The Essen Learning Model -
A Step Towards a Representation of Learning Objectives

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Abstract: The importance of the Extensible Markup Language (XML) technology family in the field of Computer Assisted Learning (CAL) can not be denied. The Instructional Management Systems Project (IMS) for example provides a learning resource XML binding specification. Considering this specification and other implementations using XML to represent learning contents in different ways, we developed a new approach to use an XML based representation of learning objectives during the development process of a Computer Supported Learning Environment (CSLE). Identifying and representing learning objectives is an integral part of the Essen Learning Model (ELM), a generic development model supporting developers, educators, and users on different levels of educational activities. We illustrate how to use XML data in the context of learning objectives to support the implementation of learning environments.

Introduction

Due to the enormous interest in the Extensible Markup Language (XML) a variety of approaches in the field of Computer Assisted Learning (CAL) have emerged recently. Current approaches more or less focus on the representation and structuring of learning contents, e.g. the Learning Material Markup Language (LMML) (Suess, 00). Another good example for the increased significance of XML in CAL is the XML binding for the Instructional Management Systems Project (IMS) Learning Resource Meta-data Information Model, which is based on the IEEE Learning Technology Standards Commitee (LTSC) Learning Object Meta-data (LOM) base document (Anderson, Wason, 00).
Textual formulation of learning objectives can only be used to outline a course (Adelsberger, Bick, Pawlowski, 00a). In this paper we will focus on the gathering and classification of learning objectives using XML. A more detailed analysis of those learning objectives, which helps the teacher to find and to design an adequate didactical method is needed to prioritize the contents. Accordingly, we developed the Essen Learning Model (ELM), a generic development model, supporting developers, educators, and users of different levels of educational activities (Pawlowski, 2000).
The ELM application, an advancement of the Essen Learning Model, supports a well-structured classification of learning objectives. Current classifications often show a lack of consistency.
We will present a new approach to classify learning objectives using the Essen Learning Model by explaining our classification and providing our representation using XML. Finally we will review consequential alternatives for the creation of a Computer Supported Learning Environment (CSLE).

Essen Learning Model (ELM)

ELM Development Model

The Essen Learning Model is a modular system (Fig. 1), supporting development processes as well as the system's use on different levels: the support of curriculum design (C-level), the development of learning sequences (D-level), and the development of learning units (E-level) (Pawlowski, 00). We distinguish between three abstraction levels: The *generic development model* provides knowledge for a variety of contexts. This generic model is customized depending on the users' needs and preferences, and transformed into a specific process model for each development project. The *process model* is implemented using the Architecture of Integrated Information Systems (ARIS) and provides a framework for educational technology projects. ARIS is a frame concept for a global description (modeling) of computer supported information systems, covering the whole life-cycle range **-** from business process design to information technology deployment (Scheer, 98). The third level is the *result* of the development process in the form of certain implementations for each module.

Figure 2 represents the main processes of the Essen Learning Model. The result of ELM-C is a detailed network of learning objectives and goals, determining structure and relations of learning sequences (courses). Based on these results, learning sequences are being developed in ELM-D. The focus of this phase is to find an adequate didactical method together with the right technology depending on learning objectives and user groups. Finally, single learning units are designed and implemented in ELM-E, using the Extensible Markup Language (XML).

