

Virtual Universities

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Abstract Due to increasing capabilities and widespread use in the Internet and multimedia, virtual distance learning has become realizable. It gives universities the possibility to reach new student markets by providing multimedia courses and communication techniques to get in contact. To implement a virtual university an evaluation about learning environment requirements is necessary. Thereafter, we can find out how well these requirements are implemented in available applications. Furthermore, we can evaluate existing virtual universities to compare them to each other.

1 Introduction

The fast development in communication technology and multimedia, especially the *Internet* and *WorldWideWeb* (WWW) gave rise to the universities vision of a *virtual university*. They want to offer their courses via WWW over the Internet, making recorded lectures available, provide communication facilities, etc. to follow the demand of people who do not have enough time or money to visit a university personally. Therefore, they have to transport the material directly to the student and to offer communication facilities to their teacher and other students. This follows the trend of distance education to reach more potential students and to support life long learning.

Additionally, it makes material easier available to local students and it gives the opportunity to reach students from other universities, especially from abroad. Therefore, cooperation between universities gets easier.

Another part besides the distance education is the new approach of multimedia in course material. This means the use of text, graphics, audio, video, animation, simulation, etc. side by side to provide better presentation and to make learning more effective.

Following this idea, which elements are necessary to provide a working virtual university? Is it enough to put things only on the WorldWideWeb or is there anything else necessary? Which communication facilities are essential? How should courses with multimedia content be built to be effective? Still some questions remain unanswered about building a virtual university. Therefore, the interworking between computer scientists, teachers, pedagogues, sociologists, etc. is necessary to tackle these problems.

Hence, this work cannot and will not touch and answer these questions. We like to concentrate on the technical part and especially on the learning environment and the communication aspects of a virtual university. However, this does not mean that a virtual university cannot have other elements, of course. It is possible and advisable to connect the learning environment with other internal work like administration to improve interaction and speed it up. However, we shall only take care of the student's sight.

In section 2 we will explain the functionality of a virtual university and try to point out some important points to give a basis for the further text. Section 3 discusses some available learning environments which could be used to realize a virtual university. In section 4 we introduce some virtual university projects to show the momentary state of the art. The last section makes some conclusions and gives an outlook.

2 Features of virtual universities

We focus on features of a learning environment for virtual universities which are visible to students and their teachers. Therefore, we will concentrate on the learning aspect of Virtual Universities and not on presentation, administration, etc. of the university itself which could be done virtually, too.

During the development of the *Virtual University of Applied Sciences* (see section 4.3) an evaluation catalogue of learning environments was created which was based on a catalog from B. Landon [1]. The ideas behind the most important parts of this catalog are explained below to provide a discussion basis for the next section.

The learning environment elements are separated by task to avoid duplicate listing. Therefore, not all elements are necessary for both, teacher and student. Because of the obvious allocation of elements to teacher and/or student there is no further mention.

In the following subsections the *information management*, *communication* and *administration* elements are discussed.

2.1 Information management

The most important part is the access and presentation of the course material. The material may contain multimedia data and, therefore, consists of several different media types such as

- **Text** The text contains the main information and is supported by the other media types
- **Graphics** Graphics illustrate complex coherences in an easier way as normal text could ever do
- **Audio** Supplement audio declarations to a text can support the learning effect
- **Video** Recorded lectures can be provided or complex coherences can be illustrated by using real examples

- **Animation** Animations give the possibility to show things which are impossible to show in the real world like in math, physics or chemistry
- **Simulation** Simulations enable the students to learn by interaction with experiments simulated on the computer

Course material should have help functions for orientation like a glossary, index, content list, content map, etc. Furthermore, students need additional information besides the lecture material, such as *frequently asked questions* (FAQs) lists, special upload areas to provide material found or created by students, archives, own notes on material, etc. These different kinds of information have to be handled. Hence, a database is necessary which has to be configured in a special way to meet these special requirements. Additionally, logging the use of material is necessary to provide statistics for teachers and students. Due to the interaction between universities and high cost of producing courses the interchange of courses has to be considered. Thereby, the import and export of courses or parts of the courses is an essential feature. This can all be summarized under the task *information management*.

