Multimedia-Systems: Learning and Teaching

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GMD -German National Research Center for Information Technology
httc - Hessian Telemedia Technology Competence-Center e.V.
Scope

Usage
- Learning & Teaching
- Design
- User Interfaces

Services
- Content Processing
- Documents
- Security
- ... Synchronization
- Group Communications

Systems
- Databases
- Media-Servers
- Operating Systems
- Communications
- Opt. Memories
- Quality of Service
- Networks

Basics
- Computer Architectures
- Compression
- Image & Graphics
- Animation
- Video
- Audio
Contents

1. Introduction
2. Fields of Application
3. Learning Scenarios - Learning Modes
4. Learning Theories
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   4.3 Constructivism
5. Learning Software
6. Cooperative Aspect
7. Metadata
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   7.2 Resource Description Framework RDF
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1. Introduction

Role of the computer in learning and teaching

Computer as Learning Subject (Computer als Lerngegenstand)
• **Something shall be learned about computers:**
  • Handling, Programming, ...

Computer as Learning Tool (Computer als Lernwerkzeug)
• **Computer is used to learn:**
  • Production of learning material, answer to exercises, information retrieval, ...

Computer as Learning Medium (Computer als Lernmedium)
• **Computer assumes the role of a teacher**
  • Presentation of information, motivation, control of success, ...
1.1 Ideal Knowledge Transfer Process

Knowledge, Information and Learning:

- definition of learning goals
- verification of acquired knowledge
- preservation of knowledge (Wissenserhalt)
- knowledge absorption
- mediation of knowledge
- preparation/editing of knowledge
- authors knowledge acquisition

ideal knowledge communications process

Information
- available, abundant but
  - where? (how to find in-time?)
  - how? (how to use effectively for own purposes?)

Knowledge - knowledge management
- structure?
- widely available?
1.2 Trends

Perspectives

- Trends: Learning gets “multimedia”
- Trends: Learning gets "mobile"
- Trends: Learning gets "modular"
- Trends: Learning gets "cooperative"
- Trends: Learning gets “multifold”
Trends: Learning gets “multimedia” (2)

adequate representation

- video and audio give the feeling of “real life”
  - view of the moon or Mongolia
  - music played by a symphony orchestra or a great artist
- illustration by animated graphics
  - simplified illustrations of complex procedures/objects:
    - model of an atom
- constructivistic learning due to simulations
  - complex procedures/objects can be experienced, understood and learned by experimenting in a virtual environment

contents representation to be adapted

- to client (learner) needs
- to the teaching goal(s)
- to make best use of infrastructure

⇒ anyhow or better “best”how
Trends: Learning gets "mobile"

- **Time**
  - at any time: in the morning, in the afternoon, at night
  - life-long: learning is no longer a fixed period in life

and

- **Space**
  - at any location: at the work place, at home, at the hotel ...
  - at any environment: technical, social, ..
Trends: Learning gets "modular"

Modularization means

- contents and time
  - "knowledge" modules
- adaptability
  - level of detail
- reusability

⇒ meta-data

I.e.

- support for
  - authors
  - tutors
  - brokers
  - learners

⇒ Learning infrastructure
Trends: Learning gets "cooperative"

Local and distributed teams
- more efficient learning process
  - e.g. distributed game, cooperative IPSI “Puzzle”
- mode
  - synchronous
  - asynchronous

Communication between organizations
- better knowledge transfer
- need for
  - e.g. rewards for useful knowledge transfer

Cooperative learning models
- Improved training success
Trends: Learning gets “multifold”

we still operate in the mode

- learner - (mediator) - teacher

“teacher” appear to be

- course designer
- author - singular contents author
- editor
  - assembles course for dedicated purposes
  - makes use of multiple contents
- presentor

learner

- becomes more responsibility for her/his success

⇒ new ways of teaching, distributing knowledge
⇒ new ways of learning
2. Fields of Application

Life Long Learning
University
School
Employee Training
### Analysis of various Application Areas

