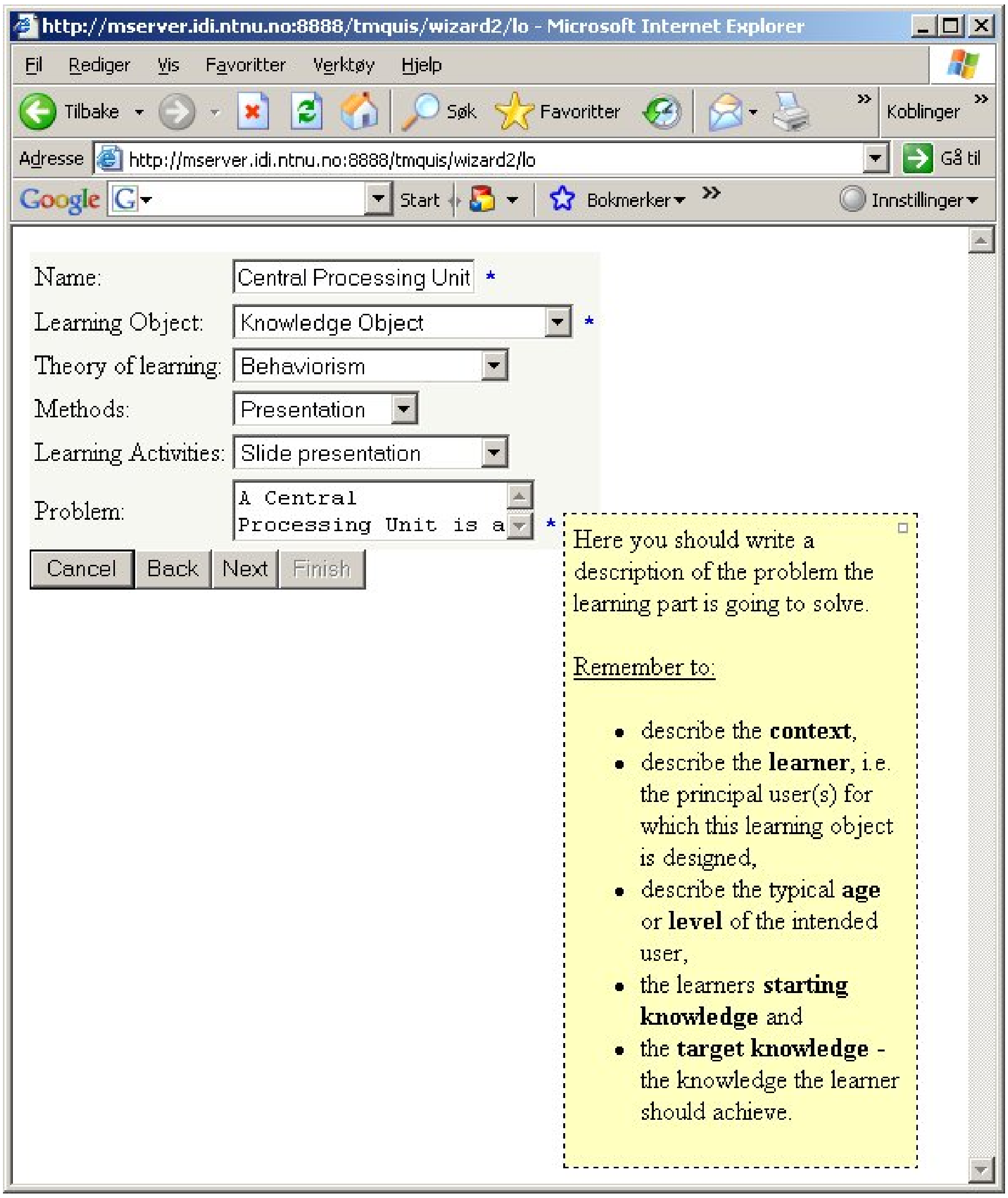

Figure 4: Screenshot 2 - The wizard, step 1.

In screenshot 2 the teacher has to fill in metadata, partly by choosing from a list, partly by writing free text. In the existing version of the prototype, the metadata covered in this phase are name, learning object type, theory of learning, pedagogical method, type of learning activity and problem description.

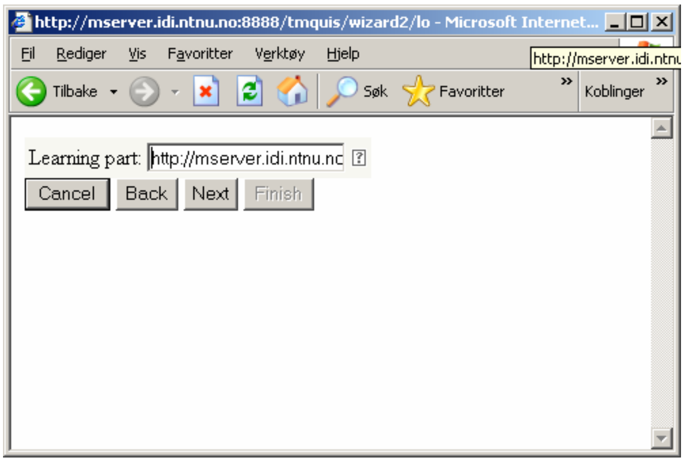

Figure 5: Screenshot 3 – adding the learning part.

Before the learning part link is provided in screenshot 3 the learning part must be developed.

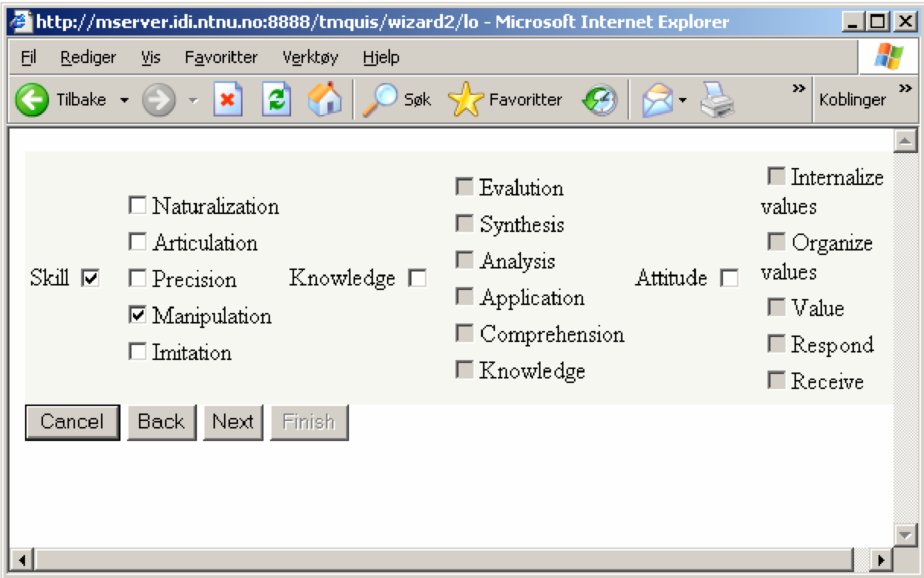

Figure 6: Screenshot 4 – defining learning objective type and level.

The teacher must in screenshot 4 mark what learning objective type and what taxonomy level(s) the learning object is covering.

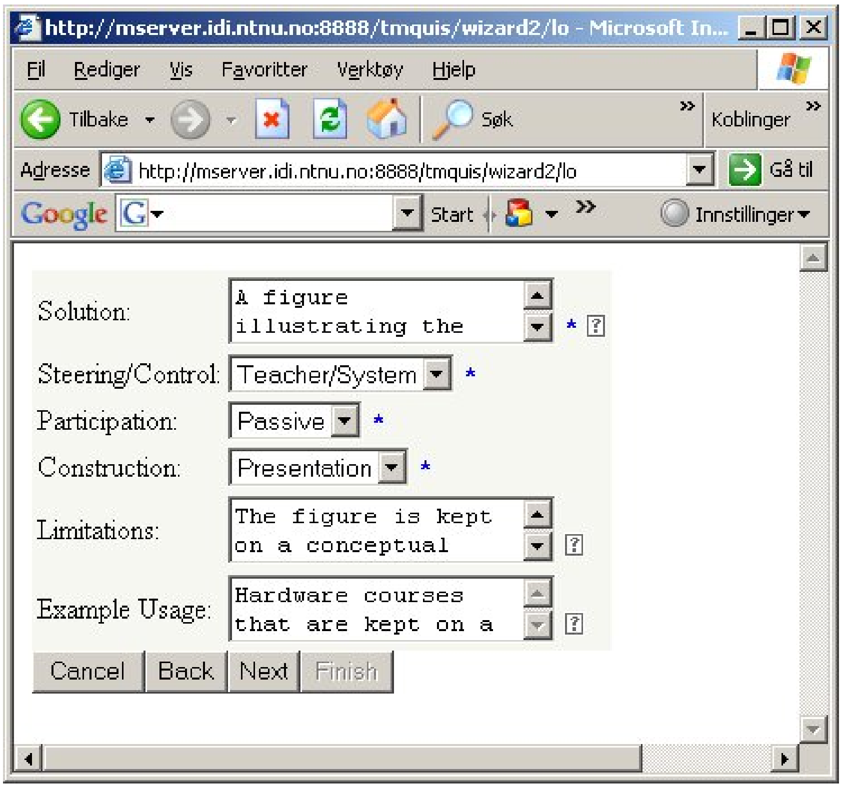

Figure 7: Screenshot 5 – adding metadata.

In screenshot 5 the teacher fills in metadata covering solution, steering/control, participation, construction, limitations and example usage (see appendix III). The question marks are containing help to the user, like it is illustrated in figure 4.

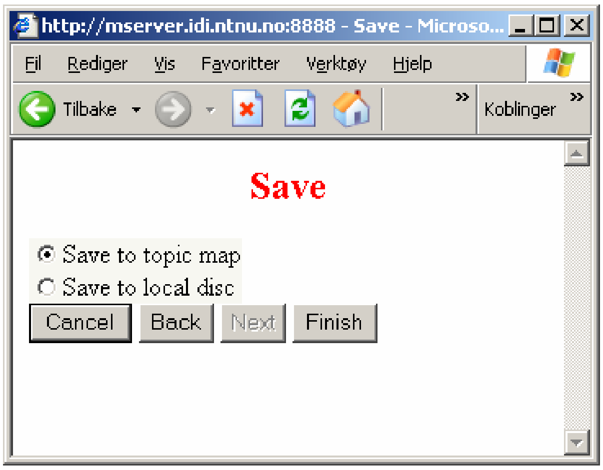

Figure 8: Screenshot 6 – saving the learning part and metadata to topic map.

In screenshot 6 the teacher may save the learning object (with its metadata) to the topic map, alternatively to a local disc.

The wizard is module-based, with independent modules. The idea is that it should be possible to insert, remove modules and change the order, dependent of which paths and choices made in the wizard. Each module is producing an XML part, which is transformed to a topic map in the final step, which in turn could be merged with the QUIS Topic Map (TMQ), or stored separately.

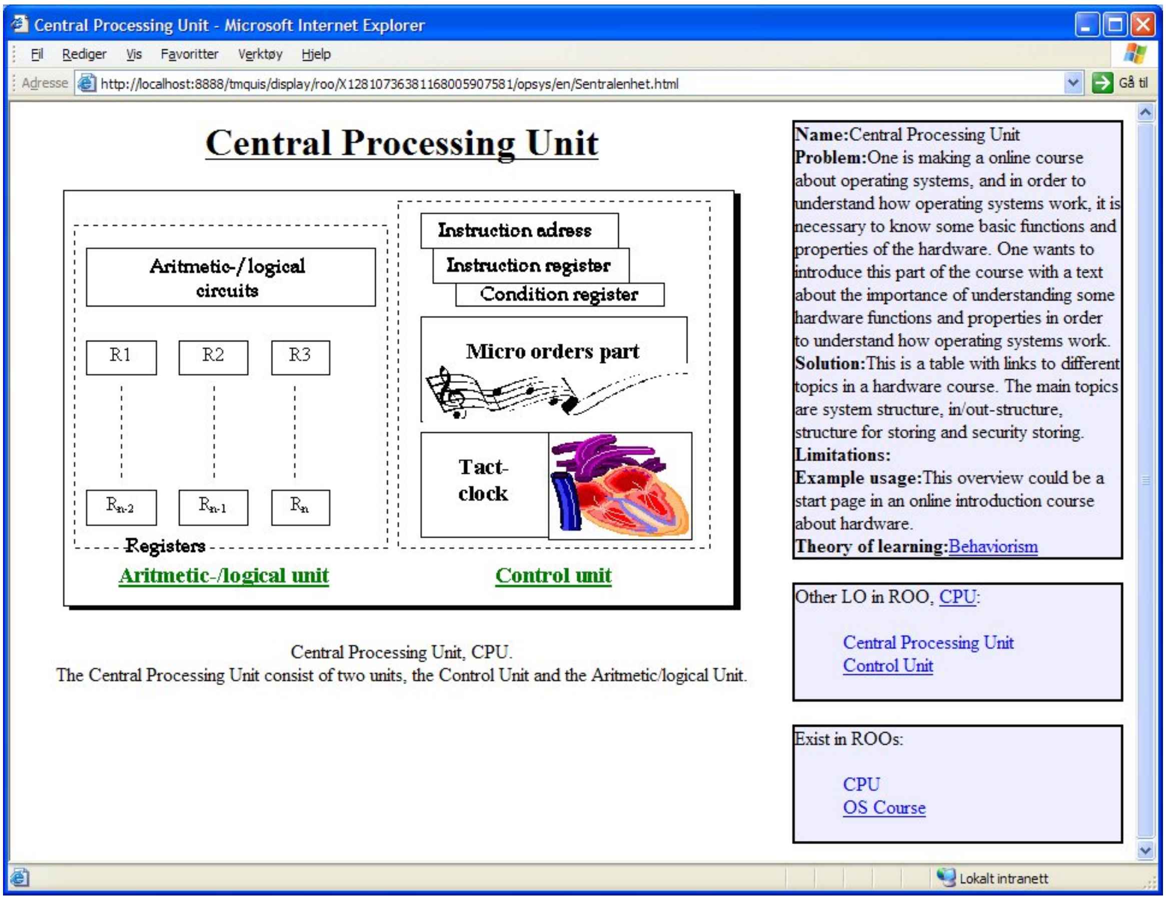

Figure 9: Example of topic map screenshot.

