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Functions and Tools in a Distributed Computer Environment for Telematics-Based Learning

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1. Introduction

The aim of this paper is to discuss the functions and tools of an open distributed computer environment for telematics-based learning. This environment is developed under the international project ARCHIMED „Advanced Multimedia-System Architectures and Applications for Educational Telematics“¹. The research and development activities in this project covered the following directions: establishing virtual environment affecting the effectiveness of the used learning methods and systems, the design, integration and testing of telematics-based services; development of new multimedia user interfaces; development of solutions appropriate for different user groups, including ways of visualisation, mobility, interactivity, hypermedia organisation

The following conclusions for the required functionality of a computer environment for educational telematics may be obtained when analysing the educational multimedia courses and the current trends in educational telematics [1, 2, 5]:

- The necessity of interactive use of the multimedia materials, allowing individualised feedback and discussion.
- Extensive use of distributed multimedia resources available on WWW.
- The necessity of effective student navigation according to the student's needs and current state of knowledge.
- The necessity for versatility of composition for fast update and modernisation of educational content.
- The necessity of modular and open-system organisation.
- The need for intelligent assistance in information handling.

The distributed educational environment under consideration is based on conceptual pedagogical model, specifying both the structure of multimedia courses and various ways of their use (for teacher-centred or learner-centred organisation of the

¹ The work reported in this paper has been supported by the EC INCO-COPERNICUS Programme, Grant No PL961060.

educational processes). Many current educational projects for distributed computer environments apply the principles of constructivist pedagogy and use models, based on the following leading ideas [3-5]:

- Learning should be context based, i. e. learning experiences should be contextualised in authentic activities; learning is acquired through making links with existing knowledge.
- Conceptual learning is through active involvement: a task is understood through participation in it.
- Learning is through collaboration with others: sharing knowledge resolves misunderstandings; understanding evolves from shared knowledge constructing;
- Learner should have personal autonomy and control over learning; teacher mediation depends on needs and skills of the learners.
- Specific content and learning outcome should not be prescribed; multiple perspectives of the learning task and different approaches to understanding are needed.

2. Archimed knowledge village and its virtual spaces

The metaphor of ARCHIMED Knowledge Village (AKV) was developed to serve as a conceptual framework for creation of distributed educational multimedia systems. The conception of ARCHIMED Knowledge Village (AKV) is oriented towards development of sufficiently general and open environment which can receive and organise in a comprehensive way an open variety of courses in very different knowledge fields. The ARCHIMED Knowledge Village may support one or more Distant Learning Centres providing distant learning courses. Distant learning centres organise learning activities in a given knowledge field and may be located in a partner site or distributed among a set of sites.

The functions and services of AKV are organised around several virtual spaces (Fig. 1). The decomposition to virtual spaces permits to combine AKV functionally related modules in groups. This decomposition facilitates AKV design and implementation as it focuses the designers' attention on the common information flow and information structures, backed up by the AKV databases.

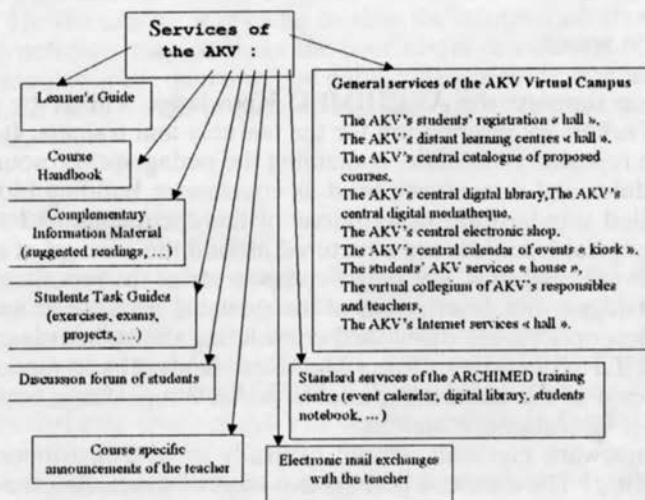


Fig. 1

2.1. Learning space

This space enables the learners to do computer-assisted learning by access to appropriate services via a user-friendly interface:

- The learner uses interactively the produced courses and courseware modules. The courses are organised as applications kept in the distributed depository. During the learning process other learning materials from the virtual library (or Internet) may be used.
- The learner executes the tests and assessments, included in the courses as well as personal assessments, assigned by the teacher. S/he develops projects on the course materials (possibly using other materials from the virtual library).
- The learner exchanges information (questions/results) with the other students, executes evaluation assignments (e. g. peer review), participates in telediscussions and eventually participates in some forms of collaborative learning.

