Customized Learning Sequences (CLS) by Metadata (On Microlearning)

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Abstract: Computer technology as a medium requires a special form of knowledge organisation, which allows learners to go individually and in a reflective way through the content (Customized Learning Sequences), thus requiring teachers to produce individually navigable hypertexts. Individualization does not mean offering "pure" self-directed learning, as learning presupposes instruction by others. We have to aid teachers in reorganizing knowledge to hypertexts that allows individual navigation. Supporting learners in finding their individual path is also a crucial factor.How to aid teachers and how to set up meaningful navigation aids will be discussed in four steps: 1.) Theoretical considerations; 2.) First step of Web-Didactics: Decontextualisation; 3.) Second step of Web-Didactics: Recontextualisation; 4.) Research. Which theoretical considerations are eternal for Web-Didactics?

1. Overview

As Meder (1998) and Swertz (2000) demonstrated in a theoretical analysis of the media structure of computer technology, this medium requires a special form of knowledge organisation, which allows learners to go individually and in a reflective way through the content (Customized Learning Sequences), thus requiring teachers to produce individually navigable hypertexts. Individualization does not mean offering "pure" self-directed learning, as learning presupposes instruction by others. We have to aid teachers in reorganizing knowledge to hypertexts that allows individual navigation. Supporting learners in finding their individual path is also a crucial factor.

1.1 Books

It is difficult to write a theory about media, since writing a theory on media presupposes the use of media. Therefore a medium could only be reflected in the relation of media (on pluralism see Fromme 1997). Comparing computer technology to books shows certain differences in the physical dimension of the medium: Books consist of colour on paper. The paper is tied in numbered sequences.

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The colour is most often used to form letters. Letters are dominantly used in books, in doing so matching the arrangement of the tied paper (McLuhan 1992). This arrangement is characteristic for the production of equal copies: Books require knowledge to be arranged in linear sequences that are reproduced in equal copies. This well known structure of books requires a certain style of instruction: The idea of „everybody learns the same thing equally" (Comenius) and the idea of an single perfect learning sequence were reflecting the equal copies of books.
These ideas change when another medium gets culturally predominant. How could computer technology be understood from this perspective?

1.2 Hypertext

Today computers are built as electrical digital universal Turing machines. Usually keyboards and mouses are used as input devices and screens as output devices. Key attributes of this medium are the possibility to use algorithms during the presentation of knowledge to alter the presentation of the knowledge and the limited space on the screen.
The application of algorithms during presentation substitutes the equal copies; an individual presentation becomes possible. From this point of view individual learning has to reflect the physical structure of computer technology. This individualisation is connected to another granularity: Screens only show a small part of computer memory – everything not shown is detracted from sensual reception.
As we know *Hypertexts* (Iske 2001) are best suited for the specific structure set by computer technology – but in practice we often find continuous texts in on line learning environments (as on this CD).
How could the question of individualized Hypertexts be answered by didactics?

1.3 Navigation

The key problem is the navigation aid: How does a learner find the next step? How could the available knowledge be opened up? How has a hypertext to be arranged to support individual navigation, self dependant learning and a individually chosen didactical model? To solve these problems we have to offer navigational aids allowing the learner to move around efficiently, and we have to offer a variety of didactical models.
Web-Didactics does not offer a single instructional design model (e.g. Problem Based Learning, Tasks Oriented Learning) but a choice of didactical models, that where approved in the educational tradition. These models were specified concerning the granularity of the computer screen. The aim of Web-Didactics is a systematically and therefore clearly structured knowledge base that takes concern of different didactical

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models, therefore allowing individual learning. Self-directed learning and dependent learning are aligned.
How should learning material be prepared to allow individual navigation?