Figure 9 illustrates how the student experiences the learning environment at the time being; the chosen knowledge object (KO) is shown on the left side of the screen.
The second block on the right side of the screen shows that the knowledge object “Central Processing Unit” is part of the resource organizing object (ROO) “CPU”. It also shows the other learning objects in the current resource organizing object, in this case the KO “Control Unit”. Its purpose is to enable navigation between objects in the resource organizing object. The current learning object is indicated without an underline.

The third block on the right side of the screen shows and provides access to all the resource organizing objects the knowledge object “Central Processing Unit” is part of. The links enables the user to change context without leaving the current knowledge object. The current KO is indicated without an underline.

All the links on the left side of the screen enable semantic-based navigation between learning objects. The prototype provides at the time being only a few navigation opportunities (based on theory of learning and ROOs), but the student will in the future have access to learning objects based on e.g. pedagogical methods, theme, media type, ranking score etc.

System overview

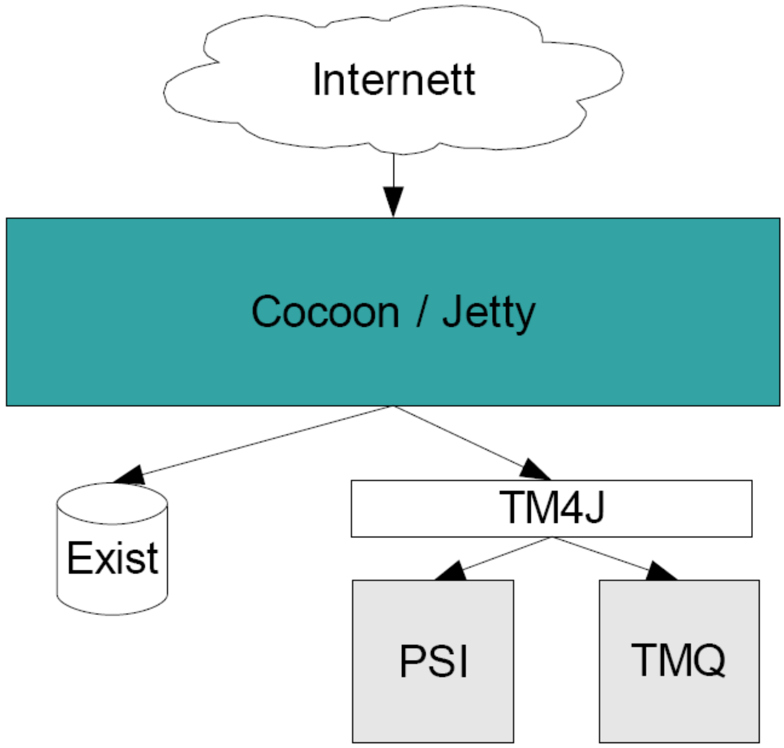

Figure 10: System overview

Explanation of figure 10:
- Apache Cocoon / Jetty [Apache Cocoon, 2006] is the XML framework.
- "Exist" [Exist, 2006] is an XML database, which stores raw data without knowledge of metadata.
- TM4J [TM4J, 2006]: The Topic Map engine. Integrated with Cocoon through TM4Web [TM4Web, 2006].
- PSI: Topic Map containing the Published Subject Identifier.
- TMQ (Topic map QUIS): The topic Map with learning objects and metadata.

The PSI Topic Map
The PSI topic map (table 2) is in our work of the PLExus prototype a local and temporal variant of a PSI (Published Subject Identifier). A PSI is necessary to ensure that the same topics are assigned the same topic names and should in the future be standardized by the educational field. The PSI Topic Map in figure 10 is the PSI of the TMQ Topic Map.

”A published subject is any subject for which a subject indicator has been made available for public use and is accessible via a URI. A PSI is therefore any resource that has been published in order to provide a positive, unambiguous indication of the identity of a subject for the purpose of facilitating topic map interchange and merge ability” [Park, 2003].

”PSI must meet certain requirements for quality:
Stability: The publisher must guarantee the permanence of the resource address.

Expertise: The definition of subjects must be validated by authoritative sources.
Trust: This evolves mainly as a consequence of the two previous requirements" [Park, 2003].

Table 2: xtm1.0-psi-tmquis

learning_object

Identifier	http://localhost:8888/tmquis/psi.xtm#learning_object
Description	Learning Object

online_occurrence

Identifier	http://localhost:8888/tmquis/psi.xtm#online_occurrence
Description	Online occurrence of Learning Object

name

Identifier	http://localhost:8888/tmquis/psi.xtm#name
Description	Name of learning Object

problem

Identifier	http://localhost:8888/tmquis/psi.xtm#problem
Description	Problem of Learning Object

solution

Identifier	http://localhost:8888/tmquis/psi.xtm#solution
Description	Short Description of solution.

limitations

Identifier	http://localhost:8888/tmquis/psi.xtm#limitations
Description	Limitations

example_usage

Identifier	http://localhost:8888/tmquis/psi.xtm#example_usage
Description	Example usage

has_skill

Identifier	http://localhost:8888/tmquis/psi.xtm#has_skill
Description	Has skill

has_subskill

Identifier	http://localhost:8888/tmquis/psi.xtm#has_subskill
Description	Skill has subskill

has_knowledge

Identifier	http://localhost:8888/tmquis/psi.xtm#has_knowledge
Description	Has knowledge

has_subknowledge

Identifier	http://localhost:8888/tmquis/psi.xtm#has_subknowledge
Description	Knowledge has subknowledge

has_attitude

Identifier	http://localhost:8888/tmquis/psi.xtm#has_attitude
Description	Has attitude

has_subattitude

Identifier	http://localhost:8888/tmquis/psi.xtm#has_subattitude
Description	Attitude has subattitude

Table 2 Continued:

has_theories_of_learning

Identifier	http://localhost:8888/tmquis/psi.xtm#has_theories_of_learning
Description	Learning Object has theories of learning

has_methods

Identifier	http://localhost:8888/tmquis/psi.xtm#has_methods
Description	Theory of learning has methods

has_learning_activities

Identifier	http://localhost:8888/tmquis/psi.xtm#has_learning_activities
Description	Method has learning activities

theories_of_learning

Identifier	http://localhost:8888/tmquis/psi.xtm#theories_of_learning
Description	Theories of learning from the E-learning Circle.

behaviorism

Identifier	http://localhost:8888/tmquis/psi.xtm#behaviorism
Description	Theory of learning - behaviorism

information_processing

Identifier	http://localhost:8888/tmquis/psi.xtm#information_processing
Description	Theory of learning - Information processing

constructivism

Identifier	http://localhost:8888/tmquis/psi.xtm#constructivism
Description	Theory of learning - Constructivism

sosio-constructivism

Identifier	http://localhost:8888/tmquis/psi.xtm#sosio-constructivism
Description	Theory of learning - Sosio-Constructivism

methods

Identifier	http://localhost:8888/tmquis/psi.xtm#methods
Description	Methods from the e-learning circle

m_drill___practice

Identifier	http://localhost:8888/tmquis/psi.xtm#m_drill___practice
Description	Methods - Drill & Practice

m_presentation

Identifier	http://localhost:8888/tmquis/psi.xtm#m_presentation
Description	Methods - Presentation

learning_activities

Identifier	http://localhost:8888/tmquis/psi.xtm#learning_activities
Description	Learning activities from the E-learning Circle.

multiple_choices

Identifier	http://localhost:8888/tmquis/psi.xtm#multiple_choices
Description	Learning activity - Multiple choices

drag_and_drop

Identifier	http://localhost:8888/tmquis/psi.xtm#drag_and_drop
Description	Learning activity - Drag and Drop

match

Identifier	http://localhost:8888/tmquis/psi.xtm#match
Description	Learning activity - Match

Table 2 Continued:

memory

Identifier	http://localhost:8888/tmquis/psi.xtm#memory
Description	Learning activity - Memory

fill_in_blanks

Identifier	http://localhost:8888/tmquis/psi.xtm#fill_in_blanks
Description	Learning activity - Fill in blanks

wiki

Identifier	http://localhost:8888/tmquis/psi.xtm#wiki
Description	Learning activity - Wiki

mind_map

Identifier	http://localhost:8888/tmquis/psi.xtm#mind_map
Description	Learning activity - Mind Map

concept_map

Identifier	http://localhost:8888/tmquis/psi.xtm#concept_map
Description	Learning activity - Concept map

gis

Identifier	http://localhost:8888/tmquis/psi.xtm#gis
Description	Learning activity - GIS

slide_presentation

Identifier	http://localhost:8888/tmquis/psi.xtm#slide_presentation
Description	Learning activity - Slide presentation

video___audio_recording

Identifier	http://localhost:8888/tmquis/psi.xtm#video___audio_recording
Description	Learning activity - Video / Audio Recording

skill

Identifier	http://localhost:8888/tmquis/psi.xtm#skill
Description	Skill from the E-learning Circle; Assessment

skill-naturalization

Identifier	http://localhost:8888/tmquis/psi.xtm#skill-naturalization
Description	Skill, Naturalization, from the E-learning Circle; Assessment

skill-articulation

Identifier	http://localhost:8888/tmquis/psi.xtm#skill-articulation
Description	Skill, Articulation, from the E-learning Circle; Assessment

skill-precision

Identifier	http://localhost:8888/tmquis/psi.xtm#skill-precision
Description	Skill, Precision, from the E-learning Circle; Assessment

skill-manipulation

Identifier	http://localhost:8888/tmquis/psi.xtm#skill-manipulation
Description	Skill, Manipulation, from the E-learning Circle; Assessment

skill-imitation

Identifier	http://localhost:8888/tmquis/psi.xtm#skill-imitation
Description	Skill, Imitation, from the E-learning Circle; Assessment

knowledge

Identifier	http://localhost:8888/tmquis/psi.xtm#knowledge
Description	Knowledge from the E-learning Circle; Assessment

Table 2 Continued:

knowledge-synthesis

Identifier	http://localhost:8888/tmquis/psi.xtm#knowledge-synthesis
Description	Knowledge, Synthesis, from the E-learning Circle; Assessment

knowledge-analysis

Identifier	http://localhost:8888/tmquis/psi.xtm#knowledge-analysis
Description	Knowledge, Analysis, from the E-learning Circle; Assessment

knowledge-application

Identifier	http://localhost:8888/tmquis/psi.xtm#knowledge-application
Description	Knowledge, Application, from the E-learning Circle; Assessment

knowledge-comprehension

Identifier	http://localhost:8888/tmquis/psi.xtm#knowledge-comprehension
Description	Knowledge, Comprehension, from the E-learning Circle; Assessment

knowledge-knowledge

Identifier	http://localhost:8888/tmquis/psi.xtm#knowledge-knowledge
Description	Knowledge, Knowledge, from the E-learning Circle; Assessment

attitude

Identifier	http://localhost:8888/tmquis/psi.xtm#attitude
Description	Attitude from the E-learning Circle; Assessment

attitude-internalizeValues

Identifier	http://localhost:8888/tmquis/psi.xtm#attitude-internalizeValues
Description	Attitude, Internalize values, from the E-learning Circle; Assessment

attitude-organizeValues

Identifier	http://localhost:8888/tmquis/psi.xtm#attitude-organizeValues
Description	Attitude, Organize values, from the E-learning Circle; Assessment

attitude-value

Identifier	http://localhost:8888/tmquis/psi.xtm#attitude-value
Description	Attitude, Value, from the E-learning Circle; Assessment

attitude-respond

Identifier	http://localhost:8888/tmquis/psi.xtm#attitude-respond
Description	Attitude, Respond, from the E-learning Circle; Assessment

attitude-receive

Identifier	http://localhost:8888/tmquis/psi.xtm#attitude-receive
Description	Attitude, Receive, from the E-learning Circle; Assessment

key_topic

Identifier	http://localhost:8888/tmquis/psi.xtm#key_topic
Description	Key topic in association

sub_topic

Identifier	http://localhost:8888/tmquis/psi.xtm#sub_topic
Description	Sub topic in association

knowledge_object

Identifier	http://localhost:8888/tmquis/psi.xtm#knowledge_object
Description	Knowledge Object

resource_organization_object

Identifier	http://localhost:8888/tmquis/psi.xtm#resource_organization_object
Description	Resource Organizing Object

Table 2 Continued:

object

Identifier	http://localhost:8888/tmquis/psi.xtm#object
Description	Learning Object in association giving the Learning Object type.

object_type

Identifier	http://localhost:8888/tmquis/psi.xtm#object_type
Description	Learning Object type in association with Learning Object.

is_object_type

Identifier	
Description	Association binding Learning Object to Learning Object type.

steering_control_level

Identifier	http://localhost:8888/tmquis/psi.xtm#steering_control_level
Description	Steering / Control level in Hutchings Cube.

steering_control

Identifier	http://localhost:8888/tmquis/psi.xtm#steering_control
Description	Steering / Control in Hutchings Cube.

steering_control_0

Identifier	http://localhost:8888/tmquis/psi.xtm#steering_control_0
Description	Level Teacher / System in Hutchings Cube; Steering / Control.

steering_control_1

Identifier	http://localhost:8888/tmquis/psi.xtm#steering_control_1
Description	Level Mixed in Hutchings Cube; Steering / Control.

steering_control_2

Identifier	http://localhost:8888/tmquis/psi.xtm#steering_control_2
Description	Level Learner in Hutchings Cube; Steering / Control.

has_steering_control

Identifier	http://localhost:8888/tmquis/psi.xtm#has_steering_control
Description	Association binding Hutchings Cube's Steering / Control to Learning Object.

construction_level

Identifier	http://localhost:8888/tmquis/psi.xtm#construction_level
Description	Construction level in Hutchings Cube.

construction

Identifier	http://localhost:8888/tmquis/psi.xtm#construction
Description	Construction in Hutchings Cube.

construction_0

Identifier	http://localhost:8888/tmquis/psi.xtm#construction_0
Description	Level Presentation in Hutchings Cube; Construction

construction_1

Identifier	http://localhost:8888/tmquis/psi.xtm#construction_1
Description	Level Mixed in Hutchings Cube; Construction

construction_2

Identifier	http://localhost:8888/tmquis/psi.xtm#construction_2
Description	Level Creativity in Hutchings Cube; Construction

Table 2 Continued:	
has_construction	
Identifier	http://localhost:8888/tmquis/psi.xtm#has_construction
Description	Association binding Hutchings Cube's Construction to Learning Object.
participation_level	
Identifier	http://localhost:8888/tmquis/psi.xtm#participation_level
Description	Participation level in Hutchings Cube.
participation	
Identifier	http://localhost:8888/tmquis/psi.xtm#participation
Description	Participation in Hutchings Cube.
participation_0	
Identifier	http://localhost:8888/tmquis/psi.xtm#participation_0
Description	Level Active in Hutchings Cube; Participation.
participation_1	
Identifier	http://localhost:8888/tmquis/psi.xtm#participation_1
Description	Level Mixed in Hutchings Cube; Participation.
participation_2	
Identifier	http://localhost:8888/tmquis/psi.xtm#participation_2
Description	Level Passive in Hutchings Cube; Participation.
has_participation	
Identifier	http://localhost:8888/tmquis/psi.xtm#has_participation
Description	Association binding Hutchings Cube's Participation to Learning Object.

