

Virtual Campus Project - A Framework for a 3D Multimedia Educational Environment

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ABSTRACT

Virtual Universities at present generally focus on formal and functional aspects. The Virtual Campus Project has the intention to consider social facets of the student's life as well. The main goal of this experimental project is to create an educational communication and collaboration environment for the „ViKar"-Distance Learning University Project. This environment should not only provide all needs and functionality for the students but also serve as some kind of „social interface“. Our actual approach is less technical but more conceptual as well as regarding content and design. Besides that we're doing research in exploring the surplus values of three-dimensional multi-user virtual environments. For the creation of a 3D-VR-environment we propose a new definition of spatial structures, a special imagery and features for orientation, communication and collaboration. Finally we present our current prototype as an experimental platform to realize these proposals.

Keywords: Virtual Campus, Virtual University, Virtual Environments, Distance Learning, Educational Applications, Virtual Reality (VR), VRML, Multi-User, Shared Virtual Worlds, Collaborative Virtual Environments (CVE), ViKar

1 INTRODUCTION / BACKGROUND

The Virtual Campus Project is a part of the „ViKar“-Project in Karlsruhe, Germany, which intends to promote the developments in distance learning research [12]. „ViKar“ is the „Virtual Association of Colleges of Karlsruhe“. Besides the 6 institutions of higher education in the Karlsruhe region the Center for Arts and Media Technology (ZKM) is a partner of this project. It aims at

- building a virtual college with a high degree of social interactivity
- developing multimedia based teaching modules which can be adapted to different needs by reusing and reassembling parts of them
- developing appropriate didactical methods
- the extension of the available educational supply of the six institutions of higher education as well as the extension of the supply of advanced vocational training in the Karlsruhe region of technology (in collaboration with companies)
- providing the necessary technical infrastructure in the Karlsruhe area.

In addition to the Virtual Campus Project the main development trends of „ViKar“ are the development of a text and multimedia based learning environment, the creation of modularized learning content and the further development of an existing learn-server, which provides students with all necessary scripts and materials. Finally all components are going to be integrated in the superior infrastructural layer for the end-user, the virtual campus.

2 THE SIGNIFICANCE OF A VIRTUAL CAMPUS

Distance learning universities at present generally focus on formal and functional aspects of teaching and learning. The usual way to present a virtual „campus“ is a two-dimensional webpage with an image map or a collection of links to all available functions.

With the Virtual Campus Project we intend to go a step further: Experiences gained from running a large university department and local preliminary inquiries into students' needs point out a strong demand of social interactivity and the importance of psychological aspects like well-being and identification. Therefore it's

not enough to regard the formal and functional aspects while creating a virtual university, the social and emotional aspects are extremely important and have to be considered also. Accordingly the basic goal of the Virtual Campus Project is not only to provide all necessary functionality, but also to integrate the students' social needs.

The very first idea for the virtual campus of the „ViKar“-project was a sketch showing a central communication area surrounded by elements like library, learn server, student's workplace, administration etc. This figure already points out the importance of communication.



Figure 1: First virtual campus sketch

Communication and also collaboration are the basis of information exchange, team work and social life. A virtual university should offer more possibilities than text-based chatrooms and newsgroups. From this starting point we created the idea of the virtual campus as a kind of „social interface“. Besides the central needs of communication and collaboration, which are main subjects of the project, the virtual campus should enable the students' identification with the virtual university like a real campus does in built reality. Furthermore the realization of the virtual campus has to overcome anonymity and accordingly has to create a sense of community and solidarity.

3 APPROACH

Resulting from the above mentioned demands the need of a campus concept different from usual concepts like pure image maps or link collections is evident. A corresponding concept for the virtual campus basic structure could be a web-based three-dimensional virtual reality multi-user environment, combined with multimedia content and two-dimensional information

where it is appropriate. Such an environment is highly visual and spatial. It could add a new dimension to social interaction on the internet, and it is certainly a forerunner of the multimedia experiences to come. [8]

For this reason we built an experimental VRML test platform for work in different research fields and for continuous integration of new features made possible by technical progress. The near future vision is to have a multi-user communication and collaboration environment which enables audio communication and shared objects.

At the actual state of the project our approach is less technical but more conceptual as well as regarding content and design. The current work concerns the following issues:

- exploration of possibilities and surplus values of virtual reality combined with multi-user technologies
- spatial structures and formative design
- orientation and navigation
- communication and collaboration
- content for an educational environment.