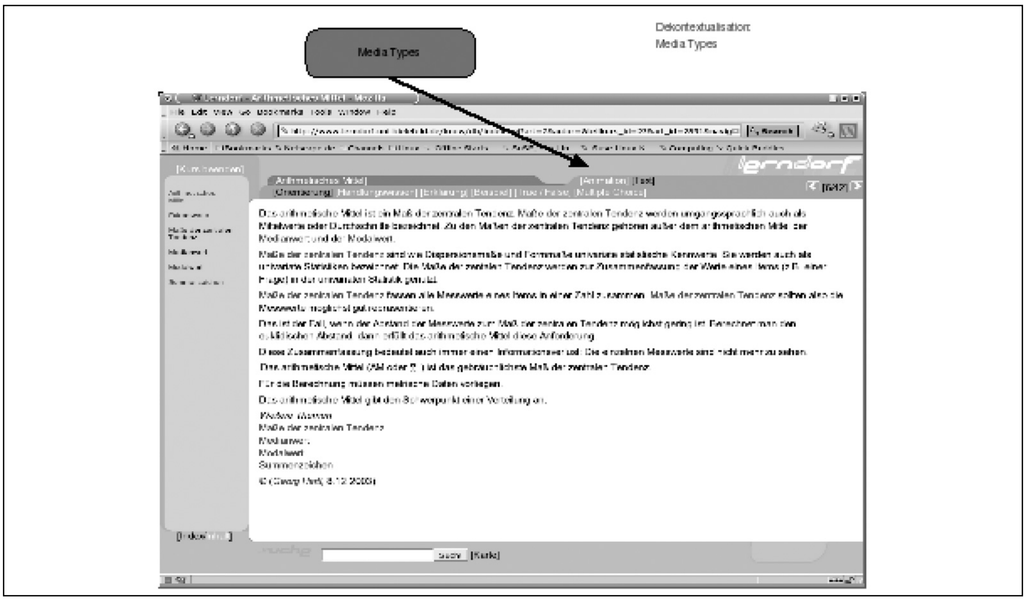
2. Decontextualisation

Preparing content for learning requires two steps:

1. The content has to be decontextualizied. It has to be derived from existing sources and transformed to the required granularity. That leads to an knowledge base being organized accordingly to didactical principles.
2. The produced elements must be recontextualisised to map them into learning time. (for de- and recontextualisation see Flechsig 1991).

Decontextualisation means building up a dicaticaly structured knowledge base. Knowledge is derived from existing contexts and is prepared for the learning process. Web-Didactics draws a distinction between four levels. The lowest level is the screen page. Which attribute is relevant on the level of the screen page?

2.1 Media Types



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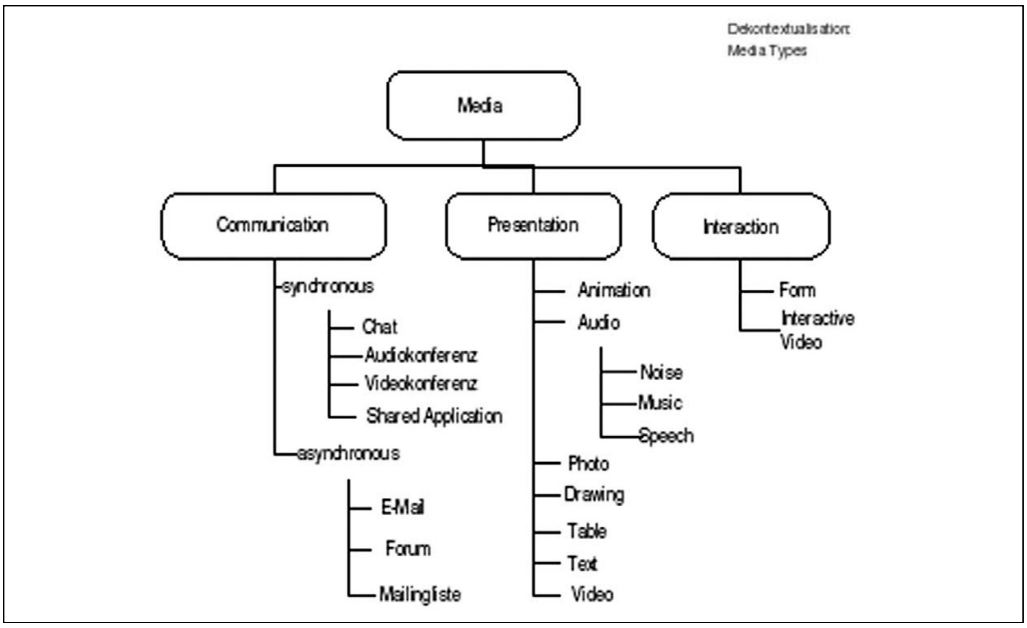
The key attribute of the screen page is the media type. The media type of the shown page from Lerndorf (www.lerndorf.de) is „Text“.
Using different media is an old didactical principle that applies to hypertexts accordingly. Computer technology offers varied forms of presentation: Pictures, drawings, videos, sounds etc. thus opening different didactical options. Which media types have to be considered from a didactical perspective?



The graphic shows the Media Types specified in Web-Didactics. The idea is not to produce every media type in every learning environment, but to guide authors to a systematic production of different media types. Crucial is the variation of media types.
For navigation different media types have to be combined with a knowledge type. Which knowledge types have to be considered?

2.2 Knowledge Types

Knowledge Types are the second level in decontextualisation. The screenshot shows the navigation between knowledge types. In other words: The knowledge types are used as a navigational aid for self-directed learning.

