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ABSTRACT

An Internet-based course management system has been under development at the Fraunhofer-Institute for Computer Graphics Rostock (Germany) for the past 5 years. It is used by experts for distributing their courses via the Internet and by students for learning with the material distributed. The "Course Management System for WWW--CMS-W3" supports self studies, group learning, and communication among students and with the tutor. There are various standardization processes on information and communication technology-based learning materials running all over the world. The Learning Technology Systems Architecture (LTSA) is one standard developed by the Institute of Electrical and Electronics Engineers (IEEE) 1484 Learning Technology Standards Committee. One important part of CMS-W3 was missing and was not described in the LTSA. It was found that the proposed LTSA was missing the part on how the knowledge is transferred through the system. This paper proposes an extension of the LTSA supplementing the process of knowledge transfer: from the expert to the resources of the system and back to the expert in the form of experience. (AEF)

Extending the IEEE – LTSA

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Abstract The IEEE developed an architecture specification for learning technology systems (LTSA). This paper proposes an extention for the LTSA covering the learning cycle taking place between expert and learner. We describe a general production model to motivate the extention of the LTS architecture as described in [Farance and Tonkel, 1999].

Introduction

An Internet based course management system (*CMS-W3*) is being developed at Fraunhofer-Institute for Computer Graphics Rostock for the past five years. It is used by experts for distributing their courses via Internet and by students for learning with the material distributed. The "Course Management System for WWW – *CMS-W3*" (see [Voskamp, 1997,Voskamp, 1999,Hambach et al., 1999] supports self studies, group learning and communication among students and with the tutor.

There are various standardization processes on ICT(Information and Communication Technology)-based learning technologies running all over the world. One standard is developed in the IEEE 1484 Learning Technology Standards Committee (LTSC). The LTSC proposes the "Learning Technology Systems Architecture (LTSA)" [Farance and Tonkel, 1999].

Following these standardisation processes we tried to match the architecture of *CMS-W3* and the LTSA. One important part of *CMS-W3* was missing and was not described in the LTSA. Going back to underlying learning processes we found that the proposed LTSA is missing the part on how the knowledge is transfered through the system.

This article proposes an extention of the LTSA supplementing the process of knowledge transfer: from the expert to the resources of the system and back to the expert in form of experience.

IEEE - LTSA

The IEEE 1484 Learning Technology Standards Committee (LTSC) developes an architecture specification for learning technology systems, the "Learning Technology Systems Architecure (LTSA)". The LTSA is

> "...an architecture specification: the technical details can be used to specify or design systems as well as detailed systems components."[Farance and Tonkel, 1999]

The specification is beeing developed in close collaboration with the Aviation Industry CBT Committee (AICC), the European Commission PROMETEUS initiative (EC/DGXIII), the European Union ARIADNE Project, the European CEN/ISSS Workshop on Learning Technologies (CEN/ISSS/LT), the IMS Project, and the US Department of Defense Advanced Distributed Learning (ADL) initiative.

The LTSA proposes a basic top-level architecture for system design and components. It covers a wide range of ICT-based learning methods and even non-ICT-based models.

Setting up such a specification architecture is a great idea. Using an existing architecture standardization prozess makes things much easier, for example defining the exchange of courseware (see [Dodds, 2000]) or student profiles. Figure 1 shows the LTSA system components. See [Farance and Tonkel, 1999] for a detailed description.

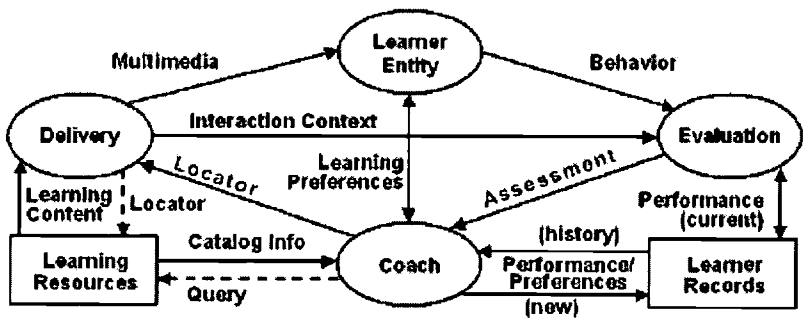

Figure1. LTSA system components model

Objectives of the LTSA

The LTSA specification states to be

"...pedagogically neutral, content-neutral, culturally neutral, and platform-neutral. The LTSA specification is neither prescriptive nor exclusive."