3.1 ASPECTS OF VIRTUAL REALITY AND VR MULTI-USER ENVIRONMENTS

One of the primary goals of the Virtual Campus Project is the research into the potential and the surplus values of three-dimensional virtual reality and spatial multi-user environments. After intensive investigations and tests in this area we found the following aspects very useful and interesting for the realization of the project:

- VR-environments allow free navigation in 3D environments as known from physical reality.
- The user can interact with objects and other persons in real-time.
- Several senses are reached at the same time; while interacting in different ways the overall context is preserved.
- Multi-user systems provide additional possibilities of communication and collaboration (more about this aspect see below).
- A social framework can be created by establishing a virtual community and by providing a supply of social interaction possibilities.
- A better understanding of complex structures, connections and processes can be gained by three-dimensional visualization and interactive models.
- VR offers new ways of data visualization and search for information: spatial arrangement of information instead of linear order, the possibility of non-selective search, navigation through information etc.

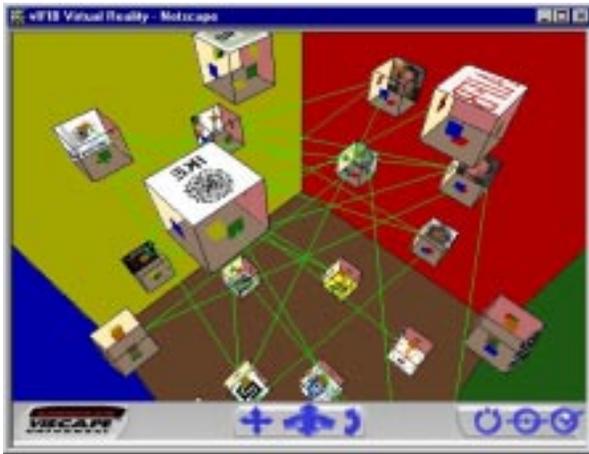


Figure 2: VR based information system in the former project „Virtual Institute“ [5]

Nevertheless, building a VR multi-user campus does not necessarily mean to have a three-dimensional graphical user interface only. Rather the selective and appropriate use of different media, a combination of a three-dimensional multi-user environment with multimedial and text-based content is reasonable to establish a complex and useful educational environment.



Figure 3: Combination of VR and hypermedia in the former project „Virtual Institute“ [5]

3.2 SPATIAL DEFINITION AND FORMATIVE DESIGN IN VIRTUAL SPACE

Space, shape and design get a new meaning in virtual worlds of cyberspace. The meaning is quite different from the experiences in the physical reality. This results from both the new possibilities of virtual reality and the conditions for the creation of virtual worlds.

In this context information, communication and collaboration are the basic elements of distributed multi-user worlds. To meet their requirements, new concepts, structures and metaphors have to be developed. These should allow an extensive abstraction on the one hand and a sufficient appeal to the users' capability of association to enable orientation and navigation on the other hand.

In virtual environments objects and buildings, which are reproduced close to reality, could be useful for representation and for orientation in advance, e.g. for students who want to visit the real components of their distance learning university. But generally, for pure virtual environments there's no need to have conventional buildings with long corridors, stairways etc. just to reach an information, a functionality or a place of interest.

For the creation of the virtual campus we propose a new definition of spatial structures and a special imagery, away from reproducing reality in cyberspace. The spatial structures and the imagery of our environment are reduced to functional needs, but they should also help the user to find his way around in the environment. The definition of space and the spatial demarcation are not performed as walls or fences, but by means of linear structures, lines, panes, thin wrappers or even by applications, e.g. by aural perception of a sound when entering a special area.

The metaphors for buildings and areas are differentiated between „open“ and „closed“ structures. The extensive use of open structures and „transparent“ boundaries gives the user a spacious horizon, which is helpful for enabling a good orientation and maintaining the overall context.

Moreover we propose the use of „object classes“, comparable to classes used in object orientated programming. These classes can be used for objects with similar base functions, differentiated in attributes like appearance, shaping, colors or design details. The use of such classes enables both the recognition of functionality and the differentiation of landmarks for orientation.