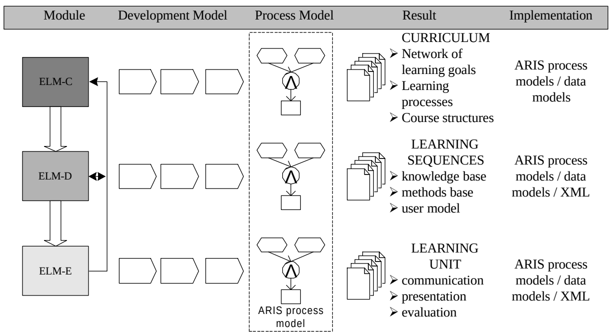

Fig. 1: The Essen Learning Model

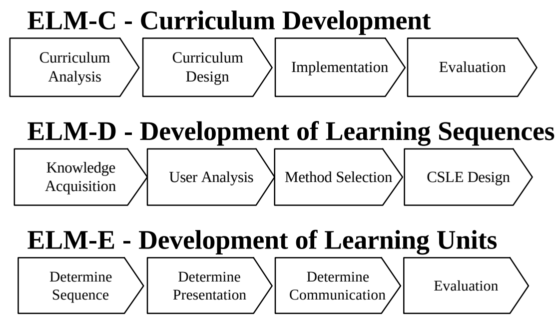

Fig. 2: Main process of ELM

ELM Application

To simplify the complex ELM development process, we developed an application which supports the author, who implements a course or a learning unit (Fig. 3). This application is programmed in JAVA, a language supporting an object-oriented, portable, and architecture-independent approach.

Compliant to the ELM development model the application uses the XML technology family on all of its implementation levels. XML provides the distinction between contents and its representation. Thus it is possible to represent a single contents in different ways (W3C, 98).

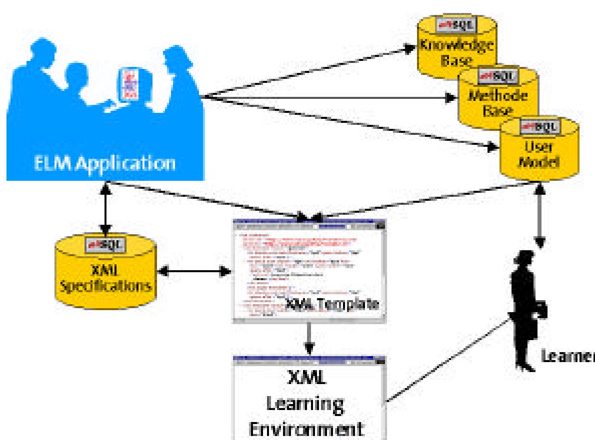

Fig. 3: ELM-Application Architecture

During the CSLE development process, special information about the learning contents and learning objectives is collected. The ELM application supports the author in classifying this information, as part of the *Knowledge Base* and converts it into XML documents. He can select an adequate teaching method according to the learning contents and user preferences (*Methods Base*). For this reason, the *User Model* contains attributes, characteristics, and the knowledge of a user. Ideally, the knowledge is represented adequately in accordance with the User Model, e.g., individual learning pace, preferred learning method, or preferred presentation format.

Considering that information and regarding the XML documents already mentioned, the ELM application generates a template, which could be tailored by the author according to his preferences and experiences. This adapted XML template results in an XML learning environment, which can be used by the learner.

Classification and Representation of Learning Objectives

Learning objectives allow to organize courses, plan teaching strategies, and evaluate testing techniques. Unless a course is defined in terms of learning objectives, a course author has no concrete means to measure the student’s success. Without any objectives at all, there is the danger of "teaching A and testing B". Using clear learning objectives, both the students and the instructor know where they are and what needs to be done (CIT, 97).
The textual formulation of learning objectives can only be used for an outline of a course. A more detailed analysis of those learning objectives is needed in order to prioritize the contents. Furthermore, this analysis helps the teacher to find an adequate teaching method.
Unfortunately, a variety of classifications of learning objectives are currently in use, often resulting in inconsistent classifications and terminologies. We suggest to use a classification of learning objectives, containing the criteria *abstraction level*, *dimension*, and *kind of content* in the ELM-Application. Our suggestion is based on the work of (Moeller, 73), (Bloom, 73), and (Baumgartner, Payr, 94).

Classification

(Moeller, 73) distinguishes learning objectives between three different *abstraction levels* according to (UNESCO, 00):

1. *strategic*,
2. *general*, and
3. *specific*.