Table 2: The PSI developed and used in the QUIS Topic Map

In theory the PSI should ensure valid values using the wizard of our prototype. This is in the prototype to some extend fulfilled, but is not done in full scale to reduce implementation time. This should be implemented in full scale when an educational PSI is standardized and stable.

The TMQ Topic Map

TMQ in figure 10 is the topic map prototype containing the metadata for the subjects / raw data. The name TMQ is short for Topic Map QUIS.

<u>Learning Object</u>

Each learning object (LO) has metadata directly connected to itself as resourceData in occurrences; problem, name, solution, limitation and example Usage. See the following screenshots and the example of a Topic Map fragment.

The metadata will in the topic map-based user interface provide the basis for the student to find other learning objects based on e.g. the theory of learning (see screenshot 8) (later based on media type, intellectual stage, learning objective type, taxonomy level of learning objective etc).

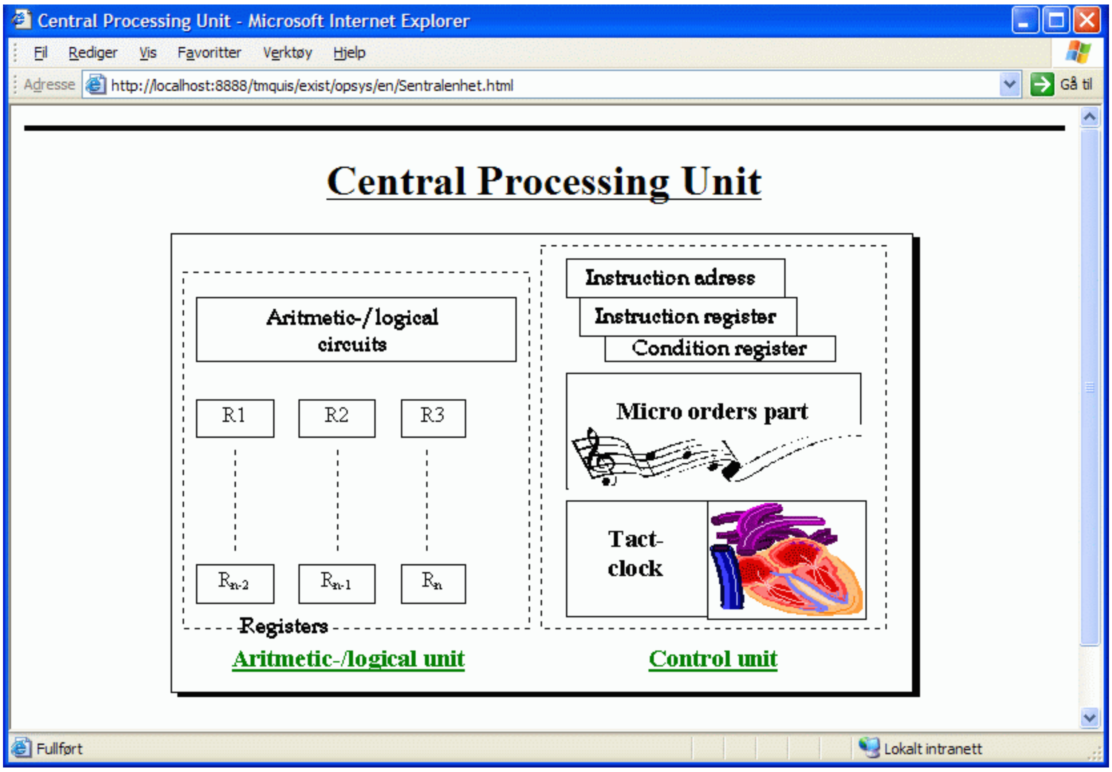

Figure 11: Screenshot 7 - Example of learning object.

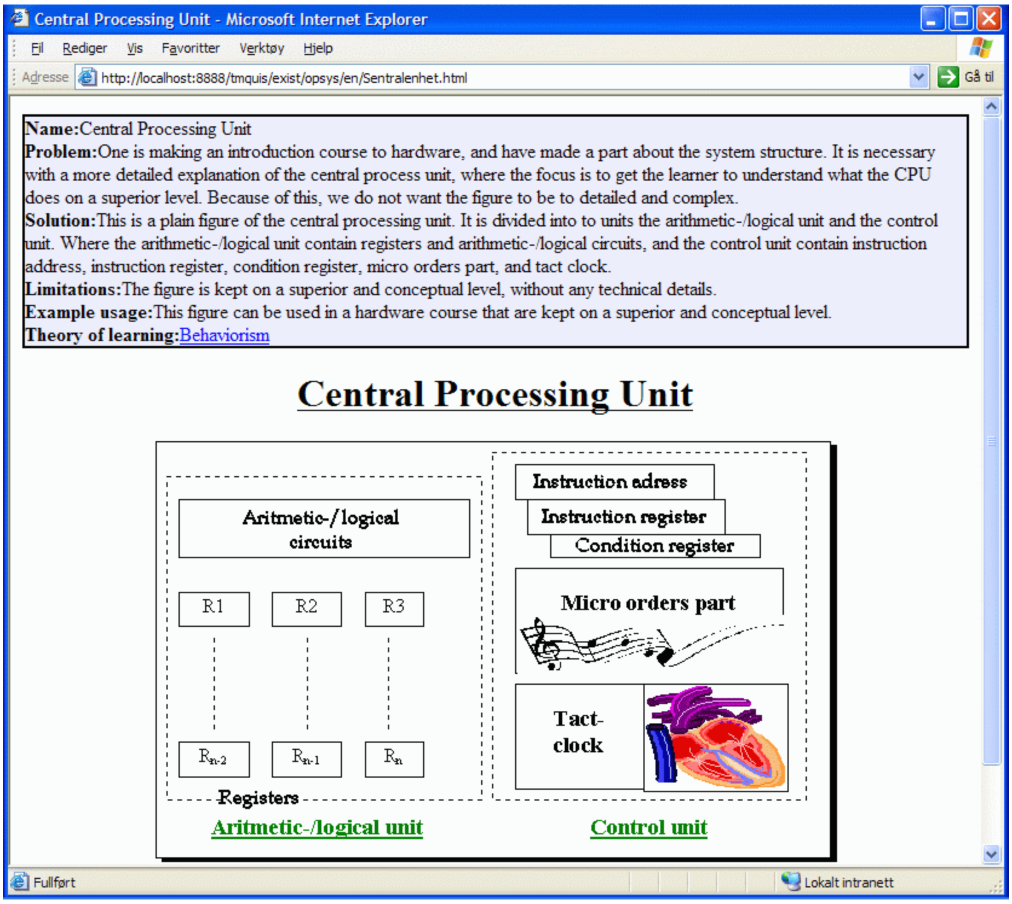

Figure 12: Screenshot 8 - Learning object with metadata.

```
<topic id="X1862299491164120529369">
	<instanceOf>
		<topicRef xlink:href="#learning_object"/>
	</instanceOf>
	<subjectIdentity>
		<subjectIndicatorRef xlink:href="http://quis/#X1862299491164120529369"/>
	</subjectIdentity>
	<baseName>
		<baseNameString>Central Processing Unit</baseNameString>
	</baseName>
	<occurrence>
		<instanceOf>
			<topicRef xlink:href="#name"/>
		</instanceOf>
		<resourceData>Central Processing Unit</resourceData>
	</occurrence>
	<occurrence>
		<instanceOf>
			<topicRef xlink:href="#problem"/>
		</instanceOf>
		<resourceData>
One is making a course in operating systems, and it is necessary to have a part about the system structure and hardware. In this part one explain the different components, and when one presents the CPU, one wants to have a short text about CPU to supplement the illustration figure.
		</resourceData>
	</occurrence>
	<occurrence>
		<instanceOf>
			<topicRef xlink:href="#solution"/>
		</instanceOf>
		<resourceData>This is a short text that explains a illustration figure of CPU.</resourceData>
	</occurrence>
	<occurrence>
		<instanceOf>
			<topicRef xlink:href="#limitations"/>
		</instanceOf>
		<resourceData>
It is not very detailed, and could be supplemented with more information about the central processing unit.
		</resourceData>
	</occurrence>
	<occurrence>
		<instanceOf>
			<topicRef xlink:href="#example_usage"/>
		</instanceOf>
		<resourceData>
This text is very short, and is difficult to use as a stand-alone learning object. It is most suitable to supplement an illustration figure of CPU.
		</resourceData>
	</occurrence>
	<occurrence>
		<instanceOf>
			<topicRef xlink:href="#online_occurrence"/>
		</instanceOf>
		<resourceRef xlink:href="http://localhost:8888/tmquis/exist/opsys/no/Prosesser_forord.html"/>
	</occurrence>
</topic>
```

Example of a Topic Map fragment of a Learning Object

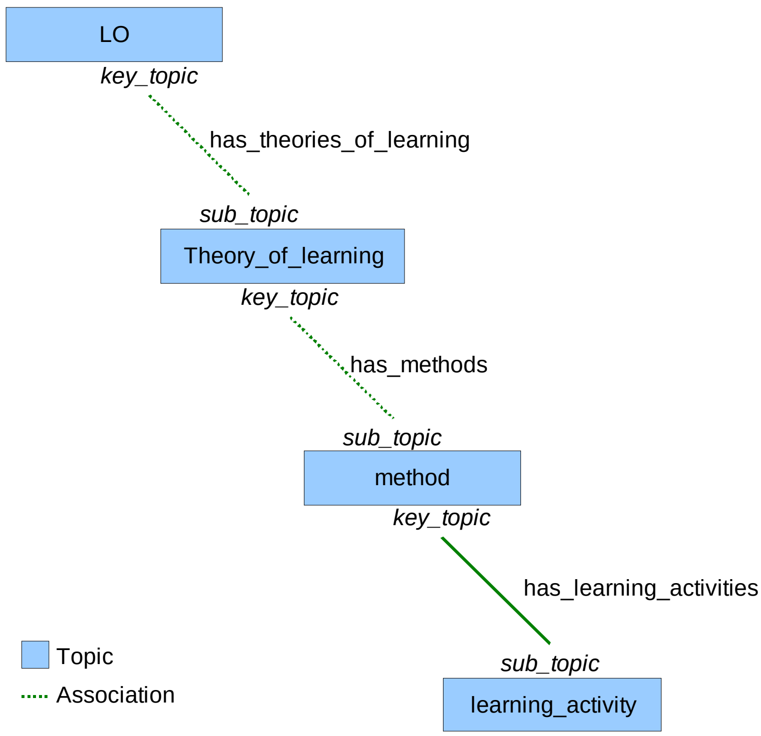

Figure 13: Example of pedagogical-based topics and the navigation path between them.

Figure 13 illustrates a possible navigation path between the some pedagogical-based topics (theory of learning, pedagogical methods and learning activity) that describe the learning object.

Theories of learning, (pedagogical) *Methods* and *Learning Activities* are connected to each other and the learning object with associations [Kolås, forthcoming]. The topics are data by existence.

Currently only one path is allowed to be chosen, e.g. two different *theories of learning* for the same learning object are invalid.

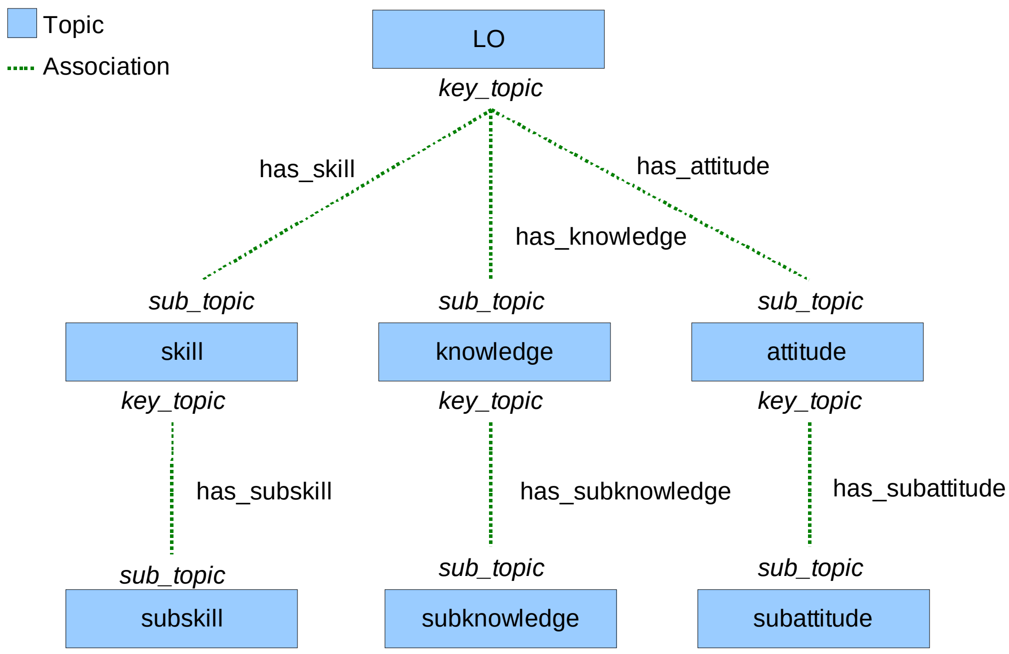

Figure 14: Learning objective types and taxonomy levels.

Learning objective types and taxonomy levels in figure 14 are topics associated with a learning object. Each *Type*: *skill*, *knowledge* and *attitude* may each have several sub categories of *taxonomy levels*.

Metadata "Solution 5.1, 5.2, 5.3" (see appendix III, table 2, p 48-49) is represented as three categories of topics, each bound to the learning object with its own association.