3.3 ORIENTATION AND NAVIGATION

Orientation and navigation are central issues in virtual worlds. In complex worlds available it is often very difficult for the user to find his way around and to know where he is located. Accordingly new ideas and features have to be developed to support the user's orientation and navigation. Besides the orientation related aspects of structure and design mentioned in chapter 3.2 we propose a few more features in this area.

One important aspect is the ensuring of a spacious horizon, corresponding to the human visual perception in physical reality. This not only a question of the appearance of objects, it also depends on the appearance of the VR-browser frame as part of the web-browser window. The frame containing the virtual world should be dimensioned about three times wider than high to avoid a restriction of the horizon and to replace the horizontal eye movement in reality.

To avoid getting lost in complex virtual environments the user needs more information about the site and his position than he could see in the limited horizon of the VR-browser. We propose an additional two-dimensional sitemap, showing a ground plan and displaying the users position at runtime, as a very helpful tool to maintain an overview. This sitemap can be used not only as an orientation tool, but also as a graphical navigation interface. By applying clickable symbols for the main landmarks of the environment the symbols can be used for navigation similar to a viewpoint list. In this way the user can navigate quickly and directly to points of interest without searching in the virtual environment.

Moreover the navigation interfaces of usual VRML-browsers, e.g. the CosmoPlayer dashboard, that we currently use for our test environment, seem not to be satisfying. One of the general advantages of virtual reality should be the intuitive navigation through three-dimensional environments also for inexperienced users, but most available interfaces do not meet these requirements. Accordingly we have planned the development of a different, more intuitive interface for a later phase of the project.

3.4 COMMUNICATION, COLLABORATION AND SOCIAL INTERACTION

A well working and functional distributed communication and collaboration environment - which is not given by providing only IRC (Internet Relay Chat) and newsgroups - is essential for a virtual university. Therefore there's a strong need for concepts

in functionality and content to make such an environment possible and to fill it with life.

An important advantage of virtual 3D environments is the integration of visual perception. This should be used to offer the additional possibilities of mimic and gestures to communication. Using these options is necessary to underline emotional expression and helps overcoming anonymity.

As a result of case studies in some 3D multi-user environments found on the internet it turned out that text-based chat is not very functional in these environments. Although while communicating in 3D-environments there were stronger emotional reactions of the users than in two-dimensional IRC, it was evident that the users couldn't take much advantage of the visual component of the 3D-environment. The users had to bundle most of their attention on typing chat text and regarding the conversation in the chat window. This points out the need of speech communication using multi-way audio. To overcome confusion by multiple participants using audio communication, there are several approaches. One idea is to limit audio to a pre-defined circuit around the user. This means that one could hear or talk to others only if they are situated within a certain distance. The better alternative to be developed would be an audio communication system which can locate the position of users and translate this in different levels of volume. So the user should hear others standing near to him louder than the ones more far way. Anyway, a minimum of possible confusion will resist like it does in physical reality.

But a chat-room in a 3D environment is not enough to make a world a useful multi-user environment, independent of the way of communicating: The environment has to offer different communication areas with different terms of use. Apart from having a public chat area there have to be forums which are related to a location or a subject as well as predefined meeting points. Besides providing different areas it's important to offer different levels of communication. Additional to a central communication area for public chat, where people can meet spontaneously and casually, there should be possibilities to limit the number of participants by spatial definition of a chat area or by inviting only selected persons to a conversation. Even single-user areas in a multi-user environment are reasonable for explicit applications, e.g. for information research and learning.

For collaboration reasons it is important to have shared persistent objects. The users need to have the possibility to modify the environment or single objects, other users should be able to see these modifications

synchronized in real-time. Furthermore the changes have to be persistent, so anybody could notice them after re-entering the world at a later time, even if all former users have left the world.

Finally, the above mentioned issues of communication and collaboration enable a lot of possibilities for content and social interaction. For the Virtual Campus Project among other things we think of

- a central communication area and a network of connecting routes for casual meetings, also while walking from one component to another
- virtual lectures, seminars, presentations, discussions and other collaborative virtual events
- single-user areas for the personal workplace and learning environment
- exhibition areas for non selective information and communication
- a student's house for collaborative learning and exercising
- shared whiteboards, slide projectors, video screens
- three-dimensional demonstration objects
- portable objects a student can take to his personal workplace
- generation of temporal working rooms with individual parameters

This means, besides functional aspects we want to offer different components that enable social life at the virtual campus. When realizing the campus as a kind of „social interface“, it will be unavoidable to have some means of social control, for instance behavior rules, an „ignore“-option for the user, if he feels disturbed by another user, or a „kick-off“ option as a final means for the administrator.