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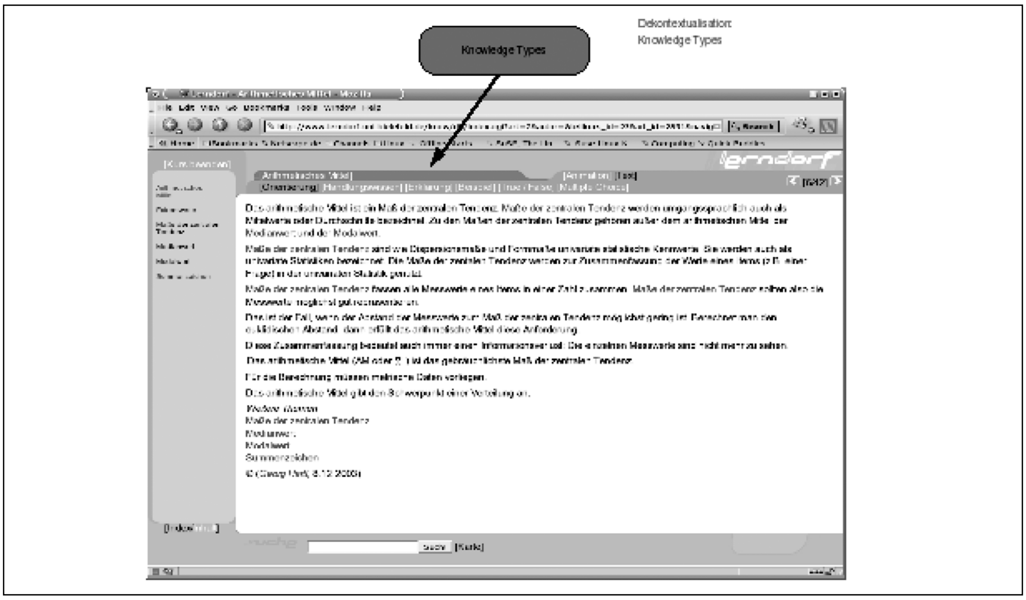

Web-Didactics draws a distinction between to classes of knowledge types:
- *receptive,*
- *interactive* and
- *cooperative* knowledge.

Receptive Knowledge is passively perceived, interactive knowledge offers interaction with the computer and cooperative knowledge means communication with other people. The distinction was made concerning the didactical models to be realised. We chose knowledge types that occur in didactical models mentioned in literature. The compilation is therefore derived through a heuristic approach and has in so far to be proven by empirical studies. The compilation could be modified if needed.

2.2.1 Receptive Knowledge

Beside perceiving the knowledge learners stay passive while using receptive knowledge. The diagram above shows the systematics of receptive knowledge types. The distinction of orientation, explanation, action and sources is derived from a concept suggested by Flechsig (1990).

Orientational Knowledge mentions objects, places them in context without detailed explanations or giving instructions on how to use them. One possible composition

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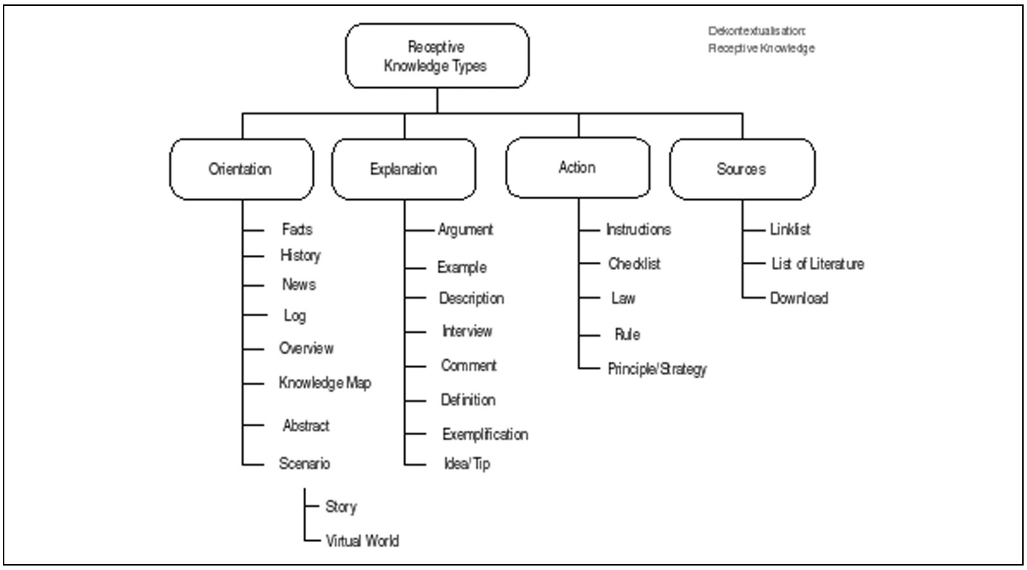

starts with by accessing previous knowledge („As you may know...“), places the knowledge in context („... belongs to ...“) and mentions relevant concepts („Important concepts are ...“).