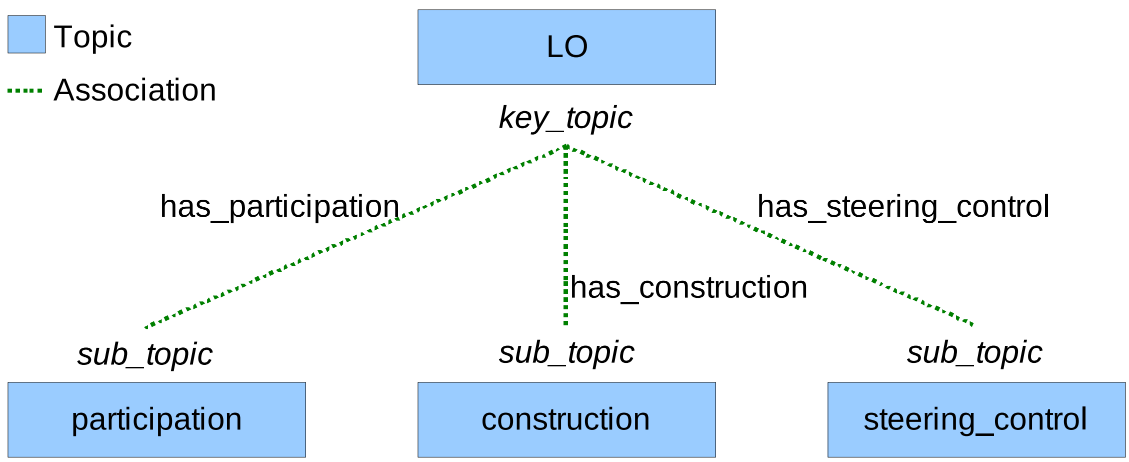

Figure 15: Solution: Steering/control, participation, construction as metadata.

The topics participation, construction and steering control each have three different types of topics, reflecting each level in its axis in the cube: 0-2 (see Appendix III).

<u>Knowledge Object (KO)</u>
A Knowledge Object topic is a LO topic, extended with a pointer trough resourceRef pointing at the subject/raw data. In addition to an association binding the topic to a common Knowledge Object topic, identifying it as a KO and allowing easier access by queries.

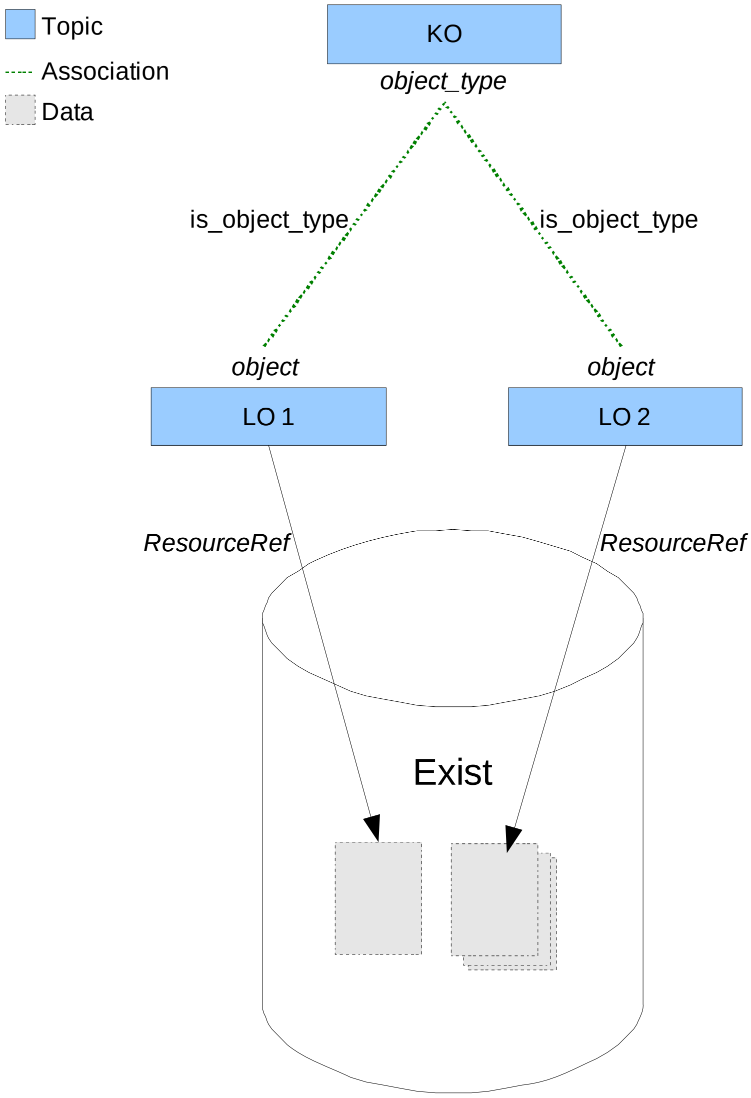

Figure 16: Example of two learning objects of the object type “knowledge object”.

```
<association>
	<instanceOf>
		<topicRef xlink:href="#is_object_type"/>
	</instanceOf>
	<member>
		<roleSpec>
			<topicRef xlink:href="#object"/>
		</roleSpec>
		<topicRef xlink:href="#X1862299491164120529369"/>
	</member>
	<member>
		<roleSpec>
			<topicRef xlink:href="#object_type"/>
		</roleSpec>
		<topicRef xlink:href="#knowledge_object"/>
	</member>
</association>
```

The association example above shows how an association is identifying a learning object as a knowledge object.

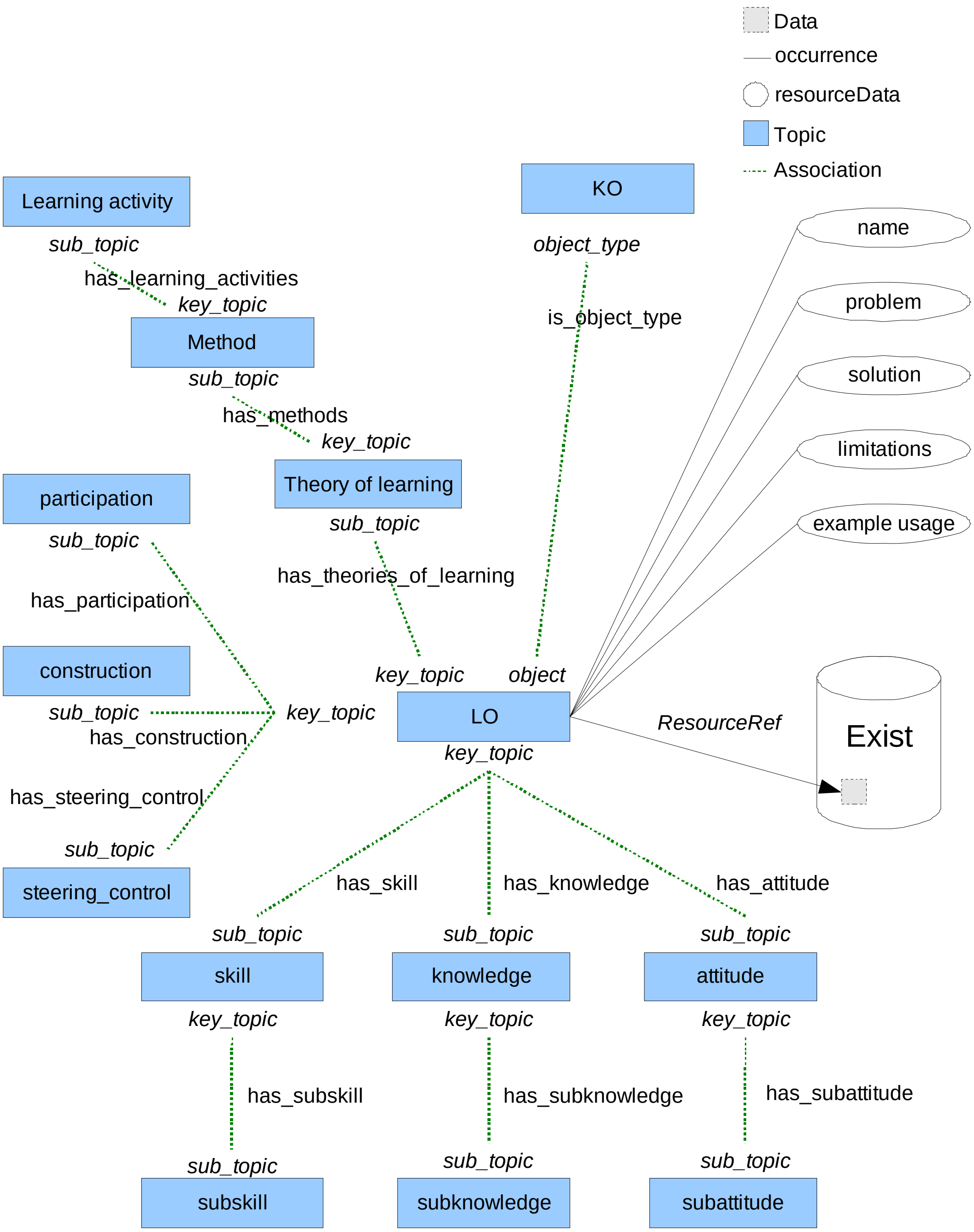

Figure 17: A learning object of the object type "knowledge object" (KO) with a variety of associations connected to the learning object.

Figure 17 illustrates a learning object of the object type knowledge object (KO) with a variety of associations connected to it. There are five different object types; knowledge object, monitor object, test object, tool object and resource organizing object (see appendix III). The first four of these (knowledge, monitor, test and tool object types) will have similar constructions. The resource organizing object will in addition to similar associations also have a wrapper, see figure 19.

The metadata presented as resourceData is written and searchable in free text.

Resource Organizing Object (ROO)

The second learning object type implemented in the prototype is the resource organizing object (ROO). As the KO, the Resource Organizing Object is a LO associated to identifying topic. The ROO's only function is to bind together several LOs, which could be other ROOs or KOs.

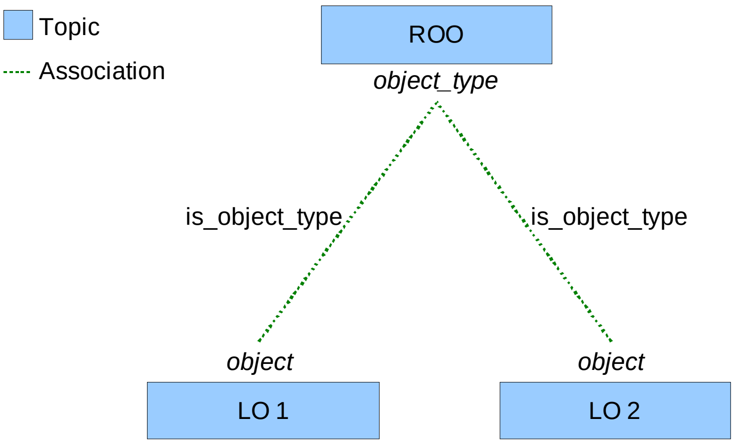

Figure 18: ROO links together other learning objects (LO).
The LO could either be KO or other ROO.

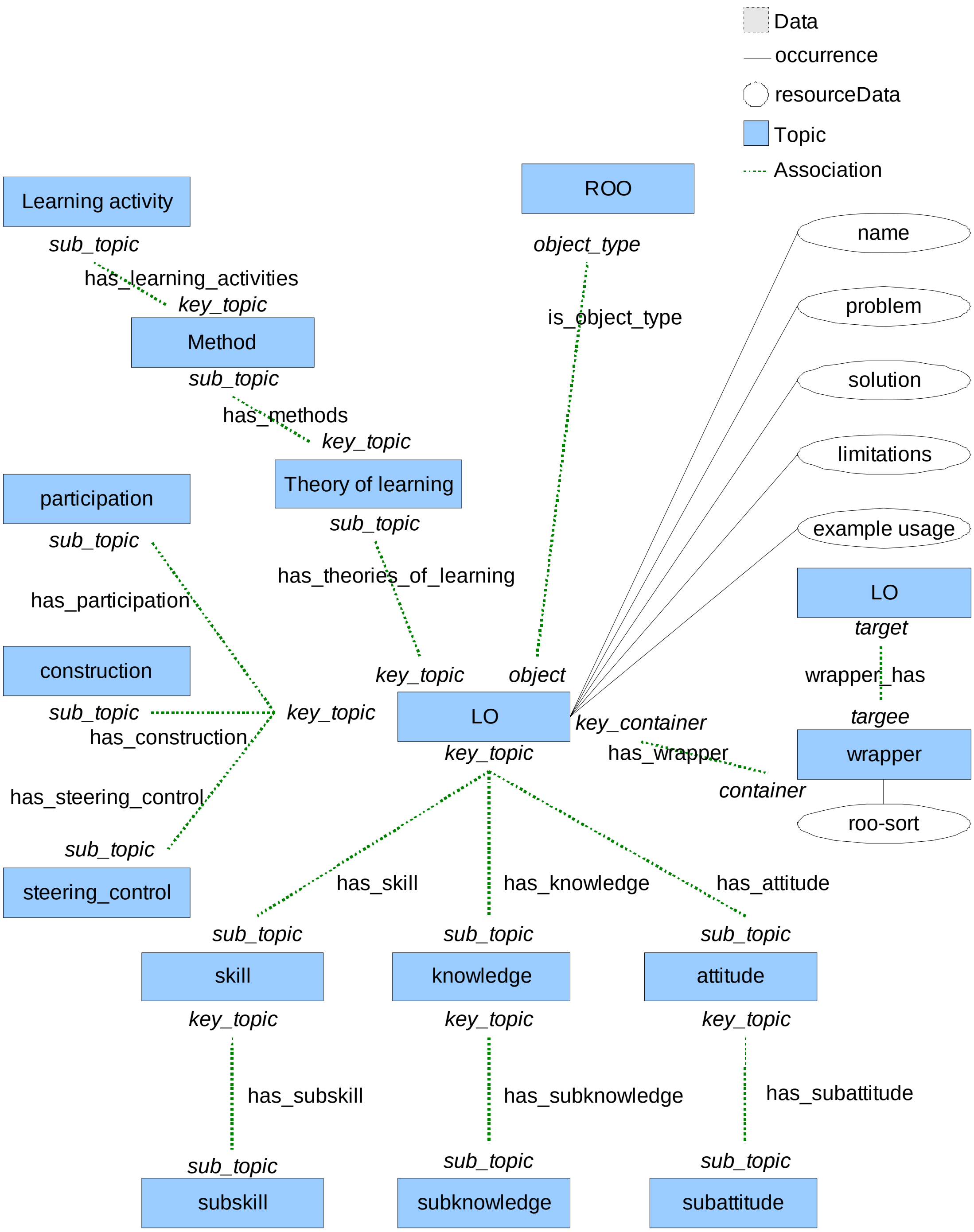

Figure 19: A learning object of the object type ROO with associations and a wrapper.

