From Virtual University to Mobile Learning on the Digital Campus: Experiences from Implementing a Notebook-University

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ABSTRACT

For some time the virtual university was in the focus of interest - a university which stands in competition with the "normal" physical university. Students can learn whenever they want and from wherever they want. Experts from all over the world generate the learning material which is in a digital form and is distributed via the internet. The learning activities are also supported by (tele-) tutors using the internet. The tutors answer questions, discuss the content and help solving problems. In this scenario it is not necessary that the students come to a real campus.
In a Notebook-University the focus changes from a virtual university to a digital campus. The digital campus does not stand in competition with the real campus. It is rather an expansion of the physical campus. The goal is to overcome the gap between the physical and the virtual world.

Keywords: notebook-university, NBU, virtual university, ubiquitous computing, change-management, media didactics, blended learning arrangements

INTRODUCTION

The eCampus-project of University of Duisburg-Essen was funded with 1 Million USD in the period of 2002 / 2003 by the federal ministry of science and education in a national program on "Notebook- Universities". The funding allowed us to explore different scenarios which were supported by Notebooks.
To change a traditional university into a Notebook-University (NBU) it is not enough to buy notebook computers for all lecturers and students. The necessary activities have to be organized and follow a timetable to get the intended effects.

CHANGE MANAGEMENT

Kerres [1] states the following four areas in which activities have to take place to implement media projects sustainable into an educational organization like a university.
First, there is the area of *Infrastructure* to be named. This refers to both the hard- and software equipment and the development and offering of services concerning this new equipment.
The area of *Organizational and Human Resource Development* creates the necessary structures and abilities for the users and therefore enables and secures the use of the new environment.
The field of *Didactical Reforms* concerns the influence of new media on already existing learning arrangements and their contents.
Last but not least, the area of *Media Development* and the later following *Distribution* play a more or less important role (s. Figure 1).

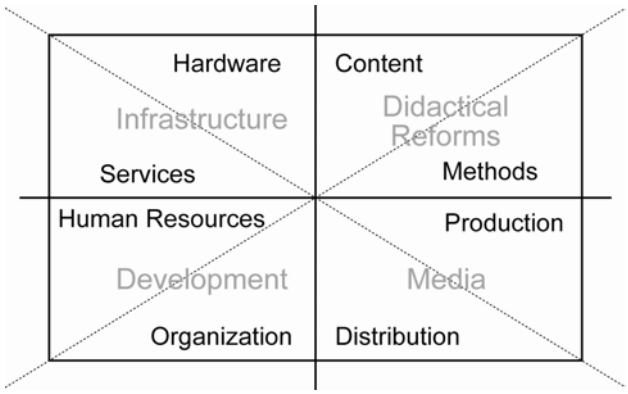

Figure 1: relevant sectors for generating sustainability [1]

The activities in the different areas are to be brought into a balance. For example,. it is little use to invest into an extensive equipment if there isn't taken any or just little action in the area of human resource development and the lecturers are either not able to operate the technique or have prejudices to use the equipment in their seminars. Moreover, the activities have to be timed successively to gain the desired effects.
In our case, enough laptop computers should first of all be available before starting to use them in the learning environment. The Infrastructure of the WLAN (Wireless Local Area Network) should also work largely first, because the notebook computers are only able to become a powerful tool with the access to the internet, e.g. in Learning Communities, Knowledge Sharing or CSCL.

DIFFERENCIES BETWEEN VIRTUAL AND NOTEBOOK-UNIVERSITY

	Virtual University	Notebook-University
Learning environment	virtual	blended learning arrangements
Organization	virtual	virtual
Media	didactically designed	mostly not didactically designed
Communi-cation	virtual with chat and mail	as well face-2-face as virtual
Cooperation	CSCL via a learning management system (LMS)	As well real as via a platform / tools
Focus	24/7, independent from place	Ubiquitous access to services and information

Table 1: Differences between Virtual and Notebook-University

The concept of virtual universities was discussed more intensively since the middle of the nineties, because of the better and easier access to the internet. A virtual university is a university that exists parallel to the traditional university and is presented digitally in the internet.
The idea included the hope of unlimited resources of learning material for students designed by the best scientists and researchers. The concept assumed that the world-wide existing universities would compete globally to attract students. The end of traditional universities was also predicted or at least the enlargement of the university with virtual parts.
Mason [3] distinguishes the following models for learning arrangements of a virtual university:

- content + support model
- wrap around model
- integrated model

In the „content + support model“ the learning material is presented digitally as e.g. electronic scripts, web based trainings or video lectures. Tutors support the students with problems and additional questions via the internet.
The further expanded “wrap around model” implements specific offers enabled through the quality of the internet like newsgroups, interactive applications and simulations next to the traditional contents.
In the center of the “integrated model” stands the communication and cooperation of the students via internet.
The traditional concept of lecturer-centered teaching is replaced by student-centered environments where students are supported in self-directed learning in the sense of the constructivism by themselves or in groups. These activities can be stimulated by tasks that have to be discussed (and solved) in groups.
Next to the didactical methods explained here (e.g. lecturing or self-directed learning) the component of the learning organization which is not closely examined by Mason, has to be metioned.
If we concentrate on the learning organization we can differentiate between the following combinations of virtual and face-to-face elements (s. Figure 2):

- *added:* Next to the regular face-to-face meetings there are virtual elements to support and deepen the work of the face-to-face meetings
- *alternated:* Face-to-face meetings and virtual meetings follow each other. In the virtual phases the students work together by themselves or together with texts and articles, do experiments and generate texts or simulations etc. The face-to-face meetings are used for presentations of results, discussions of the following steps and reflections of the experiences made.
- *replaced:* The face-to-face meetings are replaced by virtual meetings. There are face-to-face meetings e.g. in the beginning and the end that are optional. This variant is used for virtual seminars for example with international cooperation.

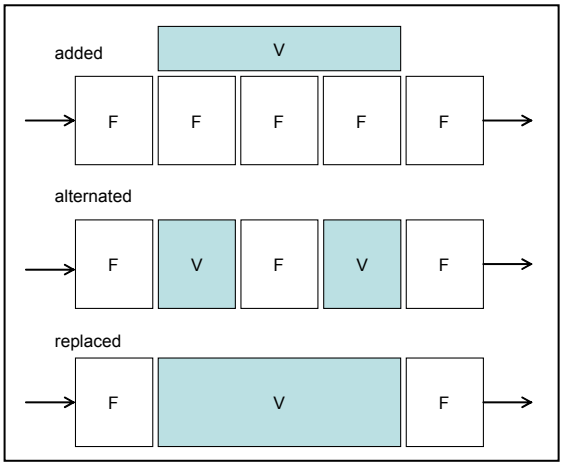

Figure 2: Combination of virtual elements (V) and face-to-face meetings (F) at a virtual university

You can see along the lines of these different descriptions of learning organization that virtual and face-to-face elements are always seen in opposition to each other.
This is the elementary problem of the concept of a virtual university. Virtual elements and face-to-face learning are seen as counterparts.
The Notebook-University overcomes the concept of a virtual university. The NBU moves a step further and does not look at virtual and face-to-face parts in contrast to each other but integrates digital media in all parts of the traditional campus e.g. Learning organization, administration or distribution of materials.

CONCEPT OF A NOTEBOOK-UNIVERSITY

The Notebook-University can be characterized by the following criterions:
It allows *ubiquitous access* to digital information at all places where students and teachers work and learn: at home, at class, in the office, in the lab etc. Times between classes can be used for research in the internet or digital libraries or for the

communication with other students via internet (e.g. awareness tools like ICQ).
The NBU allows access to all digital information and services of the campus for all participants. This means much more than the introduction of a learning management system for e.g. the distribution of learning materials, it means for example the management of administration data, online-registration for classes or data of exams. This is made possible with a *personalized portal* and a single-signon based on a distinguished role and right system which only provides access to applications and information for which one is authorized. Another criterion for an NBU is building an infrastructure for *digital tools* which are summarized in an internet portal: tools for the availability of information (access to the digital library) and the adaptation of knowledge alone or in groups as well as information systems with the availability and adaptation of relevant data.
Therefore, the characteristic of a Notebook-University is a surrounding where mobile devices play an important role on campus and within the activities of the students, lecturers and administration.
The notebook is not just a practical substitute for the desktop-computer. Moreover, it is an essential requirement for the realization of the scenarios of the Notebook-University. The notebook allows access to local data as well as data on "mass media storage" far away.
Typically, the notebook is used for the permanent availability of private data on the local device and to upload / download public resp. joint used data everywhere over the internet.