Because of the high requirements of information exchange and interaction with other applications a common standard is necessary. For this purpose the *Instructional Management Systems* (IMS) project was founded.

IMS is concerned with standards for learning servers, learning content as well as the enterprise integration of these capabilities.

Overall, the IMS attempts to address three obstacles for providing effective online materials and learning environments:

- Lack of standards for locating and operating interactive platform-independent material
- Lack of support for the collaborative and dynamic nature of learning
- Lack of incentives and structure for developing and sharing content

The version 1.0 work efforts of IMS are organized around the development of specifications in 4 areas:

- Meta-data
- Packaging and Run-time services
- Profiles
- Enterprise integration[2]

Because of the admission of new members with high industrial interest many differences in opinion have lead to a delay in publishing a final specification The release of the specification by the *Institute of Electrical and Electronics Engineers* (IEEE) [3] to reach a IEEE standard is therefore delayed.

2.2 Communication

Due to the distance to the teachers and other students the number and features of communication tools is elementary for the acceptance and success in learning. Interactive communication between teacher and student is necessary, so that the

teacher can look after a student and to give feedback and motivation. Communication between students themselves is necessary to discuss topics, exchange information about the virtual university, the course, etc. and last but not least for social contact [4].

The communication can be divided into two parts, the *asynchronous* and *synchronous* communication. Examples are given below:

- **Asynchronous communication** is required to facilitate access to learning material and other users anytime and anywhere.
 - **e-mail** electronic mail
 - **Newsgroups** Newsgroups on courses, on the Virtual University itself, etc.
 - **CSCW** Computer Supported Cooperative Work includes common calendar, common use and development of documents, etc.
- **Synchronous communication** is event-based and instructor-led like in normal universities
 - **Chat** Exchange of text based messages
 - **Whiteboard** common used text or graphic window
 - **Application Sharing** it makes the sharing of application windows with other users possible. Sharing of mouse control is an additional feature
 - **Virtual Reality** *Multi User Dungeons* (MUDs) with 3D-graphics
 - **Group browsing** All participants including a tour guide can see the same tour in a commonly used window and the interaction between the participants and the tour guide is possible
 - **Audio conference** Audio conference between several participants
 - **Video broadcasting** Broadcasting of audio and video data to users
 - **Video conference** Video conference between several participants

Electronic mail is one of the most important tools for students and teachers at universities to get in touch with each other.

Nowadays, asynchronous communication is widely deployed but synchronous communication, especially with high amount of data like in video conferencing, still faces problems. These problems are mainly caused by the small bandwidth in current networks. However, new technologies like *Digital Subscriber Line* (xDSL), especially *Asynchronous Digital Subscriber Line* (ADSL), *Asynchronous Transfer Mode* (ATM), cable modems, satellite systems, electricity supply modems and decrease in cost of current technologies like *Integrated Services Digital Network* (ISDN) make the use of synchronous communication in the near future feasible. Furthermore, mobile network technology like *Global System for Mobile telecommunications* (GSM) and *General Packet Radio Service* (GPRS) facilitate the use of mobile endsystems [5].

A few possible scenarios of synchronous communication in conjunction with a virtual university are listed below:

- **Teleteaching** In teleteaching a lecture is broadcasted (or multicasted) to all (participating) students. This could also be a recorded lecture.

- **Teletutoring** A person-to-person, normally student-to-teacher video conference to get personal advice.
- **Teleseminar** Several persons are participating a multipoint-to-multipoint video conference where everyone can talk with everyone at the same time. However, coordination is usually necessary because only one person should speak at a time.
- **Telepractical** Access to a real laboratory where the student controls machines or anything else via the network [6].