A learning object of the object type ROO (resource organizing object) needs a wrapper to add several learning objects (e.g. KOs or ROOs) into a new ROO. This is illustrated in figure 19.

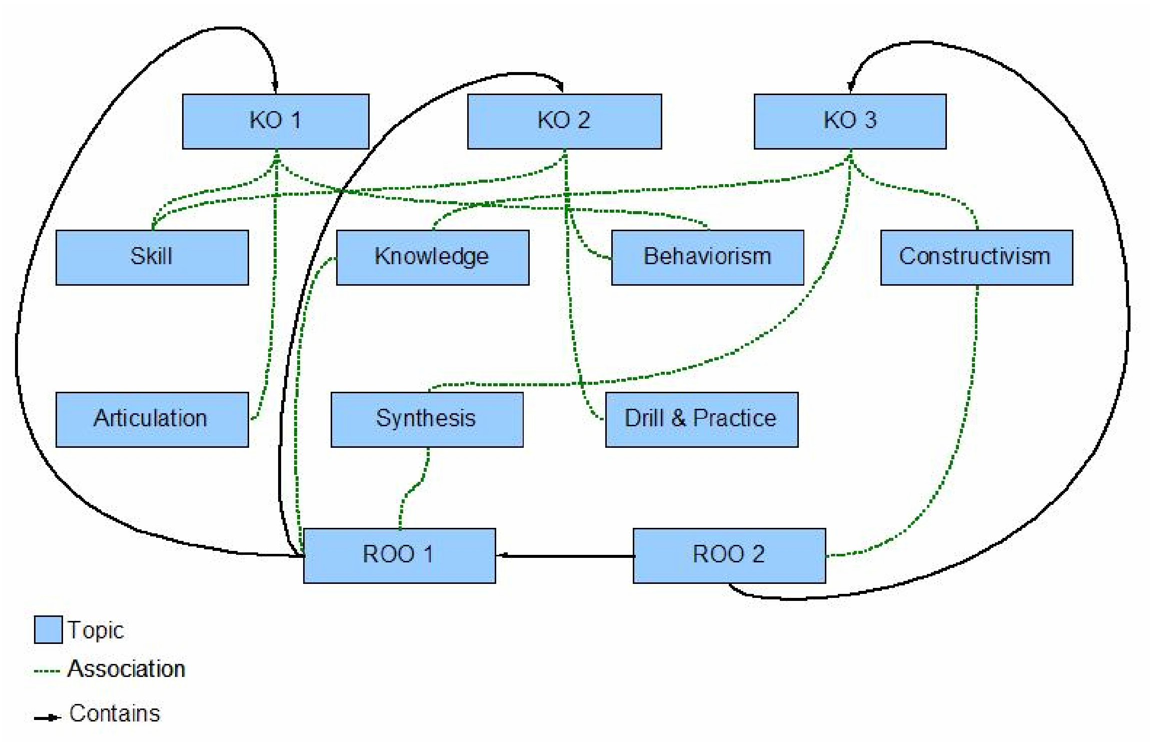

Figure 20: Example how a ROO can contain KOs and ROOs

Figure 20 illustrates how a ROO can contain both KOs and ROOs. The content of ROO2 in figure 20 is KO3 and ROO1 (existing of KO1 and KO2).

Conclusions

Appendix IV of the QUIS requirement specification presents PLExus – prototype of a PLE realized with the topic map technology. The term "plexus" means "network", which very well describes a personal learning environment based on the semantic technology of topic maps.

At the time being the PLExus prototype is only covering parts of what we would like to cover in a PLE based on the topic maps technology, but the basic structure of the system is working, and further development of PLExus in the future will be interesting.

Semantic-based navigation in e-learning will enable variation, differentiation and individualization, which are important factors developing a personal learning environment.

Acknowledgements

We would like to thank Trond Albinussen and Jørn Mikal Jensen for their contributions in the implementation phase of the PLExus prototype.

References

A complete reference list is found in the QUIS Requirement Specification.

Appendix V:

Online Tutoring – distributed interactive learning arena with synchronous video and audio.

Summary

"Online tutoring" was the name of a pilot project carried out at the Norwegian University of Science and Technology (NTNU) in the spring of 2005 in relation to two computer science courses, and part of the EU-project QUIS (Quality, Interoperability and Standards in e-learning). QUIS seeks experience of e-learning systems in order to develop requirements for the next generation e-learning system. "Online tutoring" sought to promote a new arena for tutoring, an alternative to traditional tutoring. Traditionally students go explicitly to the computer labs to be tutored on their assignments. This pilot project however provided the students with a system in which they could be tutored regardless of their geographical location. The pilot project was conducted in a technical environment and it provided a net-based service which is flexible and contains near real-time transfer of audio and video as well as application sharing and whiteboard. The research which forms the basis of this paper was conducted by two MSc students constituting parts of their thesis. The goal of the research project was to obtain the experiences the participants (students and tutors) had gained from the pilot; how online tutoring was recognized and employed by the students and tutors.

Online tutoring's largest strength was the flexibility it provided, which means that students can be tutored regardless of geographical location, as long as they have an internet connection. The survey shows that only the most technologically proficient and interested students chose to take advantage of this service. This means that the organisation of the service is of significance when it comes to the utilization of the service. The challenge is to increase the utilization, which can be achieved through certain measures such as an introductory workshop, cross-disciplinary tutor teams etc. Online tutoring can offer opportunities which traditional tutoring cannot provide; the use of private communication facilitates multiple simultaneous conversations without interference. The survey also shows that the use of private communication makes the students less nervous than asking questions in public. The students wish to hear the other students' questions thus it would be most appropriate to establish a netiquette; all communication to the tutor has to be public communication.

Geoffrey Moore (1999) describes how new technology is adopted in the market by establishing several categories of user groups and characteristics for the user group. There exists chasms (gaps) between the user groups, and "each of these gaps represent an opportunity for marketing to loose momentum"(Moore 1999 in Aarsland 2002, pp.141-142). Moore underlines that the principal challenge is crossing the chasm mainly between the user group *early adopters* to *early majority*. Strategies must be worked out in order for the technology or the concept to cross the gap. According to Moore's theories the students who have taken advantage of this service belonged to the group of *innovators* and *early adopters.* Once the technology has entered this stage, the development will make progress on its own, in

which new students obtain information and interest from other students who already use the tool.

Another aim of the research project was to consider experiences and results of the pilot project according to theories of Mantovani (1996), especially Mantovani's conceptual model of social context. The first level of Mantovani's model is concerned with the social context in general, the second that of daily situations, and the third that of local interaction with the environment by means of artefacts. The three levels nest inside each other from bottom to top. The aim is for an artefact to propagate to level 1, in which the artefact will become part of the social context. The hypothesis is that the precondition for even considering the pilot project according to Mantovani's model is the consideration of man, technology and organisation (MTO).

With regards to MTO the following assertion:

- When a technology-related artefact is introduced in an existing technological culture, it is often not enough to apply the technological artefact directly without considering changing the organisation in which it operates to best utilize the potential which the new artefact provides.

Online tutoring

Online tutoring was a pilot project carried out at NTNU in the spring of 2005. Through the pilot project online tutoring was fronted as an alternative to traditional tutoring of assignments. Traditionally tutors have been available in the computer labs for questions at specific times, which mean that the students explicitly had to go to the computer labs in order for their questions to be answered.

Through the pilot project both the students and the tutors are distributed. They use a video conferencing tool called Marratech to communicate. The tool is discussed in the next chapter.

The pilot project was related to two courses; Operating Systems and Programming. The students were introduced to the interactive learning arena and its use before they assigned to join. The students were given the choice of either assigning to online tutoring or traditional tutoring. Each student and his/her group are entitled to 2*45 minutes of tutoring a week.

As part of the preparation for the pilot project a tutoring lab was set up. This lab contained the facilities needed to take advantage of the possibilities within the interactive learning arena.

Marratech

Marratech is a desktop video conferencing tool developed at the University of Luleå, Sweden, and commercialized by Marratech AB. Marratech was chosen as the technical solution to facilitate online tutoring, as Marratech provides near real-time transfer of audio and video, and possibilities of a shared whiteboard and application sharing. Figure 1 shows a typical user interface in Marratech.

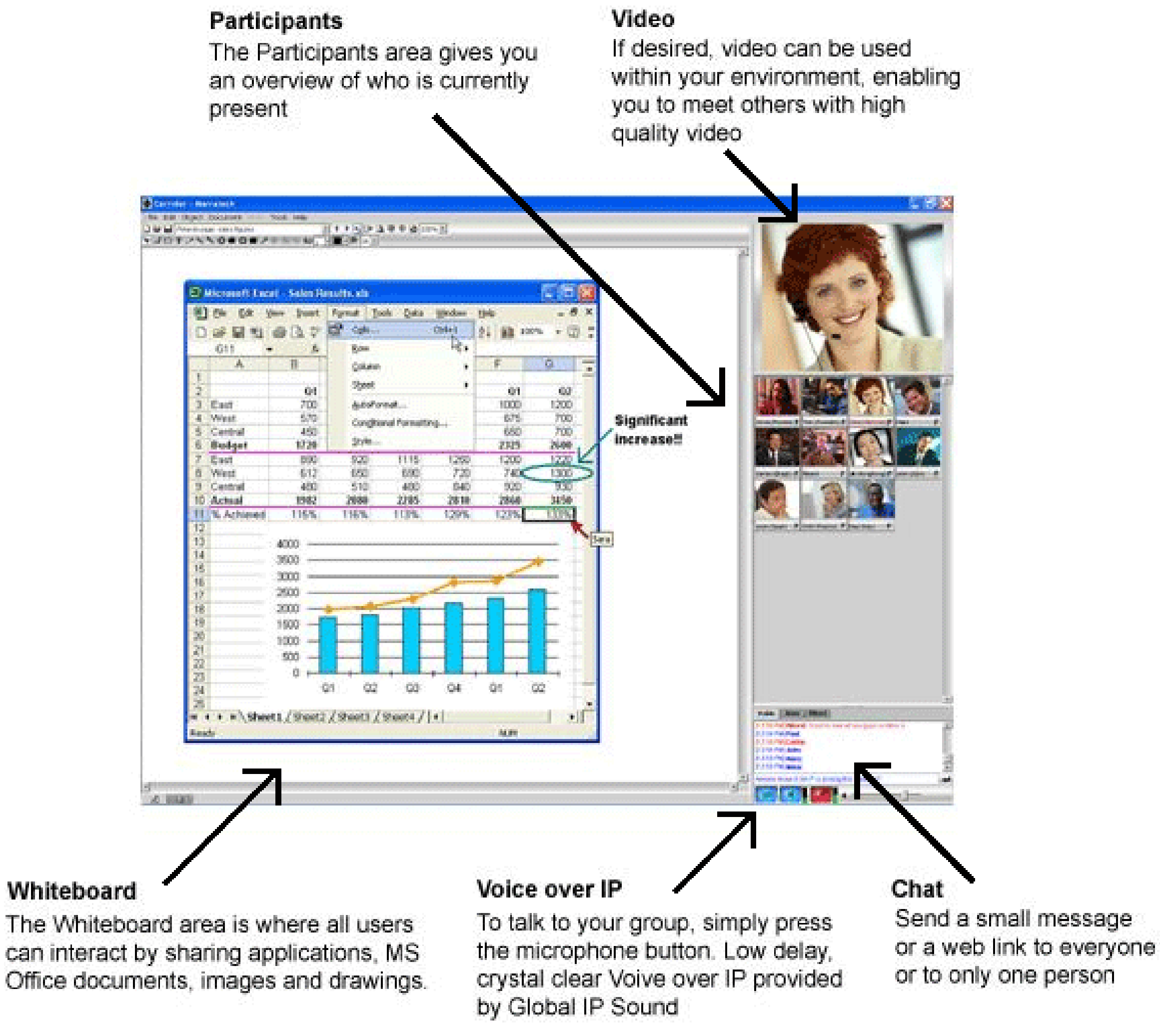

Figure 1: A typical user interface from Marratech (illustration taken from Marratech homepages)

Method

Method for data collection

The research method applied was action research, and the methods used were questionnaires and interviews. Prior to the students assigning to the pilot project they were asked to fill out a survey (Survey1), which covered the students' expectations to, and perceptions of online tutoring. This survey was answered by 70 students in the beginning of spring semester 2005. Towards the end of the pilot project the students filled out a second survey (Survey2), in which the students' experiences were registered. Survey2 was answered by 22 students in the end of the spring semester 2005. An explanation of the low number of students answering survey2 is probably because most students were busy with their final exam preparations. Six depth interviews with two students and four tutors were also coducted at the end of the semester. In addition reports from the tutors were part of the data collection.

Method for data handling

Survey1 was analysed quantitatively with statistical analysis, except for the commentary fields. Survey2 was also analysed quantitatively, while the information gathered from the interviews and the reports were analysed qualitatively.

Results

Some results from survey1

Table 1: Overview of which learning outcome the students have from the different forms of tutoring.

Grade from 1 to 4 which learning outcome you have from these forms of tutoring (1=least outcome, 4=most outcome)	(1 = Least outcome, 4 = Most outcome)				
Learning outcome	1	2	3	4	**Total**
Traditional tutoring	32,9%	44,3%	17,1%	5,7%	**100%**
Consultation with the teacher	18,8%	36,2%	26,1%	18,8%	**100%**
Traditional Learning Management System (LMS)	3%	16,7%	27,3%	53%	**100%**
Online tutoring	15,9%	38,1%	30,2%	15,9%	**100%**

From table 1 it is evident that traditional tutoring obtains the highest percentage. 32,9 % of the students has given this learning arena top grade (grade 1) and 44,3 % have given traditional tutoring grade 2. Consultation with the teacher and online tutoring obtain half of that percentage with respectively 18,8 % and 36,2 % on teacher consultation and 15,9 % and 37,1 % on online tutoring. The learning outcome of traditional LMS system does not achieve great support from the students.

The students have indicated where it suits them the most to utilise online tutoring:

Table 2: Overview of where it suites the students to utilise online tutoring.