The originally followed didactical goals for a university with these techniques are the following:
It means connecting existing places to learn on and off campus. The technology of the internet and the access through mobile devices opens a "real" connection of the learning places (s. Figure 3). Breaks between media can be avoided because e.g. results of a discussion in class that are fixed on an electronic board can be immediately used and adapted at home and anywhere else. Digital data from the lab e.g. in Natural Sciences can be directly presented, discussed, forwarded and worked with in class and on the campus. Interviews or questionnaires in the Social Sciences or Psychology can be generated in the field with support of the notebook computers and used the same way.

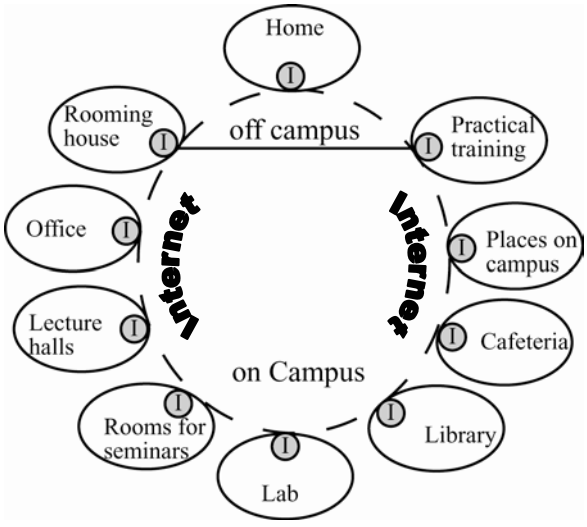

Figure 3: Connecting of learning places through the internet

Another goal is the development of new learning places on campus. The learning on campus was so far limited to the classrooms / lecture hall and the library. Now possibilities to understand the campus in whole as learning space open up. Students can work at every place on campus alone or in groups with digital texts and materials and contribute them among each other. Of course, this has consequences for the arrangement and design of corresponding public areas of the university.
It means also the development of competences when dealing with digital information, generating and communication of knowledge. The Notebook-University supports the critical review of digital information and therefore helps with the development of competences dealing with digital knowledge.
Last but not least, the promotion of didactical approaches of cooperative learning by exchanging data between teachers and students as well as between the students themselves can be accomplished in an easier way. In doing so, students can learn the principles of *Knowledge Sharing* and might be part of a learning community.
On a digital campus a lot of activities are supported by digital media as already explained. For once this means organizational and administrative activities; on the other hand, all kinds of learning activities are included e.g. usage of the notebooks in classes for quizzes, voting or cooperative work. The specialty of the approach of a Notebook-University does not become visible in a single (learning) situation. There is not one single application in which all profits come together. It only makes sense to see the Notebook-University in total. Above all, it is the digital form of data supply which helps to minimize breaks between media and other access to knowledge and the work with it.

To realize the Notebook-University, some infrastructural requirements must be fulfilled:

- the university needs an exhaustive Wireless LAN, which makes the ubiquitous access to the internet possible,
- the members of the university need devices which enable the access to the digital resources. Especially for the students the device has to be mobile, because they don't have own rooms at the university to do their work
- all offices and teaching rooms should be connected to the internet by LAN,
- all teaching rooms should be equipped with video-projectors and eventually electronic boards (whiteboards) and
- there must be enough sockets on the campus, especially at those points where students normally work (e.g. teaching rooms, cafeteria and library).

SCENARIOS OF AN NBU

All developed scenarios of an NBU can be structured into the typical scenarios at a university.
Lectures can be characterized as classes with a lot of students and mostly unidirectional communication. In lectures the notebook computers are besides taking notes used for interaction with the lecturer. This includes Online-Experiments, questionnaires and questions to the lecturer. It can also be used for cooperative work on documents e.g. group notes [see 3] and presentations.