2.3 Administration

Administration is the third area of a learning environment which is supported by special tools. Furthermore, we summarize the user interface under this point including the material presentation because all elements should be administrated by it.

A short list of tasks is given below:

- **Calendar** A calendar to schedule all tasks personally
- **Account** Account information like personal data, booked and passed courses, booked and passed exams, etc.
- **Schemes** Study schemes, time schemes and dependencies schemes
- **Courses** Tools to plan, manage and monitor course material
- **Lectures** Design and presentation of lecture material
- **Help** Help offered from administrators and teachers

Design and presentation tools for teachers have to be very simple in use because they hardly have enough time to learn how to use them. Furthermore, teachers need a special training in designing lecture material to reflect pedagogical requirements and the right usage of multimedia.

3 Concrete learning environments

The previous section described features which learning environments should fulfill but the problem is the availability of implementations. There are a lot of applications which try to realize learning environments but there are too many similarities between them. A standard learning environment application realizes asynchronous communication, content administration and presentation and rudimentary user administration. The fact that we only know applications which are not web-based is easy to explain because at the moment it is the best environment to bridge the distance gap.

Within the evaluation of learning environments for the project *Virtual University of Applied Sciences* we got in touch with several applications and some of them are presented now.

3.1 Lund University Virtual Interaction Tool

The *Lund University Virtual Interaction Tool* (LUVIT) from Lund University, Sweden, is a web-based learning environment. Documents are organised in a tree structure which is visible in an extra frame or window. The documents can be of different format and are formatted to the *Hyper Text Markup Language* (HTML) if used. Only a rudimentary user administration is available. Available communication tools are email, newsgroups and chat which are developed by Lund.

A common upload area exists for students to propagate documents among them selves. A calendar offers the possibility to administer a personal time schedule and a virtual cafe is supported, too. A rudimentary progress tracking is available where users can see if a document is ever being used, if it is in progress or if it is finished. Additionally, teachers can see how long students have accessed documents. Open answer and multiple choice tests are available.

3.2 Topclass

Topclass from WBT Systems, Ireland, works as an add-on to an existing web server which implements additional services to realise a learning environment over the Web. Therefore, services like access control, user monitoring, coordination of communication are provided.

All Web compatible applications like animations or video conferencing are supported if the applications are installed separately. Each course can be individually parameterized for each student. On the other hand, sharing common parts, is also supported and no duplicate storing is necessary. There is a possibility to create different tests.

It is possible to download learning material in advance to allow offline learning. All material has to be converted to HTML in advance. This is supported by special tools. The converter is mainly designed to convert data from Microsoft applications.

Asynchronous communication via e-mail and newsgroups is supported. Synchronous communication has to be added externally [7].

3.3 Lotus LearningSpace

LearningSpace from Lotus stands for a family of tools which are introduced later. Lotus divides the learning process in distributed learning in the three modes *asynchronous collaborative*, *synchronous collaborative* and *self-paced learning* which should be integrated into one platform. They assume the requirement of scalable management and administration tools and the use of open standards to interact with others. These assumptions fulfill all requirements as described in section 2. The following applications which are all built on top of *Lotus Domino* server are provided:

- **LearningSpace Forum** The forum is the core application which provides all asynchronous services like e-mail, chat, designing courses, content provider, user interface, etc.
- **LearningSpace Live** is based on the *DataBeam Learning Server and Lotus Sametime technology* and provides synchronous communication such as audio/video conferencing, whiteboards and application sharing
- **LearningSpace Anytime** Anytime combines Forum and Live to one environment
- **LearningSpace Campus** Campus provides tools to manage and administer all aspects around the other applications like course catalogs, enrollment, registering processes, workflows and access to external applications, wherefore a broad scalability is given to handle a great number of students

LearningSpace provides an HTML user interface so that only a web browser on the student side is necessary. The IMS project specification of meta data for student profiles and course content is provided by repositories. Due to the use of Lotus Domino no conversion of documents to HTML in advance is necessary.