Where does it suit you to utilise online tutoring?	Percent	Valid Percent
At home	84,3	85,5
At school	10,0	10,1
Other	4,3	4,3
Total	98,6	100,0
Missing System	1,4	
Total	100,0	

Table 2 shows the majority, 85,5 %, wishes to use the system at home. For most students the major strength of online tutoring is the possibility in receiving tutoring without going to school.

Table 3 indicates that the students' attitudes to the use of online tutoring are related to their studying methods:

Table 3: A cross table showing which tutoring form the students prefer and where they normally work with their assignments.

		If the use of online tutoring was as available as traditional tutoring, would you have employed it more?					Total
		1= Very positive	2	3	4	5= Very negative	
At home	Count %	29%	48,4%	16,1%	6,5%	0,0%	**100,0%**
At school during tutoring hours	Count %	0%	14,3%	42,9%	42,9%	0,0%	**100,0%**
At school, but not during tutoring hours	Count %	9,5%	33,3%	23,8%	33,3%	0,0%	**100,0%**

Among the students who prefer working on their IT-assignments at home 29 % would use online tutoring in a high degree, and 48,4 % are positive to using online tutoring. The students who prefer working on their assignments during tutoring hours are most sceptical; 42,9 % are negative, 42,9 % are indifferent and 14,3 % are positive. 9,3 % of the students working on their assignments at school, although not during tutoring hours, are very positive, and 33,3 % are positive to the use of online tutoring. This suggests that the students who normally work on their assignments at home are more positive than the students who prefer doing the work at school.

Table 4 gives an outline of the students' evaluation of their anxiousness related to asking questions to the tutor in a online tutoring situation:

Table 4: Overview of the anxiousness the students feel relating to the use of different communication channels.

	1=Agree	2	3	4	5=Disagree	**Total**
Not anxious to ask questions verbally to the tutor in the presence of other students	25,4%	32,8%	22,4%	13,4%	6,0%	**100,0%**
Not anxious to ask questions verbally only to the tutor	59,1%	18,2%	12,1%	10,6%	0%	**100,0%**
Not anxious to ask questions textually in the presence of other students	65,2%	18,2%	6,1%	9,1%	1,5%	**100,0%**
Not anxious to ask questions textually only to the tutor	77,3%	10,6%	3,0%	9,1%	0%	**100,0%**

Table 4 shows that 25,4 % of the students are not anxious about asking questions verbally to the tutor in the presence of other students, while 59,1 % are not anxious if only the tutor hears the question. When using a textual communication form the students are less anxious, even though other students see the question. 77,3 % are not nervous to ask questions textually only to the tutor.

If we relate this anxiousness with their evaluation of proficiency, there is a tendency that proficient students are more comfortable addressing an audience than less proficient students.

Extract of the evaluation by students and tutors

Tutor feedback

The tutors were very positive to online tutoring and they were satisfied with the technical implementation, which they found relatively intuitive. The turnout among students has however not been as expected, but this is related to low participation on traditional tutoring as well. Tutor1 believes in a gradual introduction of online tutoring, rather than making it the only alternative for tutoring. Tutor2 is of the opinion that the threshold was too high for the students who are not technologically proficient, and the students who have assigned to the pilot project are mostly technology enthusiasts, who, according to tutor2 are not in need of much assistance. Tutor3 on the other hand argues that the assignments the students were given were mostly of a theoretical nature, thus not necessitating much assistance. Tutor4 does not agree with the latter’s statement having received some poor assignments.

When it comes to functionality, two of the tutors reported that the chat function was mostly used as a communication medium. Tutor1 found using textual channels cumbersome, as he felt he did not get through to the students. Tutor2 communicated that the interactive learning arena whiteboard was used a lot, and tutor 1 said that the use of application sharing was beneficial.

The main advantage of online tutoring from the perspective of tutor3, was the fact that one can receive tutoring regardless of geographical location.

Student feedback

The main motivation for the students to join the pilot project has been mobility and curiosity. The learning outcome has not been as expected for the students, but the criticism was not directed at the interactive learning arena, but rather the organising concerning online tutoring with regards to availability of the service. 75% of the respondents have communicated they have asked their tutors questions, and they articulate that the questions asked by the other students logged on are of importance to them.

The majority have said that they are satisfied with the interactive learning arena’s functionality, and 60% of the respondents found the software application easy to learn. 66% felt the user interface was good, while 25% felt the interface could have been better.

When it comes to availability of the service, the students have communicated the preference of tutoring between 16 and 18 in the afternoon. The majority of the students prefer to utilise online tutoring at home rather than at school.

Students’ anxiousness regarding communication came into focus through this pilot project. During a lecture many students are reluctant to pose questions to the lecturer, and this is also the case in online tutoring although not to the same extent. The advantage in the interactive learning arena is the possibility of posing the questions either textually or orally. The respondents do not agree on whether having few students logged on or many is a positive effect. Some likes to have a lot of attention from the tutors, while others find it uncomfortable to receive a lot of attention from the tutor.

Analysis of the results

Communication

Communication in the interactive learning arena could either be verbal or textual (chat) and the students can choose whether they would like to communicate privately or publicly. Communicating privately means that a student can communicate directly to his/her tutor without other students intercepting the conversation. Communicating publicly means that everyone who has joined the session is able to hear or see what is communicated. Choosing public or private communication ought to be based on whether the information is relevant to the other students present. One student (informant) has communicated that he prefers using global communication, with the exception of practical questions with which he does not want to bother the other participants. Survey2 indicates that the students wish to hear the questions and answers the other students give. The research shows that a large percentage of the students chose to communicate through chat rather than voice, and this is related to nervousness discussed in the next subchapter.

Another student said he was very influenced by the choice of communication medium the other students chose. If they used chat, he also preferred using chat rather than oral communication. The tutors conveyed that tutoring students through textual mediums was cumbersome. Responding to question textually was more time-consuming than responding orally, and according to the tutor another student had asked him another question before he had time to answer the first question.

The number of people logged into the video conferencing system affects the choice of private or public communication. The study shows that if many people are logged onto the system, the students prefer using private communication, but if few people are logged on they choose public communication.

Compared to traditional tutoring, one of the interactive learning arena's strengths is the fact that all the students who have logged on to the system are able to hear all the communication to and from the tutor provided the use of global communication. This would not always be possible in traditional tutoring. If we take a look at private communication, the interactive learning arena facilitates numerous concurrent conversations without interrupting each other. On the basis of this information it is necessary to establish etiquette for communication channels; appeal for the use of global and oral communication.

Survey2 shows the majority of the students are satisfied with the technical implementation of online tutoring.

Anxiousness

Nervousness is a factor influencing the students' choice of public or private communication, but also whether they choose to use written or oral communication channels. The choice of asking a questions in writing or orally is more significant to the students' nervousness than communicating publicly or privately. This indicates that students are more comfortable speaking to an audience in writing than using their voices.

From the survey it is evident that the students, who evaluate their theoretical proficiency in computer science to be high, are more comfortable addressing an audience than those students who evaluate their competence to be low. This indicates a pedagogical social problem, the students who do not consider themselves proficient in computer science, who are most in need of guidance and help, are the students who are most reluctant to ask questions. This is not an unfamiliar problem within pedagogic.

Learning outcome in a distributed environment

The results from survey1 shows that 32,9 % of the students feel traditional tutoring provides the best learning outcome, while 15,9 % prefer online tutoring. From survey2 42 % of the students feel that online tutoring gives the best learning outcome. This means that the students, who were most positive to online tutoring, were actually those who made use of the service.

Experiences with the interactive learning arena and online tutoring show that half of the respondents feel the learning outcome is as good as traditional tutoring. The same amount feel online tutoring is a valuable supplement to traditional tutoring. At the same time, many of these students have communicated that the learning outcome has not been in accordance with the expectations.

Learning outcome and expectations

With the term learning outcome, the researchers expected feedback regarding the pedagogical aspect of online tutoring, but comments were made on the organisation of online tutoring.

The main reason why the learning outcome was not as expected, can be related to the students' visions concerning the availability of online tutoring. The students expected the service to be more available than traditional tutoring.

Learning outcome in online tutoring compared to traditional tutoring

Both online tutoring and traditional tutoring have resource problems when many students want the attention of the tutor at the same time. The hypothesis is that online tutoring utilises the tutors better than traditional tutoring, because public communication in the interactive learning arena is broadcast to all the students who are logged into the system. Students may have the same questions thus you obtain a rationalization gain by using this system.

Organisation of online tutoring

Participation challenges

The pilot project was not utilised to the extent expected and one reason, suggested by the tutors, could be a high threshold, by means of administrative overhead associated with joining online tutoring; having to obtain a web camera, headset, user profile for the system, installation of the software and then learn how to use the software. This may have resulted in students choosing traditional tutoring instead of online tutoring. The challenge is to make online tutoring as applicable and available as traditional tutoring.

The pilot project was based on geographical distributed students and teachers and the idea of making the interactive learning arena available on NTNU's computers was against the intention of the pilot project. The system was thus not installed on NTNU's computers. Survey1 shows that the majority of the respondents want to employ online tutoring at home.

However, we can not rule out the fact that having the system available at the university could have increased the participation, because that would give the students the opportunity to test out the software before deciding to enter the pilot project. Survey2 indicates that 1/3 of the respondents have communicated that they would have used the system more if it was available at the university. These findings demonstrate that making the interactive learning arena available on school premises might have increased the students' attendance in online tutoring.

Service availability

The students would have liked to have the service available at all times, but that is not possible. One desired time span which was suggested by the students was between 4-6 pm.

Measures to improve organisation of online tutoring

In order to increase the turnout, a few measure to meet this are listed. Student follow-up is one of them in which it could be advantageous if the tutors explicitly contacted the students to ask if they needed assistance or help. This would involve the students more giving them a greater sense of follow-up.

A different introduction to online tutoring is also mentioned as a measure, in which the students were invited to a workshop in the use of the interactive learning arena rather than a mere presentation of the software. This would activate the students and apply learning by doing to create interest around online tutoring. A workshop could be held at a computer lab with all the necessary equipment (web camera and headset) available. Students are given the opportunity to test out the software in a dynamic environment. After this workshop it will be possible to assign to different tutoring groups making informed choices when choosing whether to join online tutoring or traditional tutoring. This is means to reduce the threshold to join online tutoring.

Another suggestion is holding the first lectures online as well as in the auditorium. In this way, the students can choose whether to attend the lecture either in the auditorium or distributed through the interactive learning arena. The system opens for the distributed students asking questions which the students in the auditorium can hear as well as the other way around.

In order to facilitate for asynchronous correspondence, one could implement a forum. This system could take questions and discussion as a supplement to the synchronous sessions provided by the system. The questions posted on this forum could be answered by tutors and other students.

The full benefit of online tutoring could be achieved when it is applied to several subjects held the same semester. This will increase the utility value and interest for online tutoring for the students. In order to increase the availability of the service without introducing increased cost of tutors, there is a need for improved utilisation of the tutors. One mean is to introduce inter-disciplinary tutor teams which can tutor in several subjects. If we combine the tutoring hours of all the subjects involved to one service, the capacity of each tutor would be utilised better without increasing the use of resources.

New trials of online tutoring

The pilot project of the spring 2005 was the first test of online tutoring as an alternative learning arena, and the experiences from the pilot project created benefits for future pilots on online tutoring. The spring semester of 2006 measures have been taken in order to take into account the findings of the 2005-pilot. The measures taken include increased availability of the service by offering 12 hours a week for all students belonging to a net learning group, a forum facilitating asynchronous communication, an introductory workshop to increase participation as well as learning how the software works. In addition lectures will be broadcast within the interactive learning arena facilitating distributed students.

Online tutoring vs. theory

Moore

When considering the online tutoring pilot project according to theory, it is interesting to look at Moore (1999) and Mantovani (1996). Geoffrey A. Moore's book "Crossing the Chasm" (1999) is concerned with Moore's description of how new technology is adopted in the market by establishing several categories of user groups and characteristics for the user group. The user groups can be seen in figure 2. There exist chasms (gaps) between the user groups, and "each of these gaps represent an opportunity for marketing to loose momentum"(Moore (1999) in Aarsland (2002), pp.141-142).

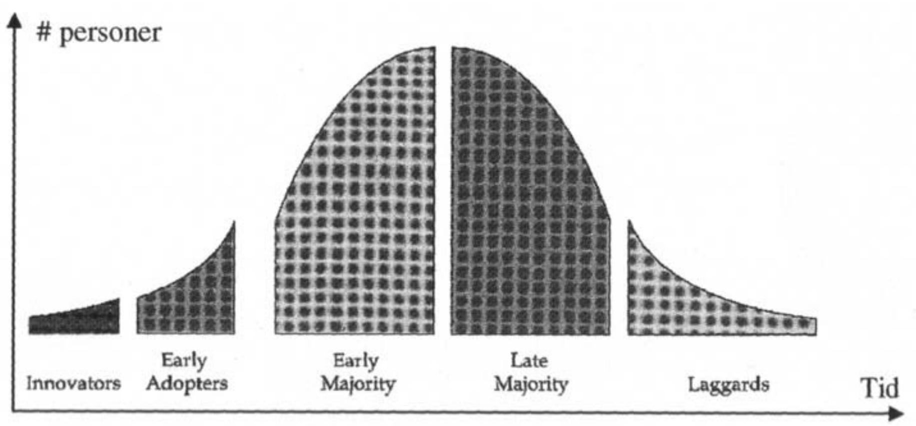

Figure 2: Moore's graph over the various user groups when introducing new technology (taken from Aarsland(2002))

Moore underlines that the principal challenge is crossing the chasm between the user group *early adopters* to *early majority*. Strategies must be worked out in order for the technology or the concept to cross the gap. Once the technology has reached the main market, the development will go on its own, in which new students obtain information and interest from other students who already use the tool.

Through the research it has been established that curiosity has been the major motivation for the students to take part of the pilot project. The students, who were most positive to online tutoring in the first place, were the students who have actually used the system. If we compare this information with Moore's theories the students belong to the group of *innovators* and *early adopters*. Online tutoring is still in the early phase of Moore's graph, meaning that efforts have to be made in order for the technology and concept to pass the chasm.

Mantovani

As mentioned earlier Mantovani's conceptual model of social context has three levels, and if we compare online tutoring with Mantovani's model, level three is the local interaction with artifacts, and the artifact in the pilot project is online tutoring. Level two in Mantovani's model is the interpretation of situations. The situation is tutoring of students on their assignments in relation to their studies. Level one, the construction of social context is the learning institution NTNU, or the individual students. The social context in Mantovani's model can thus be either a human's mental model or it can be an organisation's social context.