Furthermore, it

"... does not address the development systems (e.g., programming languages, authoring tools, operating systems) necessary to create the LTSA components, and the management systems (e.g., learning material lifecycle, quality assurance, access control, user administration) necessary to manage a learning technology system."

Consequently, the LTSA is an architecture describing general learning processes. Anyway, in our opinion the learning process is not completely descibed.

Missing points

The LTSA covers only a closed learning process. However, the knowledge to be "produced" in the head of the student has a source. It is either the knowledge the expert has or it is the experience of the student in finding and solving problems.

If there is expert knowledge to be passed to the student, this knowledge has to be translated into some kind of information (data plus multi-modal presentation). In working with and studying this information the student may aquire his knowledge – he learns.

The process of learning produces a learning history and learning performance which can be used by the expert to improve his knowledge about the way the information has to be passed to the student. This process is missing in the LTSA.

Extending the LTS Architecture

We propose to extend the LTSA by an expert process. The purpose of the extention is not to deny the LTSA but to extend it by a processes we think is essential.

The proposed extention is based on a production model which will be described in short in the following.

Production model

The relevant state S of a student for the learning scenario bases on his actual knowledge K_L and his mental state M. This state changes during one learning cycle – $S_t \rightarrow S_{t+1}$. The student starts in state S_t, which bases on the knowledge K_{Lt} and the mental state M_t where t defines the moment before the learning process starts.

$$S_t = \{K_{Lt}; M_t\}$$

Let I be a set of information objects IO. An information object contains the data which solely or in combination with other information objects is to be presented to the student.

$$I = \{IO_1, \ldots, IO_n\} \;||$$
$$\forall i \forall j : IO_i = IO_j \Leftrightarrow i = j;\; n, i, j \in N$$

The student consumes an information $I_{t,t+1}$ during the learning process $l_{t,t+1}$ presented by a set of presentation types $P_{t,t+1}$(described later) where

$$I_{t,t+1} \subset I$$

A presentation can be a simple audio presentation, an interaction, an excercise, a test as well as a discussion forum or other learning tools. The learning process $l_{t,t+1}$ is a function depending on the information, the presentation types and the knowledge as well as on the mental state of the student.

$$l_{t,t+1}(I_{t,t+1}, P_{t,t+1}, S_t)$$

For the transfer of information to the student it can be coded in different presentation types (see [Mengel, 1999]).

Information objects IO are aquired out of the experts knowledge K_e to be passed to the student as well as out of the the knowledge of other students K_{sg}.

Experts are responsible not only for the information to be transfered to the student but for the type of presentation, too. They define a set of presentation types P. A presentation type PT is one method to present an information object IO.

$$P = \{PT_1, \ldots, PT_n\} \;||$$
$$\forall i \forall j : PT_i = PT_j \Leftrightarrow i = j;\; n, i, j \in N$$

As described in [Reinhardt et al., 2000] every presentation type contains attributes which allow a decision when to use this presentation type. The presentation function $p_{t,t+1}$ returns the necessary set of presenation types $P_{t,t+1}$ to be used for the current information $I_{t,t+1}$.

$$P_{t,t+1} \subset P$$

$$P_{t,t+1} = p_{t,t+1}(I_{t,t+1}, S_t)$$

The aim is to maximize the learning function $l_{t,t+1}$. In order to maximize this function the best sets for $I_{t,t+1}$ and the best fitting set of presentation types $P_{t,t+1}$ has to be found. This is the task of the coach in LTSA.

However, $I_{t,t+1}$ depends on the learning function $l_{t,t+1}$. For this reason, it is necessary to optimize the presented information $I_{t,t+1}$, the information objects IO, the presentation function $p_{t,t+1}$ and the presentation types PT. This cannot be the task of a coach but has to be the task of an expert. For optimizing the information ojects IO and the presentation types PT expert knowledge K_e is definitly necessary.

Figure2 gives an overview on the production model.