The LearningSpace Forum is separated into the following five modules

- **Schedule** contains syllabus, assignments and learning objectives
- **MediaCenter** is the knowledge basis of all course related content
- **CourseRoom** is an interactive environment for collaborative work
- **Profiles** student profiles which contains also a student homepage
- **Assessment Manager** instructor tool for tests and surveys [8]

The usage of LearningSpace is being discussed at some universities in the German provinces Sachsen-Anhalt, Niedersachsen and Baden-Württemberg that want to work with virtual courses.

3.4 Evaluation and comparison

The main benefits of *LUVIT* consist in the combined collected presentation of course material. There are only email and newsgroups as asynchronous communication available and only chat as synchronous communication. User administration is very difficult to handle and there are only a few parameters available. A possible problem is the dependency on the Microsoft platform because it was not possible for us to use the menu bar on Solaris neither with Netscape nor with Internet Explorer.

Topclass meets administration requirements of a learning environment well. Course presentation lacks a good user interface because there is a navigation panel missing that would give an overview of the whole course structure all the time. There is no calendar and no synchronous communication possibility.

LearningSpace offers a wide range of communication tools, administration tools, document presentation, tests, statistics, self-assessment, etc., which covers the whole range of requirements. This is only valid if all tools are used.

Only LearningSpace offers synchronous communication and a good statistic tool. *LUVIT* forbids fast administration because it does not provide sufficient

information and possibilities in each administration window. It takes too much time to click through all windows. Topclass manages this better by providing larger sites with all necessary possibilities. A calendar is only missing in Topclass. Tests are provided in all three applications. Ranges of administration features are good in Topclass and LearningSpace. Topclass uses in advance HTML conversion whereas LUVIT and LearningSpace use on the fly conversion.

4 Virtual university projects

We can find a variety of forms under the term *virtual university*. The range starts at a real virtual university with a program degree and goes on to a corporate virtual university between several universities and ends at so called virtual universities like *Motorola University* (<http://mu.motorola.com>) which offers special courses for employees to get further qualifications.

We like to introduce three different projects to show the state of the art in virtual universities. The three examples are chosen to show the conversion from an existing distance learning university to a virtual university (see section 4.1), a virtual university which serves as a portal to a community of universities that offer virtual courses (see section 4.2) and one virtual university which is build from scratch by several universities (see section 4.3).

4.1 Virtual University at the University of Hagen

The University of Hagen is a German distance learning university with more than twenty years of experience. It offers a lot of programs like mathematics, computer sciences, sociology or business administration. It tends to use more and more the computer technology, especially the network technology, to distribute learning material electronically to its students. The aim is to almost replace printed materials and to make the distribution easier and more cost effective. Furthermore, communication techniques offer new possibilities for the interaction between students what leads to a collaborate learning [9].

The following modules build the basis of the virtual university at the moment:

- **multimedia learning software** means software which supports special learning features like simulation, animation, solving mathematical problems, etc.
- **multimedia courses** are old text courses with added multimedia elements and distributed via CD-ROMs
- **courses in the Internet** are like multimedia file courses but offered via Internet
- **video and television** programs are separately available
- **discussion groups and virtual seminars** are asynchronous text based possibilities for discussions and seminars and virtual points for discussions
- **tele conferences in text, audio and video** are used for synchronous communication

- **interactive exercises and tasks** are useful possibilities to give feedback about students progress, especially if electronical support in creation, execution and evaluation is available [10]

This all is integrated into the *virtual university system* (VUS) which is based on the Internet and WorldWideWeb. Standard tools of web browsers like email and newsgroups are used. User interface and general information are created via HTML. Course material can be of type HTML, postscript, *portable document format* (PDF) and *Toolbook* applications. For synchronous communication the *internet relay chat* (IRC) and Internet based video conferencing tools are used.