The hypothesis reads that Man, Technology and Organisation (MTO) forms a foundation for considering online tutoring to Mantovani's model, as can be seen in figure 3. Humans (man) are individuals who perform tasks based on their motivation, skills and knowledge. Technology means the facilities and tools utilized performing a piece of work. Organisation is the body that works systematically to realize one or more objectives. All the elements of MTO are mutually influenced; Man influences the technology as well as the organisation. Technology on the other hand influences man using the technology and the organisation. Organisation influences man and the technology.

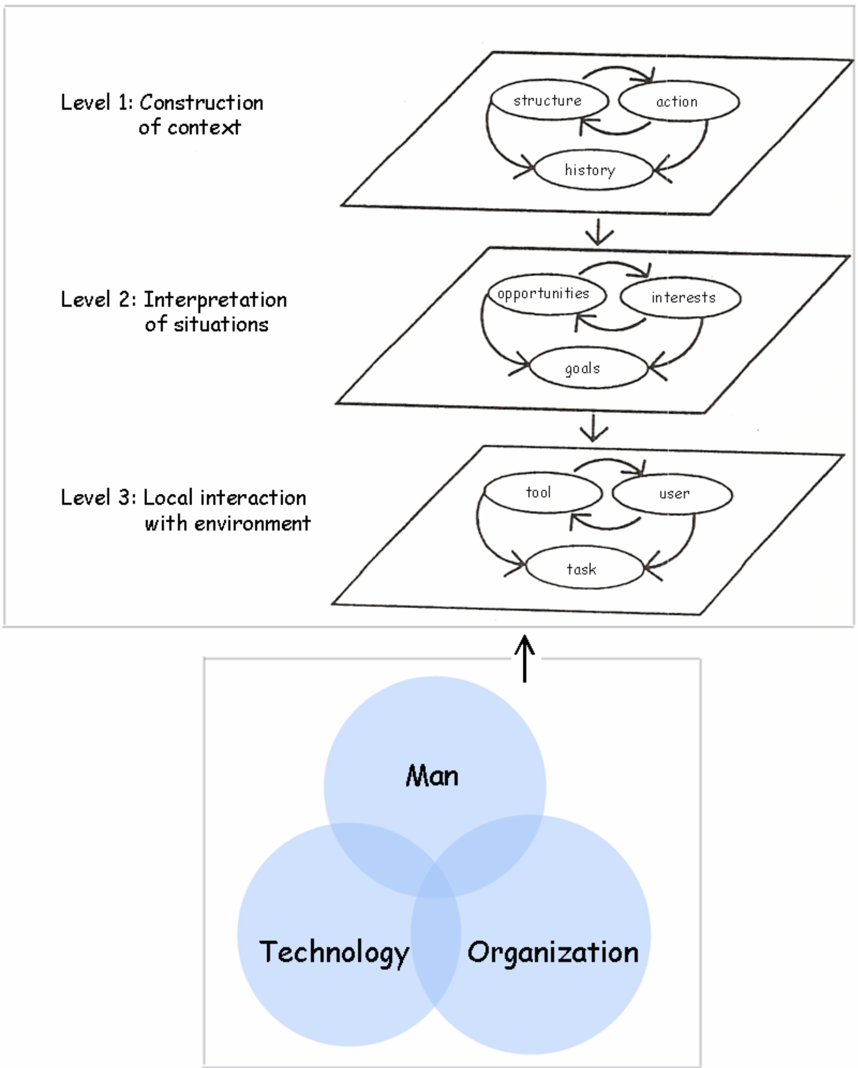

Figure 3: Illustration of the hypothesis: MTO forms a foundation for Mantovani's model

Online tutoring is a technology-related artifact which was introduced in a technical environment. Online tutoring was introduced without making changes to the organisation i.e. increased availability of the service. The new possibilities a new tool, would introduce was not included in the organisation of online tutoring.

As mentioned earlier the organisation of online tutoring was at fault in the pilot project, which meant that the MTO foundation was not fulfilled. It is thus not possible to consider Mantovani's model. Only when Mantovani's model is obtained can the students include online tutoring in their mental model (social context) through the artefact online tutoring. When entering the level of construction of social context they may see the benefit of online tutoring and the artifact becomes transparent. When the MTO foundation is not present, it is thus not expected that online tutoring as a concept becomes part of the social context, nor can it be expected of NTNU, as an organisation, to make online tutoring part of its portfolio of student tutoring.

Conclusions

NTNU is a university whose focus is set on technology and the employment of technology. Traditional tutoring has existed in its current form for decades. Later years focus has been set to the use of ICT within learning, but the traditional learning methods still exist. Online tutoring is an opportunity for NTNU to utilise technology to form a new learning arena. Through this research report it has been evident that the organisation of online tutoring is of great significance. The students would like to have an expanded service with regards to availability and inter-disciplinary tutor teams are measures to meet this objective. The implementation of online tutoring facilitates both private and public communication as well as oral and textual communication channels, which has proven useful. Anxiousness is however a factor which has led to inopportune use of communication channels, which necessitates the establishment of etiquette for the use of the various mediums of communication.

The main challenge is the student participation, but the attendance needs to be seen in light of low participation on traditional tutoring as well. Through the use of Moore's principles it has been established that online tutoring is in an early phase as students form the user groups of *innovators* and *early adopters.* The challenge is crossing the chasm to *early majority* in which the technology is accepted by a large part of the potential user base. The measures which have been mentioned are means to enter this stage of the development curve, and the development will go on its own when new students obtain information and interest for the concept through existing users. Students will then include online tutoring in their mental models and online tutoring will be part of NTNU's portfolio of tutoring.

Online tutoring was introduced without making big changes to the organisation of the tutoring, except for the fact that the tutors were distributed. When considering online tutoring to the hypothesis of MTO forming as a foundation for evaluating Mantovani's conceptual model of social context, the organisation-part is lacking and as long as it does not work on the lowest level it is difficult for the concept to propagate up the structures of Mantovani's model. When a technology-related artifact is introduced in an existing technological culture, there is a need to see new possibility in the organisation to better utilise the potential which the new artifact provides.

This pilot project was the first experience NTNU has with this type of tutoring over the internet, and as the experiences become multiple so does NTNU's handling of these types of tutoring and the possibilities it creates.

References

Aarsland, Trond (2002) "Utvikling av læringsmiljø for nettbasert undervisning ved hjelp av IKT", Master thesis IDI, NTNU.

Marratech. Retrieved 11.01.06 from http://www.marratech.com

Mantovani, Giuseppe (1996) "New communication environments: from everyday to virtual", Taylor & Francis, 1996.

Moore, Geoffrey A. (1999) "Crossing the Chasm", second edition, Oxford: Capstone Publishing Limited.

Appendix VI:

Online interactive learning arena over the Internet.

“Online interactive learning arena” was a pilot project that was carried out during the spring semester 2006 in the course “Operating systems” at the Department of Computer and Information Science at the Norwegian University of Science and Technology (NTNU) [Brastad, 2005; Vennes, 2005; Engen & Langøy, 2006]. In all, about 80 students followed the course. Some students were physically on campus attending the lecture, while some students attended the lectures via the internet. There were one teacher and five tutors.

The definition of an “online interactive learning arena” in this study is a learning arena run through an internet-based video conferencing system. The learning arena covered three areas; online lectures, online tutoring and online group work. In addition, there was a course website. The learning arena was based on a commercial video conference system [Marratech, 2006] run over the Internet.

It has also been a goal to gather as much experience and information as possible about this kind of teaching and learning, in addition to offer the students access to several alternative learning possibilities. What are the positive and negative experiences? What improvements are experienced? We have tried to illuminate these questions.

Virtual auditorium

The online learning arena made use of the video conference system to broadcast lectures in real time over the Internet. The students could actively participate in the online lectures. With a computer, a web-camera and a microphone, they could follow the online lecture in addition to ask questions during the lectures. And, by sharing applications, the teacher could also allow the students to control the activity on his/her computer. Thus, the students may, for example, write and draw on the electronic blackboard belonging to the video system. If the assignment is, for instance, to construct a machine part, this could be done by the teacher and the students, together in the video conferencing system. Then the teacher can draw a construction draft and the students can add their corrections, or vice versa.

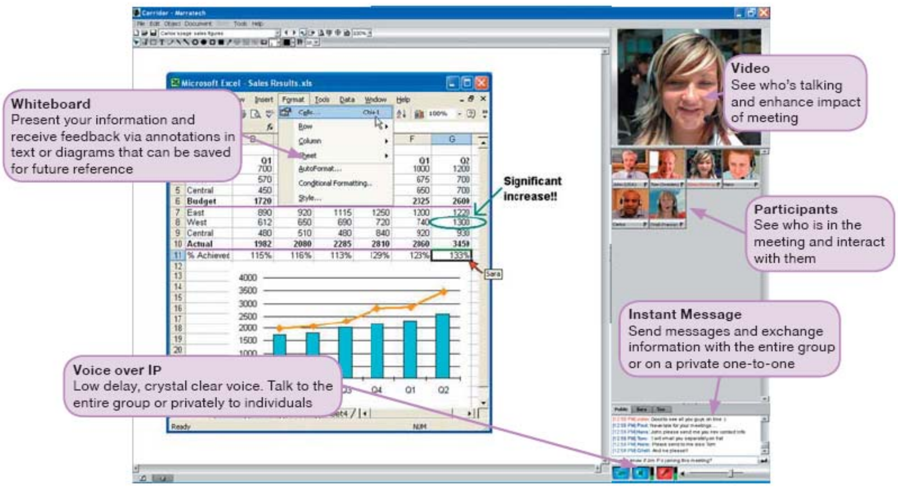

Figure 1: Screen shot of video conferencing system [Marratech, 2006]

Online tutoring
Online tutoring means that a teacher or assistant teacher tutor over the Internet, and it offers the same possibilities as an online lecture. For instance, in a programming course, student / teacher can upload the code and thus work with it together. After finishing, it is possible to run the program together, make new updates etc.

Group work
The students may work together via virtual group rooms. The group rooms offer the same possibilities as mentioned above, and they are accessible 24 hours throughout the week.

Setting up equipment in auditoriums.
In the video conference system, it is possible to enable desktop sharing, so that the other participants of the meeting can access your desktop. This function was actively used during the lectures. The lecturer shared an Internet-based hypermedia system (covering the entire course curriculum), which allowed online students to see exactly what the students present in the auditorium saw. In addition, there was a camera pointed towards the lecturer, and two cameras pointed towards the students who wanted to be physically present in the auditorium. The reason for the lecturer-camera was that the students following the lectures online also should be able to see the lecturer; i.e. to see the body language of the lecturer. The cameras directed towards the students were placed so that students following the lecture over the Internet could see the interaction between the students and the lecturer in the auditorium. We have experienced that this is a strong want from online students. Especially when there are questions from students, online students want to see the interaction / dialog between student and lecturer. So, there were at all times three pictures from the auditorium available to the online students. The people present in the auditorium follow the conversation via a canvas and speakers. The online students can choose if they want to participate with names, video and audio, or just by showing their names on the canvas/screen.

Equipment:
Camera, speaker and microphone
Most of the communication between participants is via web camera, speaker and microphone. Each of the cameras we used could be programmed for six different areas/zones in advance, i.e. where the pictures come from at all times. This makes it easy for the operator operating the cameras without causing any inconvenience for the users of the system.

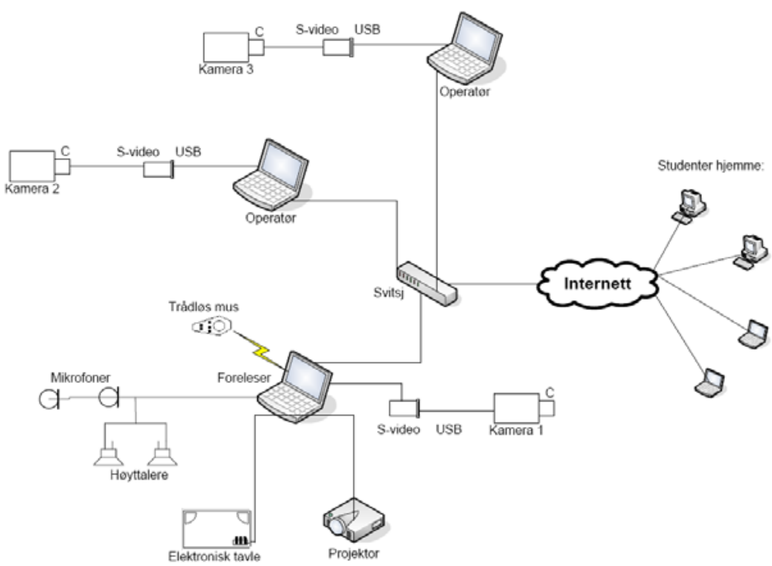

Figure 2: Equipment [Engen & Langøy, 2006]

The camera pointed at the lecturer was programmed for six different areas/zones. The two cameras directed towards the students, were also programmed for six areas/zones each. Here, one could choose towards which areas in the auditorium to point the camera, according to which area/zone the conversation between lecturer and students took place. All three cameras could be controlled by the same remote control. The setup didn't require an auditorium specially designed for video transfer, the only requirement was access to the Internet. The cameras were easy to set up. With some preparation and practice, this could be done during the break before lectures.

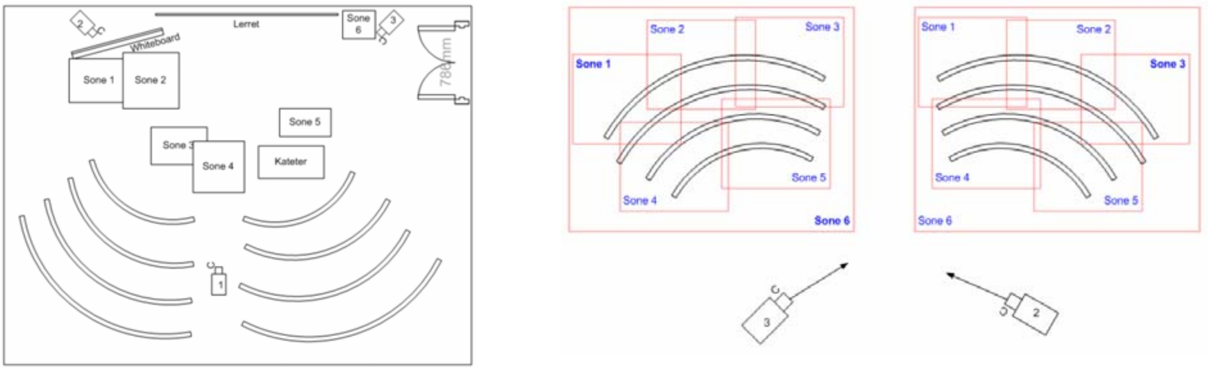

Figure 3: Maps showing camera placements in lecture room [Engen & Langøy, 2006]

We also used two powerful desktop microphones, which could capture sound from the entire auditorium. One was directed towards the lecturer, the other one towards the auditorium.