Explanational knowledge offers reasons why something is in the was it is or why something is looked upon in a certain way.

Instructional Knowledge tells you what to do and how to do it.

Source knowledge indicates places where more informations could be found.

2.2.2 Interactive Knowledge

Interactive knowledge means that learners interact with the computer. Interaction with the computer takes place in assignments where the answers could be automatically evaluated and in simulations. Assignments that require cooperation with a teacher or other learners belong to the cooperative knowledge types.
Simulation is a versatile genre that could be used from social behaviour to technical controls. Most often the association with cooperative knowledge is sensible:

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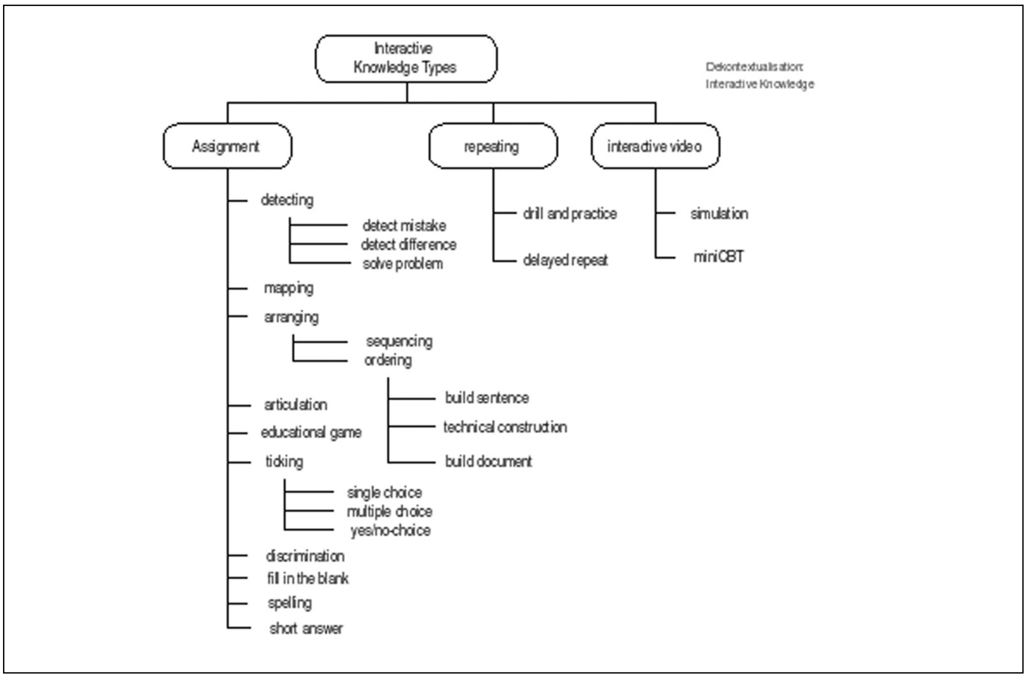

2.2.3 Cooperative Knowledge

Within cooperative knowledge learners communicate with other learners or teachers. We distinct spontaneous cooperations that could happen at any time from planned cooperations that are planned at certain point in a didactical model.
Planned cooperations are classified by group size. Consultations take place between two persons, learning conferences are planned for several hundred participants. The mentioned models are all well established and we already specified software requirements, but implementation only exists rudimentary. Empirical prove for the mentioned cooperations is therefore still a desideratum.
5-10 receptive, interactive or cooperative knowledge units are combined in a learning unit.