4 CURRENT PROTOTYPE

The Virtual Campus Prototype, our three-dimensional VRML test environment, combines spatial structures with collaborative content, multimedial elements and two-dimensional webpages. Its current implementation is a combination of VRML 97, JavaScript 1.2 and HTML 4. The environment has been developed for the CosmoPlayer 2.1 plugin running in Netscape 4.5 on PC platforms.

The actual virtual world is developed for the use with a multi-user system, but multi-user functionality is not implemented yet. A test implementation is planned after some more conceptual work. In our current prototype we tried both to implement some of the above mentioned proposals and to indicate several ideas to be examined or realized in our future work.

4.1 WINDOW PARTITIONING

The graphical interface of our prototype is a window divided into three frames, each frame having different characteristics.



Figure 4: Frame structure and Pyramid's Place

The navigation-frame at the upper left of the window is the user's guide to the world. To overcome the problems of linear navigation in the virtual world a sitemap is used. The sitemap contains a structured overview of the entire world, all landmarks of the world are directly accessible by clicking their symbols. Additionally the user can always find out his current position within the world by using the appropriate button. Three more buttons serve for reloading the site, getting text-based help and starting an Internet Relay Chat, which is reachable from the whole campus world.

The virtual world frame at the upper right contains the 3D-campus and all connected worlds. The world is realized without any default routes in order to enable selective navigation. The aim is to bring the user to the desired information in an enjoyable manner and to give him the possibility to meet other people. As a result we hope that the user becomes more interested in the educational environment and accordingly will increase the number of revisits.

The information-frame is located at the bottom of the window and contains mainly text-based information or forms, but multimedial content or other virtual objects can be displayed here as well. Generally, when the user approaches a component in the campus world a new page is loaded in this frame. This page contains detailed information on functionality depending on the appropriate location.

4.2 BASIC STRUCTURE OF THE VIRTUAL CAMPUS

The basic shape of the virtual campus, a circle with six surrounding elements, is derived from the logo of the „ViKar”-project and is a symbol for the unity and the equality of the six colleges in this union. The circle is divided into three main areas. The inner zone of the structure represents the central communication and collaboration area, the middle circle is an area of subject-related information and location-related communication and the outer circle stands for a pure information area. In the center of the whole circle structure a pyramid can be found, the symbol of the city of Karlsruhe and for the „ViKar”-union. Six radial streets, starting from this center, connect the three main areas.

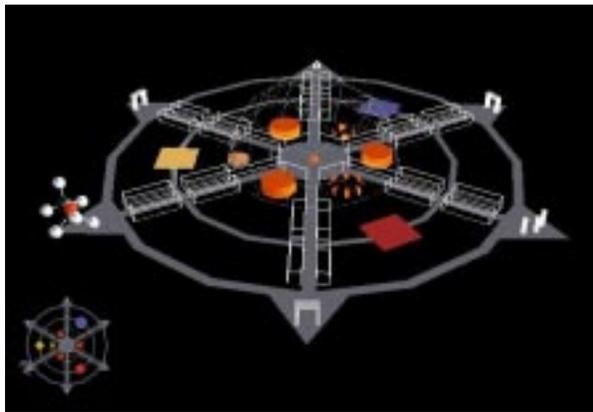


Figure 5: Basic structure of the virtual world

The most important components for communication and collaboration in teaching and learning are positioned around the central Pyramid's Place. The outer information area provides components for information and learning which can be used in a single-user mode. The in-between zone, the middle circle, contains discussion forums and exhibition areas.

4.3 THE CENTRAL COMMUNICATION AND COLLABORATION AREA

The central communication and collaboration area contains the Pyramid's Place and its surrounding components. The area is spatially defined by a transparent dotted dome.

4.3.1 Pyramid's Place / 2nd level campus

The Pyramid's Place (see figure 4) is a central location for communication, derived from a real campus. The students can meet casually and have a non-selective conversation while crossing the place.

The pyramid in the center of the place works as a „beamer” to another level of the virtual campus. At this second level the virtual world represents the six colleges close to physical reality. The basic structure is similar to the first level: the colleges are positioned at the outer circle as termini of six radial streets. This world is used for representation of the colleges and for preliminary orientation for students before their visit in physical reality.