<table>
<thead>
<tr>
<th>Yes</th>
<th>But</th>
</tr>
</thead>
<tbody>
<tr>
<td>content provider, teacher</td>
<td>not transparent</td>
</tr>
<tr>
<td>client, learner</td>
<td>very heterogeneous demands</td>
</tr>
<tr>
<td>contents</td>
<td>traditional didactic</td>
</tr>
<tr>
<td>basic technology</td>
<td>adapted to presentation mode</td>
</tr>
<tr>
<td>infrastructure</td>
<td>changing rapidly</td>
</tr>
<tr>
<td>standards (de-facto, de-jure)</td>
<td>often very different</td>
</tr>
<tr>
<td>settings, environments</td>
<td>not everywhere available</td>
</tr>
<tr>
<td></td>
<td>not well integrated</td>
</tr>
<tr>
<td></td>
<td>many</td>
</tr>
<tr>
<td></td>
<td>for dedicated learning situations</td>
</tr>
</tbody>
</table>

i.e. more detailed look at various scenarios for Webbased Learning

- distribution of traditional face-to-face teaching
- supplement for traditional face-to-face teaching or printed books
- substitution of traditional face-to-face teaching or printed books
3. Learning Scenarios - Learning Modes

- **Scenario Telelearning**
  - Teletutoring
  - Teleteaching

- **Scenario: Supplementary**

- **Scenario: Self-Teaching - Architecture**
### 3.1 Scenario Telelearning

**Characteristics**
- improvement with regard to traditional forms of remote teaching
- independence of time and location
- access to teaching for impaired people, working people
- significant amount of self-studies
- use of WWW as learning environment and as information source

**Furthermore:**

- **Tele-Tutoring:**
  - Synchronous (e.g. audio- or video conference) or asynchronous (e.g. email) support of the learner by a tutor

- **Tele-Teaching:**
  - Transmission of lectures by video or audio links to multiple locations, feedback mostly asynchronous or as audio or video conference.
Scenario: Telelearning: Teleteaching

Example: Virtuelle Universität Oberrhein
http://www.informatik.uni-mannheim.de/informatik/pi4/projects/VIROR/
Scenario: Telelearning: Teleteaching

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3.2 Scenario: Supplementary

Combination of traditional tuition and additional instruction, adjusted to the learning situation

School/University/Company:
- New learning material
- Learner-Teacher-Interaction
- Learner-Learner-Interaction
- Final tests

At home/At the workplaces via Internet:
- Exercises alone or in groups
- Additional material
- Interactive simulations
- Tests
3.3 Scenario: Self-Teaching - Architecture

General Architecture according to LTSA (Learning Technology Systems Architecture)
4. Learning theories

Pädagogical fundamentals to conceive and implement diverse strategies

- 3 learning theories
- no single one is certainly the correct and only successful one
- depends on learning situation and goals

Theories
- Behaviorism
- Cognitivism
- Construktivism
- further theories ...
4.1 Behaviorism

- Ivan P. Pavlov: Classical conditioning
  - Pavlov’s dog
- Burrhus F. Skinner: Operant conditioning
  - occurrence probability is influenced by reinforcement and punishment
  - learning is the formation and consolidation of action-reaction-chains
  - misbehavior is not analyzed, but “trained away”

brain is “Black Box”

"Reize"

extern controlled "Reize"
4.2 Cognitivism

- Jerome S. Bruner and Jean Piaget
  - Analysis of psychic processes, for example perception
  - learner can use hints to solve problems independently
  - teacher as tutor
4.3 Constructivism

Brain as a self-referenced circular System
energetically open - informational closed

Subject - Object
(Human - Environment)
are coupled structurally

• knowledge is
  • no absolute description of the world
  • is constructed in complex and real situations by the learner
### 4.4 Learning Theories: Overview