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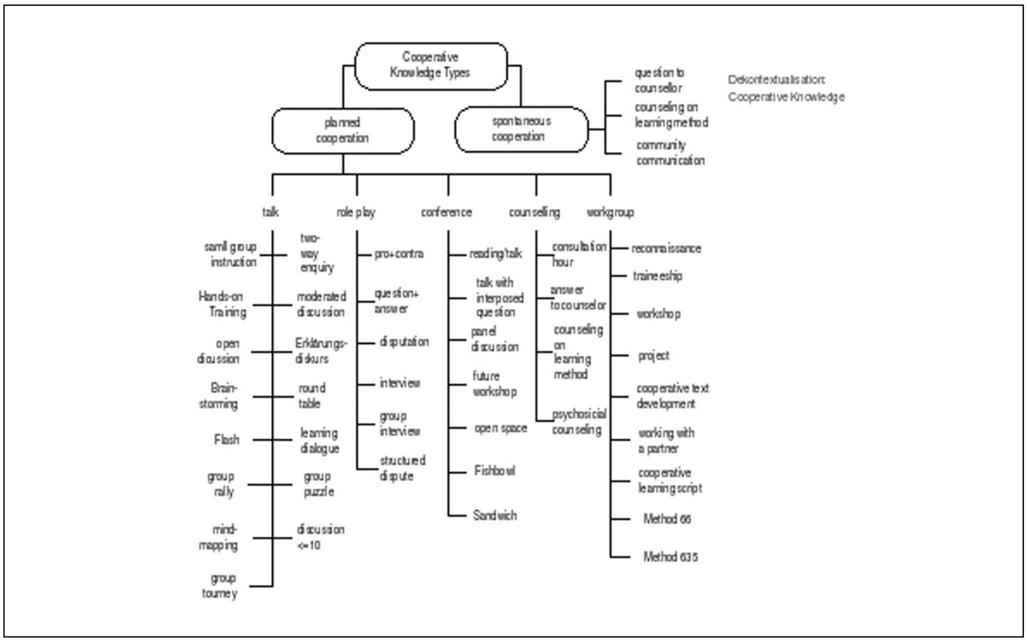
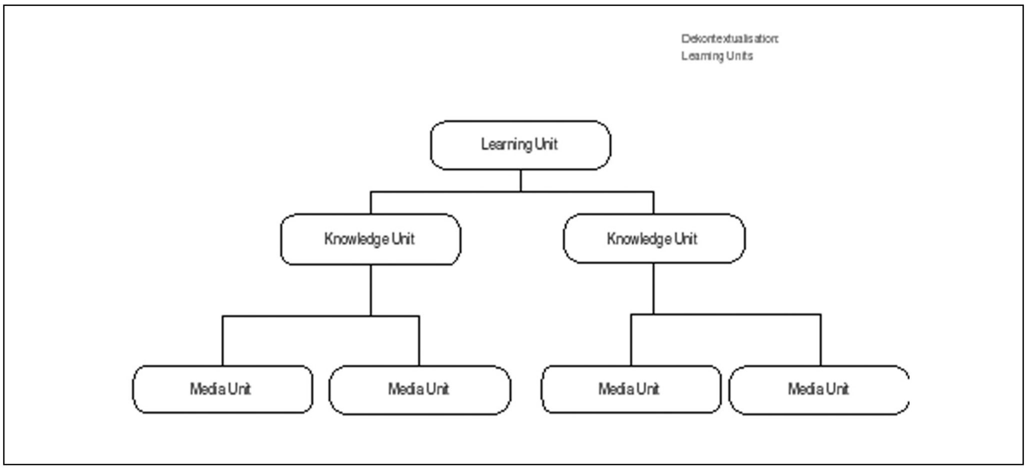


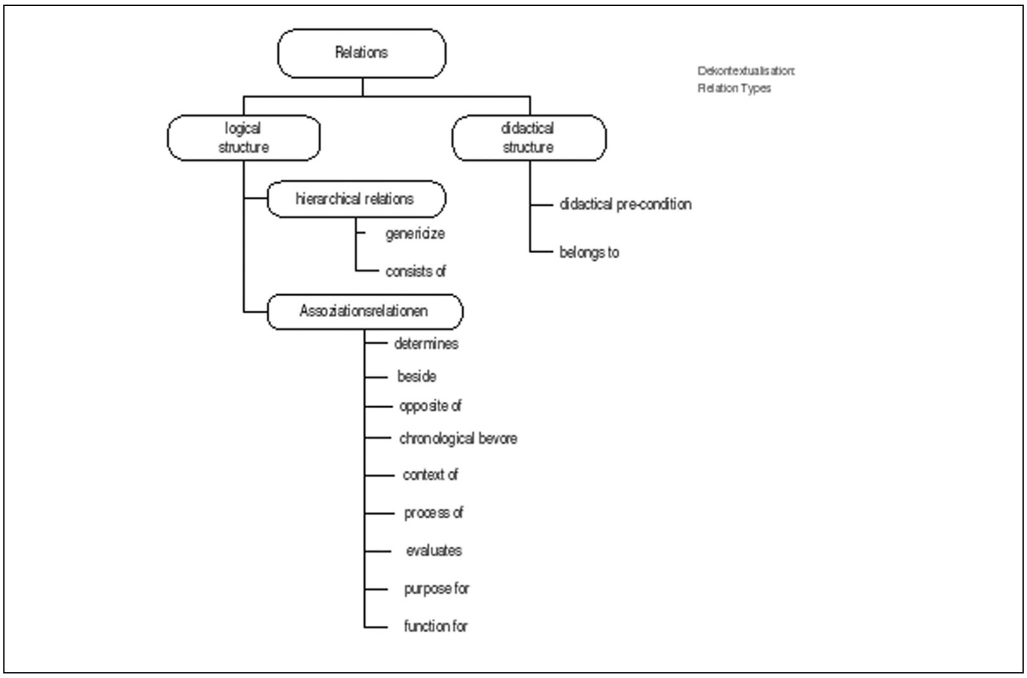
2.3 Learning Units

Learning units are the third level of decontextualisation. Learning units are defined by concepts. The navigation within concepts is highlighted in the drawing.
The distinction of media types, knowledge types and learning units makes up a hierarcical structure:



Learning units consist of knowledge units. Knowledge unit consist of media units. The network structure, that is typical for hypertext, seems to be missing. The network emerges from the following structure: The concepts of the learning unit are understood as thesaurus terms. A thesaurus term has to be unique, that is a term that occures only once in a knowledge base. The terms are linked not by a hierarchiy but through typed relations.
Terms linked with typed relations make up a knowledge network that consists of local hierarchies of knowledge types and media types. Relations make relevant concepts accessible within a media unit, when a concept is mentioned but not explained within a media unit. In this case the concept has to be made accessible through a relation to keep the coherence of the hypertext.

Which relation types have to be considered?



Relations Types are taken from thesaurus standards. Within thesauri hierarchical and associative relations are distinguished. Hierarchical relations reproduce concepts that are subordinated. Associative relations reproduce concepts that are co-subordinated.
Relations are used to map the logical structure of concepts. As the logical structure is often followed by didactical models logical structures could be used for didactical

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design. Only in rare cases didactical steps are made across the logical structure In this cases didactical relations are used.
Relations make up the forth level of Web-Didactics and they are the last element for decontextualisation. We can summarize:

Web-Didactics as an ontology to prepare knowledge for learning by decontextualisation differentiates media types, knowledge types, index terms and relations. These types could be used as a vocabulary for meta data systems (e.g. IMS-LD). The graduation is orientated an the granularity of the screen.

A knowledge base that allows for varied individual navigation paths is set up by a systematical variation of media types, knowledge types and relations. How could didactical models be applied to such a knowledge base?

3. Recontextualisation

Recontextualisation is implemented by
- media models,
- micro models,
- macro models and
- course models.

3.1 Media Models

Didactical models are used for recontextualisation, that is the arrangement of screen pages within a didactical hypertext. As self-directed learning and dependent learning are necessarily aligned (Litt 1964), we have to take care for both ideas. Web-Didactics integrate self-directed and dependent learning by offering media-types, knowledge-types and index-terms as navigation aids. These navigation aids avoid cognitive overload and lost in hyperspace problems through their systematic structure. Thus learners are offered the possibility for self-directed learning.

For dependent learning the screen pages are arranged by applying didactical models to the meta data. How could this sequence be presented to learners?
Recontextualising screen pages by didactical models means to fix a certain sequence. This sequence can be offered to learners at the same time as the navigation aids, thus integrating self-directed and dependent learning.

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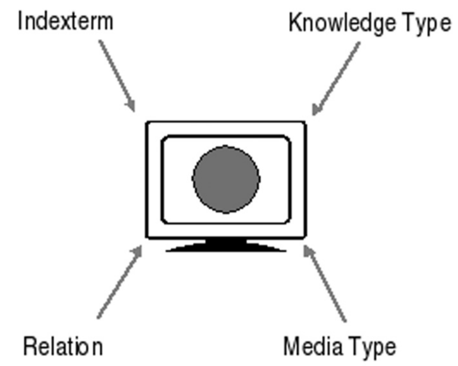
The sequence leads by simple forward and backward buttons through the media types, knowledge types and learning units. In the screen shot above the backward button leads to the screen page containing an animation.

Didactical models are specified for every level of decontextulisation in Web-Didactics.

Which didactical models have to be taken into account?



Media types are ordered according to media models. There are two media models: from concrete to abstract and from abstract to concrete. The first model goes from concrete to abstract since fewer and fewer qualities of the object are represented: The word „tree" does not show much of a real tree, while a picture of a tree shows more qualities of the real tree.
In practice hardly every possible media type is produced. In most cases only one ore two media types are presented for every knowledge type. So how are the knowledge types sequenced?

3.2 Micro Models

Knowledge types are sequenced by micro models. The next knowledge type is called if every media type within the knowledge type has been presented to the learner. Micro models are:
- example oriented models
- models according to Herbart
- learning by discovery
- task oriented models