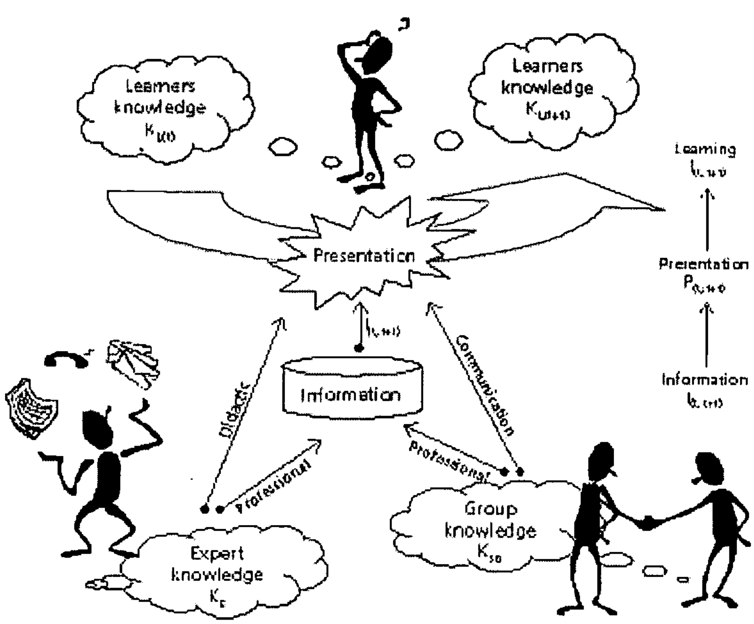

Figure2. Production model

Reasons for the extention

The main reason for the extention is to find a system architecture for learning technology systems that covers all learning scenarios – as LTSA is dedicated to be. As shown in section "Production model" the learning process is not covered by only presenting information to the student and using the learning performance to let the coach find the next information to be presented.

The learning performance of a student is used by the expert to train the coach in didactics and to transfer the right knowledge into information object to be stored in the learning resources. For ICT-based learning environments this recursion is not done for every single learning step. However, it is necessary to bear in mind that it exists. Therefore it should be included in the LTSA.

Extended Architecture

We propose to expand the LTSA by an expert process. The expert process is responsible for transferring information into learning resources and for training the coach in didactics. After the first learning cycle the expert process learns from the learner performance how the coach has to be re-trained and which knowledge has to be re-transformed into information. Figure 3 shows the extension.

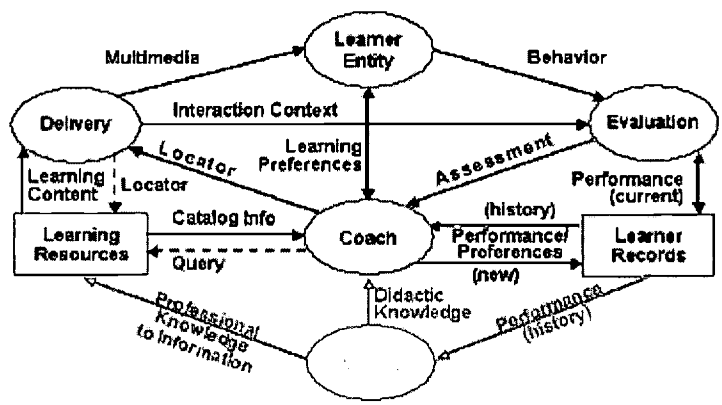

Figure3. Proposed extended LTSA

Following the description of the LTSA the coach can be an automatic process following predefined rules. This process is not able to define new didactic rules. It simply does not has the necessary knowledge.

The main reason for extending the architecture is that there is no knowledge-to-knowledge flow described in the LTSA as it exists in the real world. When trying to set up a learning specification it is important that this specification meets the daily learning business. Daily business in learning is a cyclic dependency between students and experts knowledge.

Review

The proposed extension for the LTSA adds an important part of the daily learning and teaching business. It says that the student does not only learn from the expert, but the expert learns from the student as well.

Background for the proposed extension are ICT-based learning environments. However, as stated in the LTSA specification the extended architecture covers daily learning processes like face to face learning, too, and much better.

The following list shows the steps during one learning cycle as proposed in the LTSA. The first and the last line are added due to the extension described.

1. ***Put expert knowledge into resources (knowledge to information) and didactic knowledge into the coach***
2. Start with human sensory input: multimedia delivery to learner (similar to entertainment)
3. Add coaching/feedback loop for human "unreliability"
4. Add learner records for varying teachers, infer intelligently about learner capability
5. Add rich learning resources, search, and lookup to support diversity of humans
6. Add negotiated learning preferences for direct communication with learner
7. ***Add negotiated learning preferences to give feedback to expert***

Conclusion

Using the extended learning technology systems architecture it is possible to describe the functionality of *CMS-W3* and other ICT-based learning systems. We use it as a starting point for further research in technical support for transferring expert knowledge into information objects, in didactic support for the coach and in organizing the re-transformation of information objects according to the students learning process.

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