Chat function
One possibility is to have a public written conversation where all participants that are logged in can see what you're writing, and what others write to you. Additionally, it is possible to start a private conversation with one or several participants. The latter function involves having a private conversation which is only seen by the participants invited. This could include text, as well as video and audio.

Whiteboard (on-screen sharing of applications)
One of the widely used functions is the sharing of applications. It offers an opportunity to point and mark in a lecture where the lecturer, for example, makes use of PowerPoint presentations. Each page on the whiteboard that you want to keep can easily be saved as a file.

In addition, there is a function called “Allow control”, a function that is used if you want others to take control of the application.

Using an ordinary board, whiteboard
In a meeting- or a lecture context, people often want to use an ordinary board. In this connection, an electronic board can be very useful. The electronic board that was used registered everything that was written onto an ordinary whiteboard. This is done by the use of two censors that are attached on the two upper corners of the board, and special pens that function like a computer mouse. The setup was quite easy. The only requirement was access to an ordinary whiteboard. The registered data is transferred to a computer. There, you can in turn store this data, share it with others via e-mail, print it, or discuss it in a meeting with others in the video conference system, like in the virtual auditorium. There, the electronic board was used as a shared application. It is also possible to control the computer from the board.

Recording the lectures
In addition to broadcasting the lectures live on the Internet, we also made use of the recording function in the video conference system. This gave the students, who for some reason couldn’t follow the lecture live, the opportunity to download the recordings from the Internet and watch them later on. When the students gradually became aware of this possibility, we noticed that there were many students that weren’t present. However, it should be added that the lectures began at 8 a.m.

Tutoring-lab
In connection with this project, a tutoring-lab was constructed. This lab was specially designed for online tutoring and the possibilities that the video conference system offers. The lab contains 3 pan / tilt / zoom cameras, whereas one camera is placed at the front, one at the back, and one in the ceiling above the desk. It is possible to switch between these cameras when needed. All the cameras are controlled by the same remote control. Each camera has its function;

- The camera in the ceiling is meant for showing details. For example, one can display an item and put it on the whiteboard for discussion, i.e. a page in a book, etc. The camera’s zoom function makes it possible to clearly see details such as text.
- The camera at the back is used if the tutor is to be visible when illustrating something on the electronic board.
- The camera at the front is to be used as default to show the participants present in the room. The lab also contains a canvas and an electronic board. In addition, it contains two projectors, either for projection on a canvas/screen, or on the electronic board. Furthermore, the lab contains a powerful desktop microphone. This room can be used by tutors for tutoring, so that they can make use of all the opportunities in the video conference system. All the equipment was of same quality as in the auditorium.

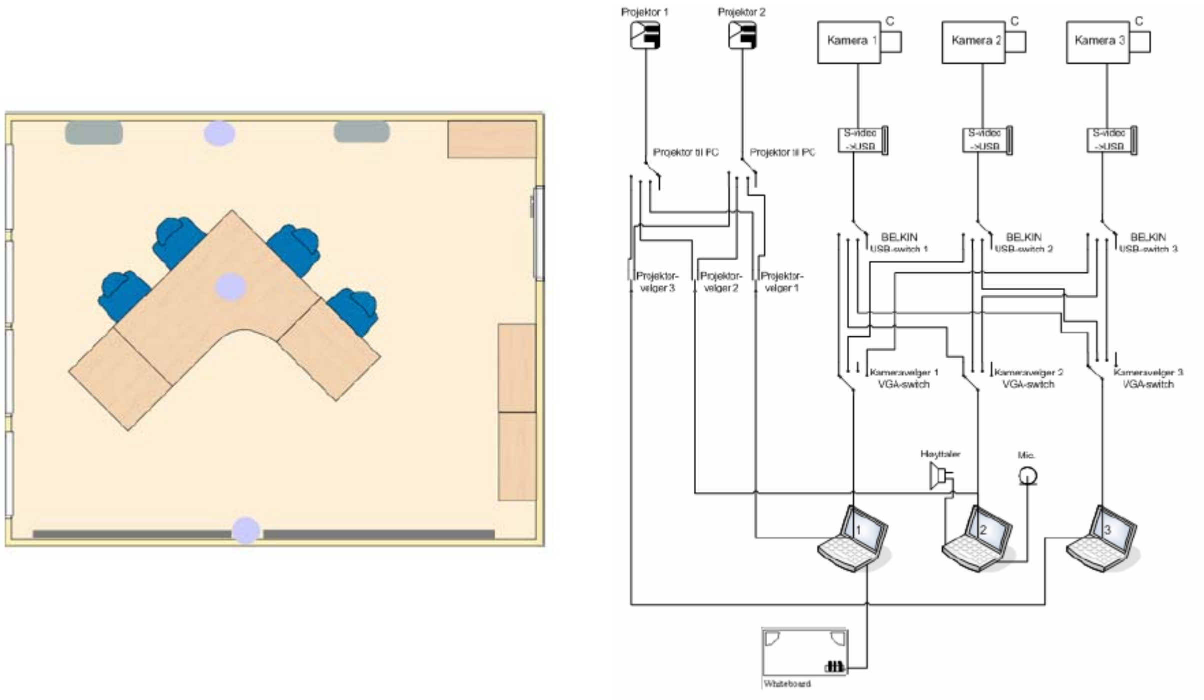

Figure 4: The tutoring lab [Engen & Langøy, 2006; Vennes, 2005]

The use of the tutoring lab was based on the department's traditional tutor organization. There would be tutors present in the lab and in the online video conference system at specific times of the week.

Students' experiences from the pilot project (survey)

In the pilot project we carried out several surveys aimed at the students. Due to practical conditions, the most extensive surveys were about the use of the tutoring lab. However, many of the results from these are probably also applicable to the auditorium part.

From the answers we got in the survey we carried out before starting, it seems that the students felt that their knowledge of computer science was quite good. From the 16 answers we got, there were barely 40 % who said that they wished to continue following the lectures over the Internet, and that 30 % of these also would consider the possibility of watching the recordings of the lectures later on, both right after the lecture, and when preparing for exams.

In all, barely 80 students followed the course. In order to keep track of how many who downloaded the lectures, we created a counter. It showed steady usage throughout the semester, on average a little over 80. Gradually, there was a slight increase. Some students have probably logged on several times.

Motivation

Both mobility and curiosity have been important factors among those students who chose to use online tutoring. A majority of the students say that the mobility, i.e. the possibility of having tutoring anywhere, is the main strength of the project.

Learning achievement
50 % of the students say that the learning achievement from this project is as good as from traditional tutoring. 25 % of the students say that online tutoring is not as good as traditional tutoring, but it is a valuable supplement to traditional tutoring.

This learning approach did not meet the expectations of 40 % of the students. None of the students answered that this learning approach was better than expected. The criticism towards the lack of learning achievement was not aimed at the functionality of the system, but the organizing of the system. Only 20 % of the students said that being able to see their tutor affected the learning achievement.

Communication
75 % of the students who answered made use of the possibility of asking the tutor questions. The others didn't feel the need to ask the tutor, and they had not been communicating with the online tutor. Only one student said that he/she didn't find the questions others ask the tutors useful at all. 60 % of the students had tried to communicate with other students online, and 40 % of the students had also made use of the tutoring room for group work out of school hours. One student says that it would never match being in the same room. Another student feels that the video conference system would function better as a medium for co-operation, rather than learning.

Usability
70 % of the students got a demonstration before they started using the video conference system. One student read the manual for the video conference system, and 25 % did not receive any kind of training. All of these felt that they received sufficient training. 60 % of the students said that the system was easy to learn, while 25 % had to spend more time and energy in order to understand the system. Only one person felt that the system was difficult to learn. 70 % of the students said that the user interface was good, while 25 % said that it needed improvements. So, in general, the students think that the video conference system was ok to use. One student thinks the video conference system also could need an interface that offers offline communication, like an ordinary forum.

Availability
Most students prefer to make use of online tutoring at home, and the majority of students prefers between 2 and 5 lessons á 45 minutes of online tutoring per week. The time between 4 and 6 p.m. is popular for tutoring. 30 % of the students would have used the video conference system more if the software was available also in the computer labs.

Technology
75 % of the students said that the technology worked fine. Two students did encounter difficulties; one of them had audio problems in Linux.

Nervousness
Students often hesitate/are afraid to ask questions during an ordinary lecture. This is also the case when using a video conference system, but not to the same extent as during an ordinary lecture. The reason for this might be that the video conference system offers the opportunity to write the questions, instead of asking orally, since many probably feel more comfortable using this form of communication.

Students feel more secure when asking questions during an ordinary lecture if they are sitting with people they know. This effect is also present in the video conference system; when others are online, i.e. people that the student knows. However, the effect here is much weaker than in a traditional lecture. In general, the students find it easier to ask questions to the lecturer in an ordinary lecture if they know the lecturer well. This effect was less present in online tutoring.

The students are divided when it comes to whether they want few or many students to be online simultaneously. Some prefer that a small number of students are logged on in order to get more attention from the tutor, while others find it uncomfortable to get that much attention.

In the questionnaire, the students could answer whether or not they preferred few or many students to be online. However, many of these students answered that they missed a third alternative; an alternative in which they could indicate something in between few and many.

Conclusion

The main strength of having an online interactive learning arena is the mobility it offers both the lecturer and the students. The students can access lectures and tutoring independent of geographical location, as long as they have Internet access. This also very much applies to the lecturer, it is easy to move the lecture outside the auditorium. The biggest challenge is the technological demands we face in communication with and between the participants. Technology must be learned before used and the students must have access to necessary equipment.

Experience from the pilot project shows that technology doesn’t always work the way it should. Package loss during transfer may give bad audio / video quality. However, it hasn’t been a practical problem, especially not for audio, since audio is always a priority in the video conferencing system. We have experienced that, at certain times, from 10 a.m. and for a few hours, there might be some package loss between Scandinavia and Southern Europe.

Only the most motivated students have made use of online tutoring. It is clear that the organizing affects the participation. The main challenge is to increase participation. We have suggested several efforts when it comes to better organizing. One of these is improved training of online tutors through workshops.

Online tutoring may offer possibilities that are not possible in a traditional lesson. The use of private communication makes it possible to have several conversations in the same room simultaneously without disturbing each other. The survey also shows that using private communication makes the students less nervous when it comes to using the system to ask a tutor technical questions. And the students also want to see questions from other students. Therefore, we believe that it could be useful to develop and to offer the users training in a special etiquette for how to apply online tutoring, so that the users as a group can benefit as much as possible from online tutoring. That is, for example, to use global communication with the tutors, and speech if written communication is inappropriate. The implementation of online tutoring offers possibilities for both private and public, as well as oral and written communication, and this has proven to be advantageous. Nervousness, however, is a factor that has led to unfortunate choosing of communication forms, and it is therefore important to create etiquette for usage of the various media.

According to Moore’s principles, the students who participate in the pilot project are categorized as *innovators* and *early developers* [Moore, 1999]. The great obstacle is move on to *early majority* where technology is accepted by a majority of the potential user group. When technology reaches this stadium, the development will become autonomous, where new students get information and gain interest in the concept from students that already make use of the system. Later on, the development has become somehow autonomous; there have been many requests for accessing the technology and other projects are in progress.

The aim of the pilot project was to fulfill Mantovani’s conceptual model of context, and one hypothesis is that the condition for evaluating the pilot project through Mantovani’s model is the man, technology, organization (MTO) perspective [Mantovani, 1996]. “When a technology-related artifact is introduced in an already-existing technological environment, it is often not enough to apply the artifact directly without changing the organizing around the artifact, in order to make the most of the possibilities that the artifact offers” [Vennes, 2005]. In the online tutoring project, the organizing was insufficient and thus it is not expected that the artifact spread within the structure, and is therefore not part of the students’ social context.

Through the pilot project, we have seen that the organization of online interactive learning arena has been of great significance. An online learning environment requires different organization than traditional tutoring. The students criticized that the new learning approach (online tutoring) was not available at the appropriate times of the day. When one starts using technology one should use the possibilities and added value of the technology as a starting point for the organization of the use, and not put technology in the same frames as traditional education.

If we want online interactive learning arena to become customary, the possibilities must be established in the mental models of the student, the lecturer, as well as “the institution”. Then, online interactive learning arena can eventually become a natural part of NTNU’s teaching and learning portfolio.

References

1. Brastad, Lodve (2005), ”*Pedagogiske strategier ved anvendelse av studiestøttesystem i nettbasert undervisning”*. http://daim.idi.ntnu.no/show.php?id=1452&type=masteroppgave
2. Engen, Anders og Langøy, Per Espen (2006), ”*Mobil interaktiv læringsarena over Internett”*. http://daim.idi.ntnu.no/show.php?id=1410&type=masteroppgave.
3. Vennes, Berit (2005), “*Distributed and co-located computer supported collaboration in a learning and working environment”* http://daim.idi.ntnu.no/show.php?id=1459&type=masteroppgave
4. Marratech, http://www.marratech.com
5. Moore, Geoffrey A.(1999) “*Crossing the chasm*”, second edition, Oxford: Capstone Publishing Limited.
6. Tool-Tribe, http.//www.tool-tribe.com
7. Mantovani, Giuseppe (1996) "*New communication environments: from everyday to virtual*", Taylor & Francis, 1996.

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Contributions to QUIS reports are produced by staff members at the partner institutions.
All of these persons have taken part in discussions and production leading to this and other reports.
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The activities in the QUIS project will be directed towards QUality in e-learning, Interoperability and reusability of e-learning material and development of Standards. The project will also look at cost beffectiveness in e-learning.

Quality in e-learning is important to be able to exchange both learning materials and learning practices across HEI's in Europe. To establish joint study programs it is essential that cooperating institutions accept each others Quality Assurance Systems (QAS).

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