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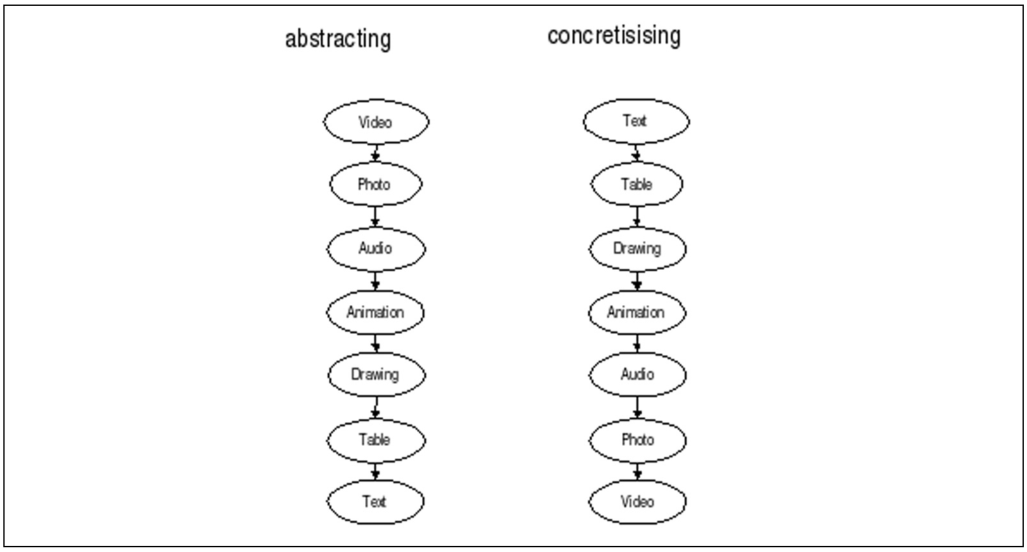
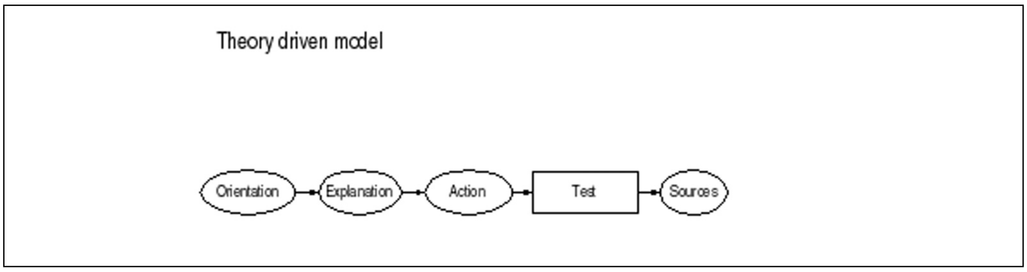
- role based learning
- theory driven
- action oriented
- problem based learning

I will show the last three models exemplary:



3.2.1 Theory driven



The drawing shows the theory driven micro model. The core is explanatory knowledge that contains the theory, understood as justification for knowledge. This model does not contain cooperative knowledge. It thus matches the requirements of the lonely learner.

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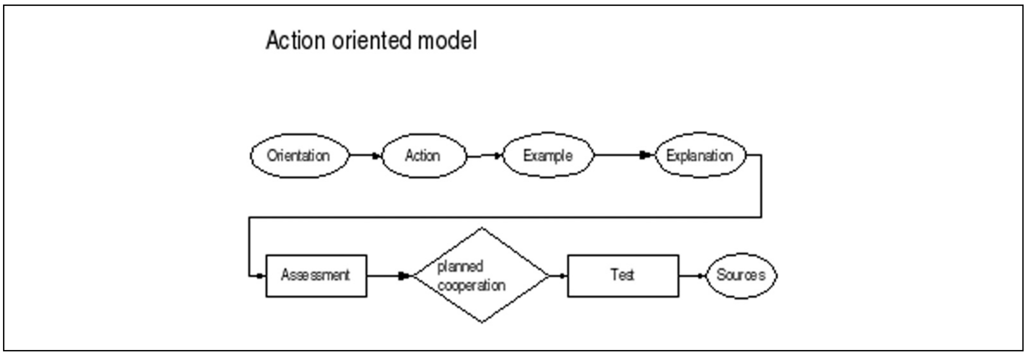
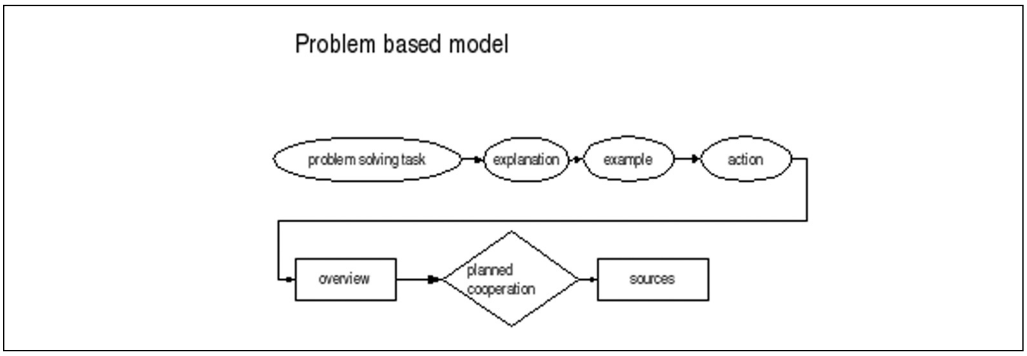
3.2.2 Action oriented