<table>
<thead>
<tr>
<th>Thinking and human brain are a ...</th>
<th>Behaviorism</th>
<th>Cognitivism</th>
<th>Constructivism</th>
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</thead>
<tbody>
<tr>
<td>Knowledge is...</td>
<td>Black Box</td>
<td>Information-handling Process</td>
<td>Closed Information System</td>
</tr>
<tr>
<td>Knowledge is...</td>
<td>acquired and stored</td>
<td>handled and stored</td>
<td>constructed and stored</td>
</tr>
<tr>
<td>Learning is ...</td>
<td>a correct Input-/Output Relation</td>
<td>an appropriate internal Process</td>
<td>to handle a Situation</td>
</tr>
<tr>
<td>Learning Goal is ...</td>
<td>Formation of Chains of Action/Reaction</td>
<td>Formation of cognitive Structures</td>
<td>Acquisition of Experiences</td>
</tr>
<tr>
<td>A Computer is a ...</td>
<td>to find a (single) correct Answer</td>
<td>to acquire the right Methods to solve Problems</td>
<td>to solve complex Problems</td>
</tr>
<tr>
<td>Program Structure is</td>
<td>authoritarian Teacher</td>
<td>Tutor, who observes and helps</td>
<td>Consultant, who helps</td>
</tr>
<tr>
<td>Type of Learning Program</td>
<td>rigid</td>
<td>constructed dynamically, depending on the</td>
<td>self-determined, autonomous</td>
</tr>
<tr>
<td></td>
<td>Computer Aided Instruction (CAI), „drill and practice“</td>
<td>Computer Based Training (CBT), (Intelligent)</td>
<td>Simulations, Micro-Worlds</td>
</tr>
</tbody>
</table>
5. Learning Software

Characteristics of Learning Software:

• **Multicodality:**
  • Use of various symbol systems: Image, pictograph, text, ...

• **Multimodality:**
  • Address different senses: Visual or acoustical

• **Dynamics:**
  • Use of discrete (text, images) or continuous media (video, animation)

• **Interactivity**
  • Interaction between learner and learning software
5.1 Type of Learning Software

1. Learning Programs
   - drill- and practice programs
     - knowledge consolidation by repeating and applying
   - test software
     - realization and analysis of learning controls
   - tutorial systems (also Computer-Based Training - CBT)
     - system takes over teaching functions
     - Intelligent Tutorial Systems (ITS): Separation of knowledge, information about learners and didactic strategies

2. Learning frameworks / environments
   - Learner controls learning progress
   - Learning software only as an offer
   - animation and simulation
     - complex procedures can be visualized dynamically and interactively
   - problem solver
     - complex exercises are chosen by the learner
     - answers based on expert systems, databases, hypertext and hypermedia systems
   - learning games and edutainment
     - knowledge mediation in form of games
5.2 Adaptive Learning Systems

Properties
- adaption to individual properties of the learner
- learning path not pre-installed
- flexible selection of Information representation
- storage of information concerning the reader in a user profile

Adaptive Learning Systems:
1. Intelligent Tutoring Systems (ITS)
   - used for well-structured knowledge domains
   - derive learning paths from behavior of the learner

2. Adaptive Hypermedia Systems (AHS)
   - used for large and less-structured knowledge domains
   - navigational hints, user-specific preparation of learning material
Intelligent Tutoring Systems ITS

Scope:

Contents:

Knowledge Domain

User Interface

Student Model

Didactic Component

Learner

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http://www.tk.informatik.tu-darmstadt.de

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Adaptive Hypermedia Systems

Hypermedia (Knowledge Domain)

User Interface

Learner

Test Module     User Profile     Navigation

Scope

Contents

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http://www.tk.informatik.tu-darmstadt.de
Examples of Adaptive Hypermedia Systems

ELM-ART
- WWW-based
- goal: programming language Lisp
- colored links (green: already learned, red: not ready)
- next-button or unconstrained selection of links with warnings
  http://apsymac33.uni-trier.de:8080/art/login-d.html

InterBook
- WWW-based
- environment: open for further content
- navigation similar to ELM-ART: Terms include weights leading to system proposals
  http://www.contrib.andrew.cmu.edu/~plb/InterBook.html

Hypadapter
- target: to learn the programming language Lisp
- adaptive presentation and navigation
- initialization by stereotypes
- bookmark-functionality
  http://www.iicm.edu/jucs_4_4/a_study_of_user/paper.html
6. Cooperative Aspect

Lessons learnt: The History of Instructional Technology
Analysis

We have

- New knowledge
- New organizational structures
- New technologies
- New infrastructures

but: mostly traditional pedagogy

So we also have the traditional drawbacks

- Limited interactivity: the „page-turning“ paradigm
- Limited adaptivity: mostly pre-defined learning paths
- Limited feedback: where is the „artificial intelligence“?