The learning space integrates the educational activities of learners and teachers/instructors around the offered distant learning courses. Each learner may follow a number of courses in AKV, but is registered only to a single distant learning centre. The instructors are employed by the distant learning centre for giving courses. A distant learning centre can have many members, including learners as well as instructors. Learners have to register to the offered courses in order to be able to follow them.

Learners follow courses and participate in examinations. Examination objects can be individual exercises, exams, projects, etc. The learning space supports also examination feedback. Examination feedback relates to an examination object of a course and a learner who has taken this examination. Examination feedback may be achieved by the following elements: discussion messages, examination results, analysis and suggested readings. Feedback messages can be exchanged with reference to an examination object between the learner and the instructor of the course. Examination results involve the evaluation marks.

Learners also participate in groups for doing team work for a course. Learner groups take part in several educational activities in the same way as individual learners do. Examination feedback may be addressed to learner groups taking an examination object

2.2. Information space

This virtual space supports the ARCHIMED Knowledge Village by providing the various types of necessary information for the learners and trainers. Its main part is the «courseware repository» module, containing the pedagogical resources (courses, courseware modules and documents, used as courseware building blocks) together with more detailed standardised descriptions of the documents and access parameters. The pedagogical resources are structured around the concept of a course, consisting of courseware elements. The major components of the repository include:

- User catalogue with descriptions of the available courseware and courseware elements. The descriptions are developed considering the standards of educational metadata (IEEE LTSC Learning Object Metadata standard) and support distributed access and retrieval of the material, available in AKV repository, both for learners and for authors of educational materials.

- The courseware elements, stored centrally or in a distributed way in the courseware database. The database permits two ways of structuring the courses: a/ as electronic books, consisting of chapters, sections, subsections etc. associated with document in any format such as HTML, Word Document, PDF or any multimedia

document format; b/ as sets of lectures, consisting of presentation slides and multimedia material. The data model also allows inclusion of examination material in the courses, consisting of exercises and projects. Simple and complex exercises are considered, the latter category comprising multiple-choice questions, answer matching exercises, interactive exercises and projects.

2.3. Teacher's and author's space

This virtual space supports all AKV activities of teachers and authors of multimedia educational materials.

- The teachers' activities in the ARCHIMED Knowledge Village is to give and organise courses and follow student progress. Course organisation mainly consists of three parts: maintenance and update of general information about a course, maintenance and update of the courseware material and finally organisation of the course reference material in the Distant Learning Centre's digital library. Other instructors' activities include the maintenance of a public calendar of events.

- The teacher monitors the teaching process by offline/online connection with the learners of the group (e-mail, billboard) and has access to local section of the repository with materials for finished/on-going tests, assessments, projects. S/he has access to lists of students questions, memorised sessions of talks 'advisor-student', memorised sessions of peer reviewing. Learner progress follow-up includes the correction of examination material and provision of feedback on learner activities, answering to learner questions and overall evaluation of learners with respect to a specific course.

- The authors create and modify multimedia courseware, by means of the available in the environment authoring tools and using materials from the «courseware repository».

This virtual space is organised through the following AKV modules:

1. The general module « virtual teacher studio » that constitutes the global publishing, teaching and management environment for teachers, instructors and responsables of training centres.

2. The « teacher's desk » module which constitutes an « individualised interface » for each teacher/instructor, helping him to organise his/her teaching activities. The teacher's desk module is the entry point of the instructor in the distant learning environment. He/she can use it in order to view the information about him/herself, about the instructed courses, or about the courseware of a course.

3. The « courseware production and publishing » module which covers methods, services and tools for the publishing and delivery of courseware materials via the World Wide Web.

2.4. Administrative space

This virtual space organises two groups of administrative activities in the AKV:

- Management of the learning/teaching/authoring processes with registration of learners, teachers and authors with appropriate access rights;
- Management of the AKV information resources, including further development of the sites, realising the ARCHIMED Knowledge Village.

The administrative space of AKV is organised through the following AKV modules:

1. The « student's registration » module for the obligatory registration of any user having the intention to follow one or more courses in the ARCHIMED

Knowledge Village. Each student has a login and a password for entering the distant learning centre. In case of registration an entry for the student is generated in the learners' data base, containing his/her identity, login name and a password, as well as personal information and profile. This entry is used further for recording the history of learners' pedagogical activities (courses followed/taken, exercises and evaluation procedures etc.).

