

The concept of a Unit of Learning Material in multimedia databases

Gerrit Hiddink
Centre for Telematics and Information Technology
University of Twente

February 8, 1998

1 Introduction

At the department of Instrumentation of the faculty of Educational Science and Technology of the University of Twente, the concept “ULM” has been developing over several years. The latest developments are taking place in the context of the Idylle¹ subproject “distributed educational multimedia databases: design, production and application”.

The emphasis of the concept as it is presented here, is on its use in computer-based learning environments that are built on multimedia databases. In this paper, we will describe the properties of the ULM as it has evolved, as well as various other aspects, such as where it is used, by whom, when it is used, and how it can be used as a building block in a computer-based learning environment.

2 Why do we need ULMs?

The production costs of multimedia material, and in particular video clips, can be quite high. These costs can be reduced by reusing material in possibly different contexts: material for a new course can be created using components from previously developed courses (see also Olimpo, Chiocciariello, Tavella, and Trentin (1990)). Also, material for courses for various educational levels and for varying target groups can be created using the same

¹*Innovative DIstributed Learning Environments*, a multidisciplinary project of the Centre for Telematics and Information Technology, University of Twente

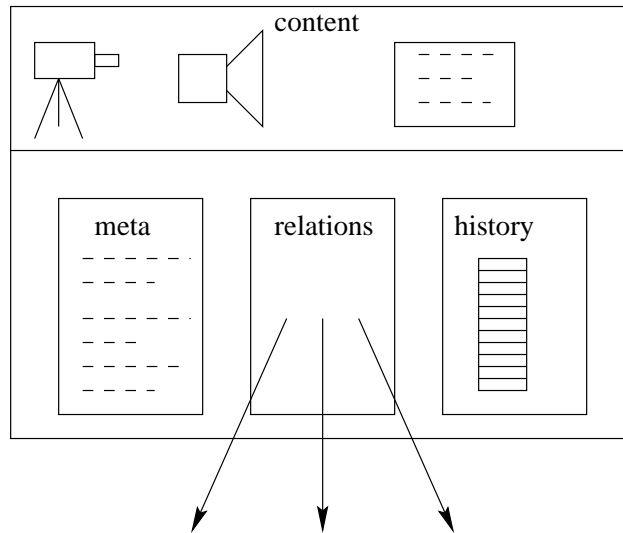


Figure 1: An example of a basis ULM

basic material. A teacher can modify an existing course to his or her own preferences and educational objectives by switching on or off certain components or building blocks, or create new material by compiling large components. The question then raises: *What is the nature of these components so that they can be stored in a computer system, and so that they can be retrieved and configured for flexible reuse?*

We have worked out this concept which we have called ‘Unit of Learning Material’, or ULM for short.

3 What is a ULM?

A Unit of Learning Material as we have defined it is a digitally stored piece of information that was created for some kind of educational purpose, and consists of educational content, educational meta information, relations to other ULMs and a history file (see figure 1). These four will be treated below.

3.1 Educational content

The educational content of a ULM is a collection of audiovisual, textual and interactive data (such as Java programs or Authorware modules) that

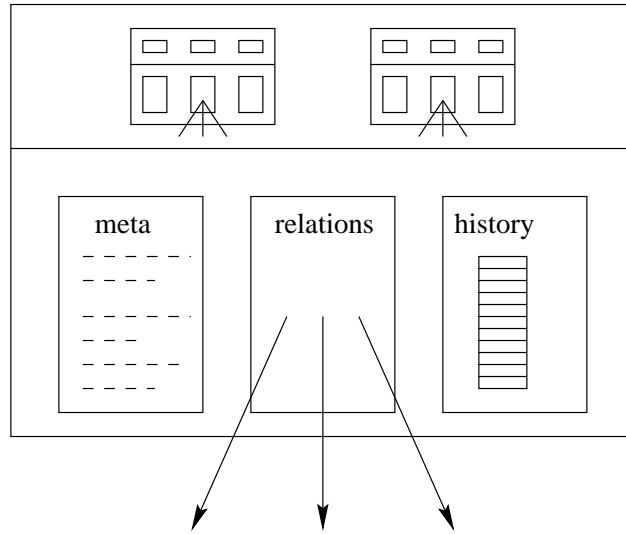


Figure 2: An example of a composed ULM

together forms some kind of educational unit. It depends on the person creating the ULM (hereafter called *educational designer* and the situation in which the ULM is to be used what is considered to be a unit. This depends on personal insights, the subject area, and other external variables; this aspect will be dealt with in section 4.