Figure 6: Virtual representation of the Faculty of Informatics at the University of Karlsruhe

4.3.2 Surrounding components

The surrounding components of the Pyramid's Place on the first level campus are differentiated into two formal groups, depending on appearance and content. The three components „auditorium”, „bulletin board” and „multimedia lab” belong to the group of open structures. They have a different appearance, but the spatial demarcation of their areas is defined by linear structures, which allow a transparent vista through the components. The other three components „administration”, „seminar building” and „student's house” are closed structures with an orange wrapper of the same appearance. Inside these components selective communication takes place.

Auditorium

Lectures, presentations and official gatherings take place in the auditorium. The video screen offers to reuse films of former lectures and probably live video streaming in the near future. At the current state a video begins to run as soon as someone enters the area of the auditorium and only the users inside this area can hear the sound of the video. This means an additional spatial definition by function.

Administration

The administration building area is planned to offer all administrative options a student, a staff member or a visitor needs, e.g. getting information, registration for the „ViKar“-college, modification of personal information, registration for exams or download of general materials.

Multimedia Lab

The actual multimedia lab indicates a place for students to present their work in progress on several virtual terminals. This presentations can be used for discussing the projects with other people.

Student's house

The student's house is established for collegiate working groups to collaborate. The students pick their exercising room depending on the project or subject they're working on. The rooms are equipped with whiteboards, so students can illustrate their ideas. Furthermore the students can use a virtual object for discussion and exercise. The objects can be uploaded from the computer by using an appropriate form in the information-frame. Before uploading the chosen object has to be scaled and positioned by using the form.

Bulletin board

The actual prototype indicates the idea of realizing a bulletin board in a three dimensional environment: Four boxes contain boards with predefined advertises; learning groups, travelling, assistant jobs and general. If the user finds an interesting advertise he can click on it and response by mail. After the realization of this idea the user should also be able to use a form in the information-frame to send his own advertise to be loaded on the bulletin board.

Seminar building

Within the seminar building users can enter already existing rooms or even generate new temporal rooms for special needs after presetting individual parameters.

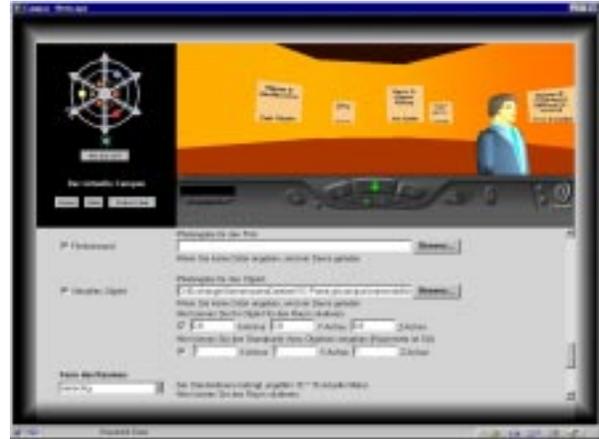


Figure 7: Room generation form

An input form in the information-frame offers options for presetting the shape, dimension, color and duration of usage of the new room. Furthermore the user can define which components he wants to be loaded into the room. The form offers a choice of whiteboard, slide projector, video screen and a virtual object. Slides for the projector, movie files for the video screen and virtual demonstration objects can be uploaded by browsing on the own computer. The objects can be scaled and positioned in the same way as in the student's house.



Figure 8: Generated seminar room with slide projector, video screen and demonstration object

After sending the form the room will be generated. The idea is to store this temporal room on the server for the predefined duration of time. The option of generating new rooms should be reserved to tutors or staff members, for instance by password protection. Additional ideas are limiting the usage of the room to certain persons, e.g. participants of a course, and automatically sending e-mail information to participants when creating a new room.

4.4 THE MIDDLE CIRCLE

Within the in-between zone of the middle circle the user can find selective communication and non-selective information. There are three colored places that serve as discussion forums. Here we use the above proposed „object classes”: The places have the same function, but they’re differentiated in color and appearance.

The user becomes aware of entering a place because of its spatial definition and the height limited by some kind of roof. In our current prototype an IRC window appears within the information-frame. Only the people located in the same place at the same time can chat together through this channel. All discussion forums are equipped with a whiteboard which the participants can use in their discussion.