By means of this abstraction levels, a certain hierarchy concerning the learning objectives can be realized. For example, in the field of simulation, a strategic objective is the optimization of a production planing process. For this purpose, using simulation is a general objective. Finally, performing a simulation study using a specific simulator describes a specific learning objective.

Secondly, we use a classification of *dimensions*. Extending Bloom's classification of intellectual behavior (Bloom, 73), we distinguish between four dimensions:

Dimension	**Complexity**
• *cognitive*,	1. *knowledge*,
	2. *comprehension*,
	3. *application*,
	4. *analysis*,
	5. *synthesis*, and
	6. *evaluation*.
• *affective*,	
• *psychomotor*, and	
• *social*.	

The social dimension describes skills like the capacity for teamwork, solving conflict situations, the ability to assert oneself, etc.
In order to identify an adequate didactical method, it is necessary to identify the *complexity* of learning objectives. In our example we focus on the cognitive domain. Bloom identified six levels within this domain, from the simple recall or recognition of facts as the lowest level, through increasingly more complex and abstract mental levels, to the highest level which is classified as evaluation.

The third approach is according to (Baumgartner, Payr, 94) the classification concerning the *kind of learning content*:

1. *learning facts and rules* (remember, receive)
2. *rules, procedures* (apply, imitate)
3. *problem solving* (decide, select)
4. *gestalt perception, pattern recognition* (explore, understand)
5. *complex situation* (invent, master, cooperate)

The first level describes learning environments whose main purpose is to present and transfer contents (verbal, multimedia). The main activity of the user (interaction) is to navigate among pieces of information. The second level typically consists of exercises and tests. The learner acquires and tests procedural knowledge. On the next level, the learner is asked to deal with more complex situations by planning his own procedures. The goal of the fourth level is to perceive and holistically understand processes with their causes and effects, and to discover common characteristics and patterns in various "cases" (Baumgartner, Payr, 98). The experience of complex situations, e.g., in simulation games, offers the student the opportunity to increase his thinking flexibility (Geuting, 89).

Taking into account the criteria of classifying learning objectives (e.g., *abstraction level, dimension, complexity, and learning content*), we specified learning objectives for a computer based simulation course for graduate students of business information systems (Tab. 1). In this course we focus on the basic methods and concepts of simulation. The students learn how to model, implement, and evaluate simulation systems for specific manufacturing problems in selected simulation languages.

abstraction level			dimension	complexity	content
strategic	**general**	**specific**			
Applying the concept of simulation in the context of manufacturing enterprises			*social*: • capacity of teamwork • decision-making ability • performing simulation studies in small teams	evaluation	complex situation
	Definitions, concepts, and applications of simulation		affective	comprehension	facts & rules
		Definition of simulation	cognitive	knowledge	facts & rules
		Fundamental Simulation concepts	cognitive	comprehension	facts & rules / procedure
	Performing a simulation study		cognitive / affective	evaluation	complex situation
		Problem formulation	cognitive	analysis	gestalt perception
		Solution methodology	cognitive	application	problem solving
		System and simulation specification	cognitive	synthesis	rules, procedure / problem solving
		Model formulation and construction	cognitive	synthesis	complex situation
		Verification and validation	cognitive	evaluation	problem solving
		Experimentation and analysis	cognitive	synthesis	problem solving
		Presenting and preserving the results	cognitive	application	problem solving
		Interpreting the results	cognitive / affective	evaluation	gestalt perception
		Comparing and benchmarking of alternative system models	cognitive / affective	evaluation	gestalt perception
	Simulation with SIMAN		cognitive	application	complex situation
		(Primary) SIMAN blocks and elements	cognitive	application	procedures / problem solving
		Basic Interaction	cognitive	application	procedures / problem solving