An important feature of our definition of the concept, is the fact that the educational content can also contain “sub-ULMs” instead of the aforementioned data. We will name ULMs that consist of sub-ULMs *composed ULMs*, and ULMs that only consist of audiovisual, textual and interactive data *basis ULMs*. ULMs that contain both sub-ULMs and plain data are named *mixed ULMs*; as we have not yet found any specific use for this type, we do not consider it further.

In figure 2, an example of a composed ULM is depicted.

3.2 Meta information

A Unit of Learning Material not only carries educational content, but also meta-information, for example who created the ULM, for what subject area is it intended, or for what educational level was it created. A ULM can best be seen as a container: on the outside, there’s a description of what is in it, while the interior is somewhat hidden but consists of a unit of some

kind. We will call the meta information *labels*, as they are intended to help retrieving the ULMs for specific educational purposes.

3.3 Relations to other ULMs

Units of Learning Material often have some kind of educational relationship: ULM A can be an example of ULM B, or A can give a deeper understanding of the subject matter in B, etcetera. These relations have a specific educational purpose. In order to make ULMs better accessible, these relations can be stored in the ULM, so that when accessing ULM A it is also possible to easily access ULM B.

3.4 History information

Finally, a Unit of Learning Material carries a history file which describes in what courses the ULM has been used in the past. This file holds knowledge about for what courses the ULM has been considered to be useful by some educational designers.

Suppose, for example, that a teacher is preparing material for a course on recording information on magnetic surfaces for a Computer Science course, and he or she poses a question to the database application to retrieve some material. The teacher likes the material he or she gets very much, and would like to find related information. The teacher then accesses the history information of the retrieved ULMs to see in what courses they have been used, and learns that the faculty of Electrical Engineering also has a course related to magnetic recordings. The teacher asks the database what other material was used in those courses, and finds a useful animation of the mechanics of a floppy drive. It will be clear that storing history information can increase the reuse of learning material.

4 The size of a ULM

One major question about ULMs is: *What is the desired size of a ULM?* Earlier research by Verhagen (1992) indicated that

This depends on two factors, which will be treated below.

4.1 Educational purpose

The purpose of a particular collection of learning material may determine if the collection can be considered a unit, or should be considered to form several units. For example, a description of a chemical reaction can consist of many units (bits of theory, bits of examples, images) in a chemistry course, but it can also serve as one large example of how descriptions of chemical reactions look like in a course on scientific communication, and as such the description can be considered to be one large unit. In the first case, the educational purposes of the respective units are 'theory', 'example' and 'visual representation', while in the second case the educational purpose is 'example'.

4.2 Personal preferences

Personal preferences may influence what a designer considers a unit. Different designers may use different instructional approaches to design instruction, and designers each have their own unique experiences in designing instruction which may also influence their opinion about what can be considered an educational unit.

This flexible definition suggests that almost every ULM will have an unpredictable size, because each is created by different persons for different educational purposes. This would seem to reduce reuse, as the desired size would not seem to correspond easily with any ULM that is present in the database. There are two cases:

- the ULM the designer is looking for, should be larger than the ULMs he or she has retrieved from the database. In this case, the designer could easily create a new composed ULM consisting of (a selection of) the retrieved ULMs;
- The ULM the designer is looking for, should be smaller than the ULMs he or she has retrieved from the database. If one of these is a composed ULM, then perhaps a sub-ULM fits his or her goals. If not, then a multimedia editor may be needed to split the data in one of the ULMs into smaller parts and create new basis ULMs using this data.