Approach:

⇒ to integrate peer-learners and teachers into the learning process
⇒ cooperative learning
Cooperative (and Multimedia) Learning

Definition of CSCL (computer-supported cooperative learning)

cooperative:
- Two or more persons
- Work together
- In mutual dependency
- With a common goal
- Towards a joint result

cooperative learning
- Problem-centered:
  - Application of individual competencies towards a joint solution
- Socially embedded:
  - Integration of individual and cooperative learning methods into a social context
Dimensions of CSCL

CSCL has various dimensions:

- Local vs. distributed learner groups
- Synchronous & asynchronous usage
- Pre-structured vs. self-organized learning process
- Symmetrical vs. asymmetrical learning
- Small / medium-sized / large groups

Important field of application:

- D-CSCL - Distributed CSCL

Challenges of D-CSCL:

- Social presence
- Common knowledge
- Coordination of the learning process
Usage scenarios: University teaching & learning

Tele-lecture:
- Coupling of lecture halls
- Connections to home learners and experts
- Mostly synchronous, one-way-communication

Tele-seminar:
- Coupling of seminar rooms
- Highly interactive, synchronous and asynchronous use

Tele-learning:
- Learners download material, e.g., to prepare for examinations
- Asynchronous usage

Tele-tutoring, Tele-consulting:
- Electronic office hour
- Synchronous and asynchronous usage

Administration:
- Enrollment, grade management
- „Electronic study book“
7. Metadata

Definition

- “data about data”
- descriptive information about resources
  - purpose of finding, managing and using data more effectively
- It can be seen as a system of labels
  - purpose to describe
    - a resource or
    - object’s characteristics and its objectives.

rigorous specification methodology required
- i.e. Objects can be described by multiple dimensions
  - a polygon may have a certain number of sides and be of a certain colour
  - number of sides can be varied independently from the colour
- independent dimensions are orthogonal.
- sometimes the fields are not completely independent.
  - i.e. relationship between difficulty and user level are not fully independent.
- to try to define the more independent metadata fields as possible

Purpose of Metadata

In general

- to summarize the meaning of the data
- to allow users to retrieve and use the data
- to allow users to determine if the data is what they want
- to retrieve and use the data
- to prevent some users from accessing the data and give informations that affect the use of data (legal conditions, size, age, etc.)
- to instruct how to interpret the data (format, coding, encryption)
- to enable the development of learning objects in units that can be combined and decomposed in meaningful ways.
- to enable computer agents to compose automatically personalized lessons for an individual learner.
Building Blocks: diverse Initiatives

Semantics
- PICS
- P3P
- LOM

Structure
- RDF

Syntax
- XML
- SGML

Areas
- **Adaptive Hypermedia Systems**
  - e.g. Adaptive Hypermedia Machine
  - e.g. Open Hypermedia Systems Working Group
- **Digital Libraries**
  - e.g. Dublin Core
- **Video**
  - e.g. MPEG7
- **Learning Systems**
  - e.g. Learning Object Metadata Scheme IEEE P1484.12
Building Blocks: diverse Initiatives

Platform for Privacy Preference Project P3P
- activity of the The World Wide Web Consortium W3C
  - to enable Web sites to express their privacy practices
  - to enable users to exercise preferences over those practices

Platform for Internet Content Selection PICS
- W3C began in 1995 with PICS
- mechanism for communicating ratings of web pages (server to clients)
- contain information about the content of web pages
  - e.g. particular page contains a peer-reviewed research article
  - e.g. or contains sex, nudity, violence, ...
- limitations in the PICS specifications were identified to address the more general problem of associating descriptive information with Internet resources

Resource Description Framework RDF
- allows to implement e.g.
  - dublin core
  - learning objects metadata

HTML Meta, XML
- allows to implement dublin core, learning object metadata, rdf
7.1 Dublin Core Meta Data

Characteristics
- intended to facilitate discovery of electronic resources
- conceived for author-generated description of Web resources
- targeted groups:
  - museums, libraries,
  - government agencies, commercial organizations.