Table 1: Extract of the Learning Objectives Network

Representation

After presenting our approach to classify learning objectives, we will now lead over to the implementation of them in XML. Besides a multitude of dynamic representation alternatives, XML could be described as a simple dialect of the Standard Generalized Markup Language (SGML).Whilst designed initially for the display of documentation distributed via the World Wide Web (WWW), XML has been widely adopted as

a means of interchanging information between computer applications. XML in particular is widely seen as the best solution for the interchange of meta-data about stored objects and programs (ETHOS, 00).
Obviously, XML is not only a markup language similar to HTML (Hypertext Markup Language), but rather a meta-language, which supports the definition of own “tags” to structure a document.
The existing XML recommendation will be complemented by two extensions. The Extensible Stylesheet Language (XSL) will provide a method to specify the presentation style and control the behavior of XML elements. The Extensible Linking Language (XLink) will enable XML documents to be linked together (ETHOS, 00).
The rather complex process of creating a CSLE and especially the process of creating a learning objectives network is simplified significantly with the use of the ELM application. The conceptual model of the learning objectives network, as shown in Table 1, could be seen as a hierarchical model, which represents data consisting of elements and subelements. XML is most suitable to represent this hierarchy.
In our approach, the process of classifying learning objectives is managed using the ELM application form (Fig. 4). Here, the ELM application stores this data, as shown in Table 1, in an XML document (Fig. 5).

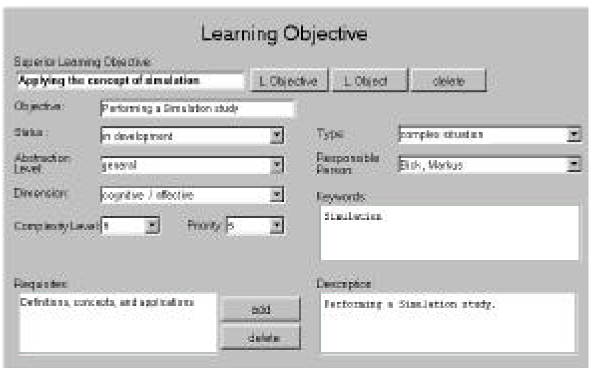

Fig. 4: ELM application form

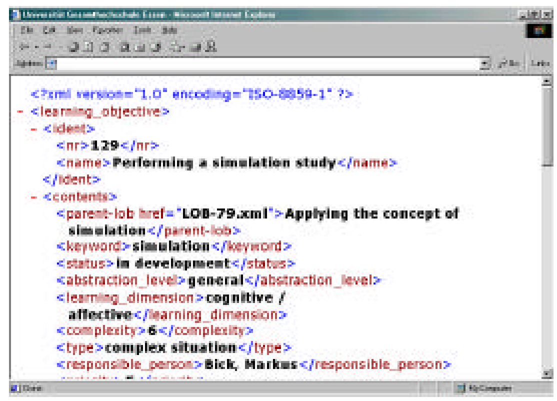

Fig. 5: Learning Objective XML document

Generating a special report, the ELM application offers all people involved, a way to comprehend the learning objectives network implementation process. The generated XML document contains the essential information, it acts as the learning objectives database. This XML document supports the author during the CSLE development process , using the features offered by the XML technology family; on the other hand a report can be generated using the same base document.

Conclusion

We described the importance of identifying and classifying learning objectives. The Essen Learning Model supports a classification approach regarding abstraction level, dimension, complexity, and learning content. Using a multilevel-development model we support the development process for CSLE during the important Curriculum Analysis (Fig. 2). In this paper we focused on classifying learning objectives as well as representing and storing them using the advantages of the XML technology family.
We illustrate how the XML technology family could be utilized during the development process of a CSLE besides the sole structuring and representing of the learning contents. Combining this approach and our related work of a standard model of learning processes (Adelsberger, Bick, Pawlowski, 00b) the development process of a learning environment can certainly be improved. In the next step of development the ELM application will also support the representation of teaching methods using the XML technology family.

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