The core of the action orientated micro model is action knowledge, that is to say it is placed early in the learning sequence. This model shows advantages derived from decontextualisation: By organising knowledge to media types, knowledge types and learning units it is possible to offer different didactical models without rearranging all of the knowledge for every model. As explanatory knowledge is used in the theory driven model and in the action oriented model the same knowledge unit will be presented to the learner. This allows for an effective reuse of knowledge units. This can also be seen on the problem based learning:

3.2.3 Problem based



The core of problem based learning is the task to be solved. Hence the task is presented at an early stage within the learning unit.
Problem based learning shows another thing to consider while using Web-Didactics: Learner do not need to complete the learning sequence: If learners are able to solve

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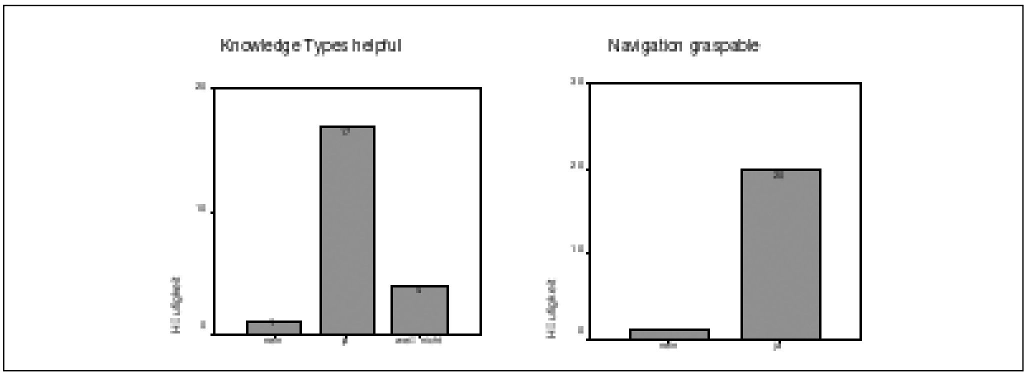
the tasks without further knowledge, they can answer the question and skip to the next learning unit.
The presented micro models gave evidence that a great variety of didactical models could be realised by different sequences of media types, knowledge types and learning units. If the possibility of altering the media types, knowledge types and relations is considered too, the complexity of didactics shows up. To develop varieties matching the requirements of different cultures is an interesting task that requires empirical research.

3.3 Macro Models



The third level of decontextualisation covers the sequencing of learning units. The next learning unit is called if all media units and knowledge units within the learning units are passed through. Which didactical models can be differentiated on the third level?
Didactical models on the third level are referred to as macro models. As micro models use one knowledge type as a key type, macro models use a relation type as a key type. Macro models that have been specified so far are (key relations in brackets):
- deductive model (hierarchical relations) with the varieties depth first and width first
- inductive model (hierarchical relations) with the varieties depth first and width first
- goal based bottom up (hierarchical relations)
- spiral model (context-of)
- constructive model (used-for)
- network model (all types)
- guides tour (didactical before).

As an example the drawing shows a simple hierarchy of learning units. The inductive model with width first sequences the learning unit as 4-5-2-6-7-3-1. The deductive model with depth first sequences the learning units as 1-2-4-5-3-6-7.

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In bigger learning environments the learning units can be combined to courses. Between courses only the relations "generalize" and "beside" are used, accordingly only inductive and deductive strategies are used.

4. Empirical Studies

By decontextualising knowledge to a knowledge based on considering different didactical models it is made sure that different paths for individual navigation are available. At the same time the recontextualisiation enables the single learner to choose his own didactical model, as the application of the models to the metadata can be done by algorithms.

What do empirical studies show about the Web-Didactic?

One point we use quantitative studies for is to test the satisfaction of learners with knowledge types and navigation aids. The diagrams show results from a small seminar in a University (n=21). We asked learners if they feel that the knowledge types are helpful („Knowledge Types helpful") and if they fell they understood the navigation aids („Navigation graspable").

Results show that the knowledge types are accepted and the navigation aids where judged as helpful (Ja = Yes). Critical points where that we do not offer off line versions and that the content could not be downloaded at once.
For qualitative research we asked learner to use the platform while thinking aloud. We used a screen cam to record the visible screen and the verbal expressions. We analysed the recordings taking account for usability, navigational behaviour and knowledge reception.

Our analysis shows that learners understand the navigational aids very fast – even without any introduction (we gave learners just the task to learn something about a certain concept and the URL) the navigational aids are used intuitively. While learning learners use very different strategies for navigation. That shows that the aim of Web-Didactics, to support an individual navigation, is reached.

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