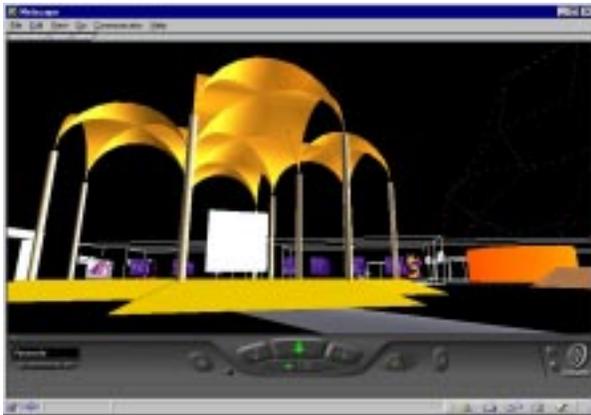


Figure 9: Yellow forum with whiteboard

The radial streets with abstract exhibition areas on both sides also belong to this area. Inside the galleries, which are defined by line structures, all kinds of objects or information can be presented. The galleries could show for instance finished students projects, college developments, research results and artwork. By approaching or clicking objects or images further information and multimedial content can be displayed both in the virtual world and in the information-frame.

The user is invited to rummage among these objects and to gain some new information, cultural experience or inspiration for the own work. By the way the exhibitions can add cultural components to the virtual campus as well as they encourage casual communication. With changing exhibitions the user is also motivated to come again and look for new presentations the next time.



Figure 10: Radial street with exhibition area

4.5 THE OUTER CIRCLE

At the outer circle there are three components that deliver information to the student. They are planned to work as single-user areas for learning and research. The components „knowledge tree”, „search engines” and „personal workplace” alternate with the three exits at the end of the radial streets. All components in the outer circle serve as experimental objects; they are not yet elaborated.

Knowledge Tree

The symbol used for knowledge is a model of molecule. By clicking the molecule a connected abstract world containing a cone tree is being loaded into the world frame. By clicking the elements of this cone tree all subjects the student can study and all courses he can participate are displayed in a three-dimensional hierarchical order. Using this cone tree is an experiment with 3D data visualization, we are not sure yet if this could be more reasonable than a two-dimensional information display.

Search engines

Here the user can gain information by applying three different search engines for the internet, the internal databases and the electronic library of „ViKar“. The actual representation serves as a presentation of this idea and is to be developed further.

Student's personal workplace

Each student needs a personal workplace. The workplace is symbolized with a linear structure containing a computer display. By clicking this display the student loads both the workplace in the virtual world frame and the appropriate HTML-interface in the information-frame.



Figure 11: Student's workplace

The working place could offer interfaces to the learning environment and other „ViKar“-components, an interactive personal profile with 3D display of the student's actual status of studies (see figure 11), the storage of collected 3D exercising objects, buttons to access software, an address book, the college's newsgroups, an overview of grades and a lot of other features.

5. CONCLUSION AND OUTLOOK

In this paper we discussed the requirements for a virtual university campus considering social needs. We described the possible advantages a 3D virtual reality multi-user environment can contribute to a virtual campus and suggested the combination of a virtual world with multimedial and text-based content. In our opinion, a lot of solutions in the field of large-scale 3D virtual worlds are not satisfying concerning the issues of design, orientation and navigation. For these issues

different features and strategies have been proposed; the implementation of these means is presented in our prototype, as well as some content components for a virtual campus environment.

Regarding the aspects of communication, collaboration and interaction we defined requirements for the Virtual Campus Project. The available systems we tested so far do not meet these requirements at present state. But we're optimistic that technical progress in the near future will offer particularly higher bandwidth and usable solutions to realize our vision of a collaborative, social interactive virtual campus with audio communication and shared persistent objects.

Our future works will contain further research in the design of virtual environments, especially in the psychological aspects of shapes and colors as well as in issues of orientation. After some more investigations in VR multi-user systems one of the next steps will be the test implementation of our prototype in a multi-user system. On this basis we're going to do some case studies with students using this environment.

Apart from these investigations we will work on the realization and implementation of suggested ideas, features and functions. Furthermore the integration and the cross-linking of other components, which are currently developed in the „ViKar“-Project, are main tasks to establish a holistic educational environment.

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