Dublin Core Workshop Series gathered
- experts from library world,
- networking and digital library research communities,
- variety of content specialties
- in a series of invitational workshops

Central feature of Dublin Core
- building of interdisciplinary, international consensus around a core element set
- open mailing list supports ongoing work
Dublin Core Attributes

- **Title**
- **Author or Creator**
- **Subject and Keywords, e.g. embedded into html (META)**
  ```html
  <META NAME="DC.Subject.Keywords" LANG="en" CONTENT="Communication Networks">
  ```
- **Description**
- **Publisher**
- **Other Contributors**
- **Date**
- **Resource Type**
- **Format**
- **Resource Identifier**
- **Source**
- **Language**
- **Relation, e.g. embedded into html (META)**
  ```html
  <META NAME="DC.Relation.IsBasedOn" LANG="en" CONTENT="http://www.cs.bsu.edu/ethernet/concepts.htm">
  ```
- **Coverage**
- **Rights Management**
7.2 Resource Description Framework RDF

Resource Description Framework (RDF)

- developed under coordination of World Wide Web Consortium (W3C)

Characteristics

- infrastructure that enables for structured metadata
  - encoding
  - exchange
  - reuse

- metadata interoperability through
  - design of mechanisms that support common conventions of
    - semantics
    - syntax
    - structure

- i.e.
  - does not define semantics for each resource description community
  - provides the ability for these communities to define metadata elements as needed
RDF: Example

```xml
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:DC="http://purl.org/DC#">
  <rdf:Description about="http://www.kom.e-technik.tu-darmstadt.de/ethernetApplet.html">
    <DC:AUTHOR>Amir Ghavam</DC:AUTHOR>
  </rdf:Description>
</rdf:RDF>
```

http://www.kom.e-technik.tu-darmstadt.de/ethernetApplet.html

Author

Amir Ghavam
Portability: RDF to make Learning Objects available

Different providers (companies, universities, portals) can share LOM

- in RDF format
- e.g.
7.3 LOM - Learning Objects Metadata

IEEE LTSC P1484.12 Learning Object Metadata Working Group

• **Full Name of Standard:**
  - Standard for Information Technology -- Education and Training Systems - Learning Objects and Metadata

• **Scheme consisting of 9 categories to describe learning resources**
  - General, Lifecycle, Meta-metadata, Technical, Educational, Rights, Relation, Annotation

History, mainly based on

• **ARIADNE (Alliance of Remote Instructional Authoring and Distribution Networks for Europe)**
  - EU project on
    - collaborative web browsing, developing and extending metadata for learning content

• **IMS (Educom's Instructional Management Systems)**
  - US driven cooperative of commercial, institutional, and government organizations
    - that are developing technology for the education industry.

**Learning Object**

• any entity, digital or non-digital, which can be used, re-used or referenced during technology-supported learning
LOM: Goals

- To enable learners or instructors to search, evaluate, acquire, and utilize Learning Objects.
- To enable the sharing and exchange of Learning Objects across any technology supported learning systems.
- To enable the development of learning objects in units that can be combined and decomposed in meaningful ways.
- To enable computer agents to automatically and dynamically compose personalized lessons for an individual learner.
- To compliment the direct work on standards that are focused on enabling multiple Learning Objects to work together within an open distributed learning environment.
- To enable, where desired, the documentation and recognition of the completion of existing or new learning & performance objectives associated with Learning Objects.
- To enable a strong and growing economy for Learning Objects that supports and sustains all forms of distribution; non-profit, not-for-profit and for profit.
- To enable education, training and learning organizations, both government, public and private, to express educational content and performance standards in a standardized format that is independent of the content itself.
LOM: Goals

- To provide researchers with standards that support the collection and sharing of comparable data concerning the applicability and effectiveness of Learning Objects.
- To define a standard that is simple yet extensible to multiple domains and jurisdictions so as to be most easily and broadly adopted and applied.
- To support necessary security and authentication for the distribution and use of Learning Objects.

Example of LOM editor implementation
LOM: Attributes

- General
- Life Cycle
- Meta MetaData
- Technical
- Educational
- Rights
- Relation
- Annotation
- Classification

Identification, Title, Location, Language etc.
Author, Version, Contribution(s)
Kind of Meta-data, Name of Editor
Size, Format, Technical Requirements, etc.
Interactivity-Type, Difficulty-Level, Target Group
Copyright, Cost, Conditions of Use
Structural references to other LOs
Comments
Characteristics, Purpose, Taxonomies, Keywords
Web Interface for Learning Objects

- Users can query the system via the web interface
- an rdf generator converts the result table into rdf
Layers

7.4 Learning Technology Systems Architecture

Layer 1
- Learner
- Environment
- Learner Environment Interactions

Layer 2
- Human-Centered Features
- Five Human-Centered Features

Layer 3
- System Components
- Layer 3

Layer 4
- Stakeholder Perspectives
- 40+ Stakeholder Perspectives

Layer 5
- Business Interface Protocol
- Layer 5
LTSA: Basic Process
Relevant Components for LOM