The VUS implements its own learning environment which consists of the following elements:

- **Education** allows participation in courses, seminars, etc. and use of communication tools
- **Office** includes administrative functions
- **Information** contains general information about the university
- **News** a campus wide blackboard
- **Research** gives access to all research materials of the university
- **Cafeteria** offers a forum for social contacts
- **Library** access to the Library
- **Shop** a shop to get material offered by the university [11]

The virtual university is accessible at <http://vu.fernuni-hagen.de>.

4.2 California Virtual University (CVU)

California Virtual University (CVU) is a project of the *California Virtual University Foundation*, a distance education consortium of higher education institutions of California, founded in April 1997. It was established to meet the needs of California which is a highly Internet-oriented state and has a high number of post-secondary students.

All courses are reviewed by the *Western Association of Schools and Colleges* (WASC) to provide a high quality standard to students. A fundamental principle of CVU is the campus responsibility. Each campus retains its political, regulatory and fiscal environment what includes all around courses and programs like degree requirements, academic terms and nature and scope of their offerings,

CVU is designed as a central broker of information about distance learning, concrete courses, degree programs, etc. offered by participating institutions. Therefore, a common web page (<http://www.california.edu>) was designed which provides links to participating institutions, search engines for courses and general information. To get concrete information or to enroll you have to go to the appropriate institution wherefore no central place is given to gather all information and execute all communication. Therefore, each institution can use its own learning environment, for example, *Rio Hondo College* (RHC) retails the *Rio Hondos's Virtual College* which uses Topclass (see section 3.2) as learning environment. It is available under <http://www.rh.cc.ca.us/online/index.htm>.

4.3 Virtual University of Applied Sciences

Virtual University of Applied Sciences is a project of a German consortium of about 13 universities of applied sciences, 2 universities and several industrial partners. The project leader is university of applied sciences of Lübeck and it is supported by the *Bundesministerium für Bildung und Forschung* (BMBF) under the *Leitprojekt* (leading project) “Nutzung des weltweit verfügbaren Wissens für Aus- und Weiterbildung” (use of world wide available knowledge for education and further training). It started in January 1999, and intends to **implement** and **run** a virtual university of applied sciences (<http://www.vfh.de>). They provide unitized subjects and further training with systematical support of multimedia techniques and networking to use world wide accessible knowledge. Hence, two agencies for programs and further training will be founded by the 13 universities of applied sciences to run the virtual university. It is intended to invite other universities of applied sciences to join later.

At the beginning two subjects of study *multimedia systems* and *economic engineering* with a Bachelor and Master degree will be implemented. The degrees have to be internationally accepted. Contrary to a complete virtual concept it is intended to realize a mixture of virtual and present studies. The effectiveness of this combination has to be evaluated and, if necessary, to be changed. As an aim of the whole project, the appliance of new teaching and learning methods as well as the new technology support has to be evaluated. Hence, a learning environment has to be bought first and adapted to the requirements as described in section 2. To use course material for further training, to reflect real demand, to facilitate easy maintenance and provide material for further training course material must be split into smaller stand alone modules. If possible it is intended to buy modules or whole courses from other institutions to support the use of world wide knowledge. This mix on module or course level between own and bought material is a fundamental requirement.

One main objective is it to provide an alternative to existing programs and further trainings and not only to offer an additional distance learning option. It should replace present programs and trainings and, therefore, the use of **multimedia** and **telematic** in conjunction with new **teaching** and **learning methods** are fundamental to have success. Consequently, main work is centered around these three areas. Nevertheless, tasks like marketing, building programs and agencies have also to be considered.

4.4 Evaluation and Comparison

As we saw in the last section, there are a lot of different kinds of virtual universities.