So, in order to meet the personal preferences and the requirements in unforeseen characteristics, we have to adopt a very flexible unit-size. We theorize that the recursive definition of a ULM and the provision of multimedia editors will prevent the decrease of possible reuse.

There is an interesting trade-off between size of a ULM and its usability: a large ULM is often more specific than a small ULM, so that the large ULM is less reusable than the small one. Consider for example a ULM consisting of a video fragment of 2 seconds showing a blue sky with some fluffy clouds, and a ULM containing a video fragment of 20 seconds showing the same sky crossed by a swarm of bees chasing the queen bee. The ULM of 2 seconds with the blue sky can be used in learning material about weather forecasting, cloud types, the filtering of specific colours by the atmosphere, or the lifecycle of water on this planet. The ULM with the bees is actually only suited for learning material about bees. So, the small ULM is more reusable, however it is difficult to put labels on the 2-second ULM so that it can be retrieved for all courses we mentioned.

5 Context adaptors

One of the main problems when reusing ULMs can be that the context for which the ULM to be reused is created, differs from the context in which the ULM will be reused. For example, suppose a teacher is preparing a course on mathematics, and would like to show some practical uses of a chemical process about enzymes. The teacher uses a database application to search the database, and finds some material on the use of enzymes for making cheese. However, the material includes an audio track with a narrator talking about “the previous exercise”. As the teacher does not have a previous exercise, this sentence is inappropriate and may confuse learners. It is very difficult for the teacher to remove or edit that part of the audio track, however, as the teacher does not have the technical skills to do this. So, the teacher enters a small text saying “What you are about to see, is an example of how enzymes are used to break up milk components, taken from a course on making cheese. Pay special attention to the animation which illustrates the chemical processes we are currently studying, and ignore the mentioning of a previous exercise”. We will call such a text a *context adaptor*, as it adapts the context of a specific ULM to a new context so that it can be more appropriately reused. Using context adaptors further facilitates configuring a heterogeneous set of reused ULMs into consistent new learning material. They can be placed before and/or after a ULM whose context needs to be adapted.

6 Examples of computer applications

Every computer-based learning environment which needs the concept of some kind of building block, can make use of our concept of ULM; for example:

- Drill-and-practice tutorials;
- a digital encyclopedia of learning material, which the learners can browse to find specific learning material;
- a database of learning material from which teachers can select material for their courses;
- systems for exploratory learning, for example by using a semantical network between ULMs;
- a database containing a conceptual network of interrelated learning material that learners can use to explore a subject area;
- a knowledge database in an Intelligent Tutoring System (see for example Elsom-Cook (1990), who uses a different definition of a ULM).

7 Conclusion

In this article, we have presented the concept of 'Unit of Learning Material'. One of the main goals is to achieve reusability of (often expensive) multimedia material. The reusability can be increased by adapting the context of a given ULM to the context it will be used in. The ULM concept can be used in a wide variety of computer-based learning applications. Not only do we expect ULMs to increase reusability of material, we also think that separating educational content from retrieval mechanisms will increase the flexibility of courseware. The content can be changed without modifying the retrieval mechanisms, so that learning material can be easily updated.

Currently, a prototype computer-based learning environment is being developed in which we will test our current ideas of ULMs, and to measure to what extent reusability can be achieved with ULMs.

References

- Elsom-Cook, M. T. (1990). The ECAL teaching engine: pragmatic AI for education. In *Learning technology in the european communities: proceedings of the delta conference on research and development* (pp. 329 – 340). The Hague.
- Olimpo, G., Chiocciariello, A., Tavella, M., & Trentin, G. (1990). On the concept of reusability in educational design. In *Learning technology in the european communities: proceedings of the delta conference on research and development*. The Hague.
- Verhagen, P. W. (1992). *Length of segments in interactive video programmes*. Enschede: University of Twente.