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web based learning
8. Example: Multibook

Multibook learning system

- **lessons personalized by using**
  - user profiles
  - knowledge base consisting of
    - modular information chunks, an ontology, rhetorical relations and standardized metadata
  - algorithms to match the profiles to the knowledge base
Interactive simulations realized by Java applets

Component based

Interactivity

Different levels of complexity
Multibook Architecture: View 1

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Multibook: Domains

Differentiation between

- **ConceptSpace**
  - node: topics (incl. keywords)
  - edge: semantic relations
  - navigation in knowledge, in semantics
    - enables alternative representations for the same content
    - enable e.g. automatic content index generation

- **MediaBrickSpace**
  - node: multimedia information unit
  - edge: retorical relations “Rhetorisch-didaktische Relationen”
    - in order to provide coherent course units
    - in order to satisfy different user needs
  - navigation in media units
    - enables replacement of “knowledge incarnation”
    - enables open book paradigm

Knowledge base as semantic network well known but

- separation in different domains
- with different relationships
<table>
<thead>
<tr>
<th>LOM</th>
<th>Multibook</th>
</tr>
</thead>
<tbody>
<tr>
<td>isPartOf</td>
<td>example</td>
</tr>
<tr>
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<td>References</td>
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<td>IsBasedOn</td>
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<td>analogy</td>
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<td>Requires</td>
<td></td>
</tr>
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<td>IsRequiredBy</td>
<td></td>
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</table>

Infrastructure

- Exchange of material
- Communication channels
- Coordination:
  - Shared workspaces, cooperative tools
Computer-support Tools

Communication:
- Synchronous: Chat, Audio, Video
- Asynchronous: e-mail, news groups, www

Coordination:
- Group Calendar
- Workflow Management

Collaboration/Cooperation:
- Shared Whiteboard
- Shared file repository
- Team database
- Virtual information rooms
9.1 Learning Environment VITAL

- **VITAL** (for: Virtual Teaching and Learning)
- Developed at GMD-IPSI (1997 - 1999)

VITAL provides a virtual learning environment with virtual rooms for a variety of collaborative learning situations:

- private rooms
- group rooms
- auditorium,
Learning Environment VITAL

Chat & audio

Tele-pointer

Cooperative hypermedia

Group & role awareness

Orientation & navigation

Scope

Contents

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9.2 Concept: Learning Protocols

- Compensate missing social and non-verbal cues
- Structure learning processes
- Determine who can do what in which learning phase
9.3 Learning Environment CROCODILE

- Virtual learning rooms
- Learning tools
- Group & role awareness
- Learning protocol panel
9.4 BMBF-Project: L³-Life-long learning

- 18 Partners from science and industry (SAP, GMD-IPSI, TU Dresden, xlink, University of Mannheim ...)
- Nation-wide learning infrastructure (Service Center and Learning Center)
- Broad approach: Technical platform, tools, business models, content, and methods
- GMD-IPSI develops the cooperation platform and specialized collaboration tools for tutors and learners
9.5 Concept: Point-of-Cooperation (PoC)

Points-of-Cooperation (PoC)

- Positions at which a cooperation can be initiated in the context of a course are called Points-of-Cooperation (PoC).

According to the intention of the course author we distinguish:

- Intentional Point of Cooperation (iPoC)
  - PoCs are integrated into the course at fixed places inside the content structure.

- Spontaneous Point of Cooperation (sPoC)
  - cooperation is not coupled to specific places inside the content structure
10. Conclusion

learning becomes more and more multimedia and cooperative

learning requires

• Mobility, modularization & cooperation
  • Integration of heterogeneous approaches and systems
  • Flexible adaption of the content representation to technical constraints
  • Didactically validated learning methods
  • Flexible knowledge transfer
  • Task-adequate knowledge modules

• this enables
  • Distance training
  • Virtual universities
  • Life-long learning

Key Issue: metadata

• can help to overcome "information overload"
• LOM scheme covers almost every aspect a learner and an author must know/specify about a multimedia learning resource
• with the use of relations between the resources, it is possible to build resource maps
• relations should be limited to content based relations