The first virtual university was developed on top of an existing distance learning center. Therefore, existing material and teaching methods have to be adapted to the electronic environment. Hence, the full power of new technologies cannot be used. Additionally, the use of old methods with new technologies can lead to a decrease in quality. Another problem in our opinion is the fact that the

learning environment is completely implemented by the distance learning center. No available commercial learning environment was used. This gives freedom in implementing but costs too much time and money which could be better invested into course material improvements.

CVU is not a virtual university in its proper meaning. It is a portal to a collection of offers which are not presented in a complete, uniform and consistent manner. For example, users can detect each participating institution, use different learning environments with different quality and functionality and work under different rules.

The Virtual University of Applied Sciences implements a virtual university from scratch wherefore no existing constraints have to be considered. All offered services are available through one entry point and all participants are hidden behind them. Therefore, users have a consistent, uniform and complete overview. Course material can be imported from other institutions [12].

The three approaches differ in following points (see table 1).

	Virtual University at University of Hagen	California Virtual University	Virtual University of Applied Sciences
participants	one	many	several
learning environment	own	different	one
visible participants	one	many	one
existing institutions	yes	yes	no
course import	no	unknown	yes

Table 1. Virtual university differences

Participants mean participating institutions, for example, Virtual University at University of Hagen is autonomous whereas CVU consists of many institutions.

Used *learning environment* differs in all three examples. CVU makes no assumptions about learning environment because each institution is responsible for itself. The Virtual University at University of Hagen makes its own learning environment and the Virtual University of Applied Sciences uses exactly one learning environment but not necessarily self built.

Visible participants means how many institutions are visible to users. Only CVU users can see all institutions involved.

Existing institutions shows if there existed anything before the project virtual university has started. It is important to know dependencies on existing conditions which influence decisions.

If *course import* is possible course material from other institutions can be used. Because each institution is responsible for itself in CVU we cannot evaluate that point.

Last but not least we like to name other virtual university projects which have not been mentioned so far. The *Open University* (<http://www.open.ac.uk>) got

a lot of honours for their courses and is the English equivalent to the University of Hagen. It offers a wide range of subjects. *Western Governors University* (<http://www.wgu.edu/wgu/index.html>) is also a portal for institutions in the Western United States. Contrary to the Open University or University of Hagen and like CVU, *Electronic University Network* (<http://www.wcc-eun.com/wln/campus/eun/index.html>) is a portal for a collection of universities which offer distance learning with support of computers since about 10 years. *International Tele-University Germany* (INTUG) (<http://itu.ira.uka.de>) is comparable with the Virtual University of Applied Sciences because it consists of 4 universities which try to build a new institution that offers courses to international students who can study from their home university [12]. *VIRTuelle Universität Ober-Rhein* (VIROR) and *Virtueller Hochschulverbund Karlsruhe* (ViKar) are part of the program *Virtual University* (<http://www.virtuelle-hochschule.de>) sponsored by the state of Baden-Württemberg. They like to use new technologies for education and to extend their local programs by virtual courses from participating institutions.

5 Conclusions

Further development, acceptance and success of virtual universities is dependant on the offered elements as shown in section 2, the applied learning environment (see section 3) and the institutional form. A high range of elements, a good integration of these elements with an easy to use user interface and a integrated, unique offer of high quality multimedia course material by one institution is a promising way to success. This should be embedded into a *flexible, scalable* and *open solution*.

However, to reach this objective the communication infrastructure has to be widely deployed. Hence, new techniques like ATM and xDSL have to be implemented to overcome the small amount of available bandwidth. This would make synchronous communication more usable. Furthermore, the use of multimedia in education has to be increased wherefore teachers have to be instructed in using multimedia right. All this requires *new pedagogical methods*. If all these conditions are fulfilled virtual universities could be successful.

Present universities shall not be replaced, they should, however, use multimedia technology to provide better courses. A virtual university cannot replace the atmosphere of a real campus which offers more than only knowledge. Students like to socialize because they are not only a community to learn something. Therefore, virtual universities offer new opportunities to a high number of potential students but it will not replace the good old present university [13,14].

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