2. The « teacher's registration » module for the obligatory registration of any « professional » user having the intention either to build and manage a training centre or to publish via the world wide web his/her courseware materials or again to follow his/her students during their learning phases. Teachers are registered as instructors in a distant learning centre with assignment to courses to be taught. A new instructor is specified by a set of Instructor entity attributes and a corresponding entry is created in the instructors' database.

3. The « generation of distant training centre » module which integrates all necessary services for building, visualising and maintaining a particular learning centre in some specific knowledge field.

3. Classifications of AKV courseware

The implementations of AKV modules reflect the features and intended methods of use of different multimedia courseware, developed under the project ARCHIMED and kept in the AKV courseware repository. The courseware considered in the current project may be classified according to three organisational features, determining the specific features of the courseware content and its presentation. These features are important for the design of the learning environment and of the Graphical User Interfaces (GUI) to AKV spaces and services.

3.1. Classification according to the learners target groups

- Introductory courses

The courses of this class are oriented toward acquisition of initial knowledge for the discipline under study. They may serve as general introduction in the field for non-specialists or as a first basic course in the field, supposed to be followed further by other specialising courses. Usually such courses are built as teacher-centred courses, i.e. they are mainly expositive¹ courses with less attention to interactivity and exercises. The authors of these courses are mostly interested in presenting the content through text and graphics, though some set of tests may also be present in the course content.

- Intermediate and advanced courses

The courses of this class are aimed at deepening the knowledge in the problem area. They often have as a target also skill acquisition and mastering. In the current practice of technology-supported learning there is a strong tendency to develop such courses as active² learner-oriented courses, possessing essential „learning-by-doing“ features. Therefore besides the work on the multimedia presentation of the course content the authors' attention is focused also on its interactive features and on the organisation of exercises and projects, integrated in the courseware.

¹ In an expositive course, the information flows mainly from the resource to the learner. The learners' input to the course is mostly in the form of navigation clicks. Expositive documents are typically used for learning-by-reading.

² In an active course, the information flows in both directions - from the resource to the learner, but also from the learner to this resource. Semantically meaningful input to the computer is expected in the courseware organisation. Active documents are typically used for learning-by-doing.

3.2. Classification according to the courseware organisation as computer application

- Courses, organised as stand-alone applications

Normally the authors use various authoring systems for creating multimedia courseware. Often the end-products of such systems are organised automatically as stand-alone computer applications running under a popular operating system. These applications contain all the necessary multimedia information structures as well as the control sequences for their presentation. A classical inner organisation of the stand-alone applications content is the electronic book organisation.

- Courses with modular organisation

This organisation uses more adequately the possibilities of database technology. It permits easy reconfiguration and generation of variants for different learner groups. It encourages reusability of the educational materials in the courseware repository and is considered more useful for teachers and authors. In the same time this organisation needs more efforts for its implementation, though the use of an appropriate user interface over the distributed database technology may help in courseware production. In the AKV courseware repository the modular course organisation is achieved by set-of-lectures database elements.

Both types of courseware are kept in the courseware database module, realising the courseware repository. In the case of stand-alone applications the users have access only to the whole course, while in the second case different levels of the courseware are accessible: variants of the whole course, different modules, their units („lectures“) and possibly their building blocks.

3.3. Classification according to the course content organisation

- Courses/modules, organised as electronic books/book chapters

This organisation is appropriate for expositive courses. They are characterised with pre-defined sequential navigation through the lessons/exercises, possibly with additional hypertext links. This type of courseware is natural for domains when the verbal content is predominant not only in presentations but also in the learning goals (e.g. in language learning). In this case there is a strong trend to perform assessments in the form a small variety of tests (multiple-choice tests, fill-in tests etc), which may be checked automatically. The authoring systems for multimedia documents offer means, permitting relatively easy to create courseware in the form of electronic book. Such an organisation of the course content requires a small number of control elements in the Graphical User Interfaces, which facilitates their design and implementation.

- Project-oriented courses/modules

This organisation is appropriate for active courses. Their important characteristic is that the learning goals include not only acquisition of knowledge, but also acquisition and mastering of respective skills. Such courses require more on-line interaction with the learning environment in the AKV distant learning centre and are oriented towards learner-centred education. This specific of the course content fits more naturally to the modular courseware organisation. It requires also more user control and therefore supposes the construction of a control panel with more functional elements in GUI. An example of such course type is the AKV course „Authoring computer graphics“ (Fig. 2 and Fig. 3)

The conceptual scheme of the AKV courseware database module makes possible an association of the book and lecture types of content organisation through their finer structural elements, as for a specific course entity chapters and lectures refer to

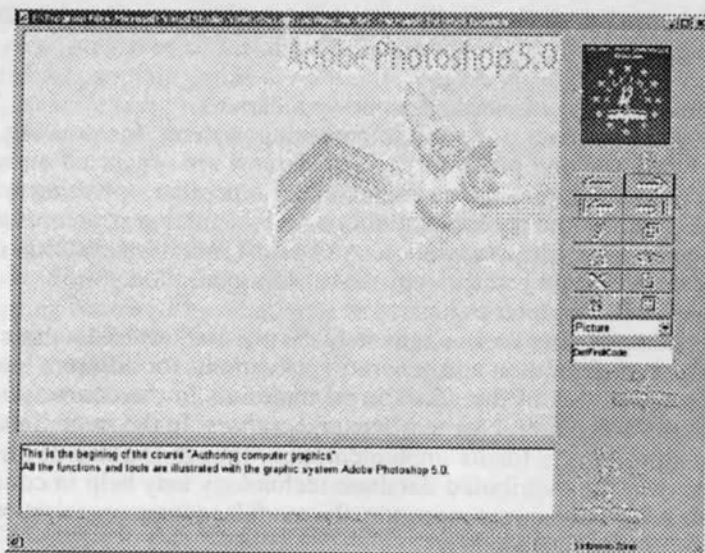


Fig. 2

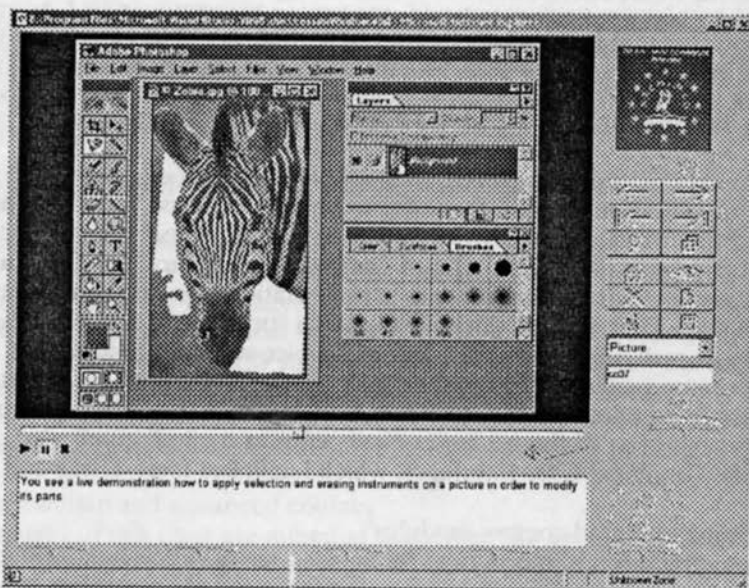


Fig. 3

the same material. In fact the two organisations represent different ways to view or present the learning material of a course. Therefore the same multimedia documents from the database may be integrated in an electronic book courseware or in a modular lecture-based organisation.

4. AKV implementation directions and decisions

The choice of appropriate hardware and software platforms for implementation of AKV modules is based on the analysis of the necessary functions and services of ARCHMED architecture and of the computer and communication infrastructure of the university partners. This analysis leads to the following design and implementation decisions for use of software system and instrumental tools:

- The main modules of the AKV virtual spaces are developed as applications working under the operation systems Microsoft NT Server / Microsoft NT Work Station.
- The multimedia courseware is developed by using different authoring tools like Microsoft PowerPoint, Macromedia Director etc. in accordance with the course content and authors' experience and preferences.
- The prototypes of the courseware repository and other databases are realised using Microsoft SQL Server.
- The organisation of the communications inside and between the learning, teaching and administrative AKV spaces is performed through execution of control sequences (scripts) by the applications - implementations of the main AKV modules. The scripts are written using appropriate scripting languages as Visual Basic Script.
- More complex communication services inside the local computer networks of the project partners, which constitutes instances/subsets of AKV realisation, are to be covered by the product Microsoft Site Server.
- Totally distributed realisation of ARCHIMED Knowledge Village is designed to be implemented with the use of Microsoft Exchange Server on the top of the sketched hierarchy of computer and communication means.

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Функции и средства в распределенной компьютерной среде для цели телематического обучения

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(Резюме)

Цель статьи является обсуждением функций и средств в распределенной компьютерной среде для телематического обучения. Исследования связаны с международным проектом Archimed. Рассматриваются следующие направления: установление виртуальной среды, влияющей эффективности методов и систем для обучения; проектирование, интегрирование и тест телематических услуг; развитие новых мультимедийных интерфейсов; развитие решений, подходящих для разных групп потребителей. Среда основана на концептуальной педагогической модели, учитывая структуру мультимедийных курсов.