These features help to change the typical lecture into more interactive scenarios where students are more involved into the activities. There has to be taken notice that these scenarios have higher demands on the lecturer and might require more preparation time.
In seminars there is naturally more interaction between the students and the lecturer, because the number of participants is usually smaller. The notebook computers are used as tools for collaborative work with documents or for the support of group discussions [see 4]. Moreover, results can be presented ad hoc with them. And because of the digital form of the papers they can be distributed and processed easier without breaks in media.
Exercises are distinguished by the practical and deepening application of theoretical knowledge in smaller groups.
The notebook computers' use here is one as a working tool which gives assistance with individual or cooperative reports or the manufacturing of a specific product e.g. a software practical training where a team is meant to build a programme with a specific functionality.
A ubiquitous access to the shared application at different places is possible through the use of the notebook computers and the WLAN.
The individual use of documents stands in the foreground in libraries and on the campus. Here the notebook computers serve as tools as well as to generate e.g. scientific work-pieces. They can be used for research in the internet and databases.
The last scenario concerns learning and research in the field. This scenario was not possible at the traditional university. Through the disposal of notebook computers students are able to do questionnaires and experiments in the field or develop data in another way and immediately place it at someone's disposal through putting it on a central server. If the instruments of research are on the server, too, possible changes on the instrument can be done in this central place and changes can be directly taken into account by (student) interviewers on the campus.

ACTIVITIES AT ECAMPUS DUISBURG

As just described the concept of the NBU differs decisively from the concept of a virtual university. There is a number of potentials linked to the integration of notebook computers into the everyday life of the traditional university that can above all be summarized under the keywords *support of interaction / cooperation, improvement of visualization* and a *greater flexibility* (compare "scenarios of an NBU).
These potentials do not turn up by themselves but are tied to conditions that are shown in Figure 1. The described requirements in relevant sectors for generating sustainability are explained by means of the *model of a framework of a Notebook-University* which names the different levels of an educational organization. In detail these are the *organizational level, the group and the individual level.*

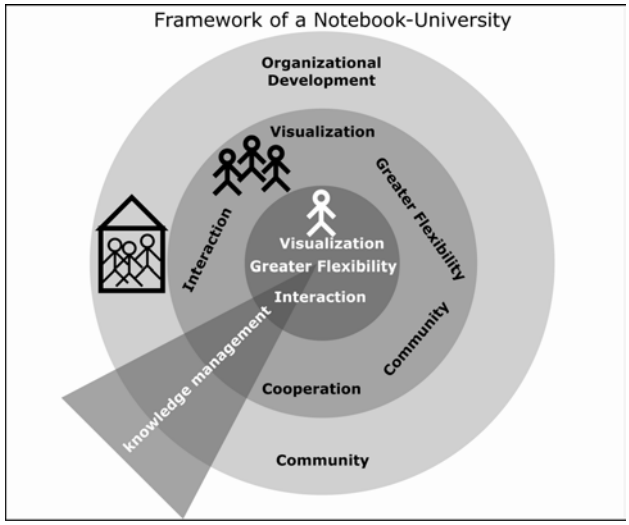

Figure 4: Framework of a Notebook-University

Organizational Level
To stride onto the necessary path of the Change Management Process it is required to take not only scientists but also the administration and the existing institutes for infrastructure on the campus into account. This is the only way to implement the necessary lasting changes!
At the beginning of the project a *wireless local area network* (WLAN) architecture was built up which covers with 45 Access Points 95% of the campus area. This way the ubiquitous access to the internet can be ensured at almost any place on the campus. Two courses of studies were provided with *subsidized notebook computers* at the beginning of the project, too, in order to have the chance to try out different scenarios with the employment of notebook computers. The supply of the students with notebook computers lead to a strategically partnership with a well-known supplier of notebook computers.
The university profits from this partnership in many ways:

- The notebook computers can be received at favourable conditions
- Providing students and employees with notebook computers was made much easier
- The notebook computers can be repaired by employees of the IT-Center without losing the guarantee
- The university has spare parts at stock at its disposal, this leads to very short failure times

The infrastructure of the rooms on campus has to be adapted to the new conditions to enable the students to use their notebook computers appropriate in the described scenarios. Next to the building up of the WLAN, this concerns the supply of the campus with enough *sockets*. This is necessary, because most notebook computers have a battery run-time of just a few hours and therefore couldn't be run the whole day at university. The lecture halls should also be equipped with a beamer and eventually with whiteboards and thus enable digital presentation and visualization.
On the Organizational Level the qualifying of the lecturers and the hardware equipment play an decisive role. Both the dealing with the techniques and the information about the intended potentials have to be explained to the users. For this reason the *competence center digital media* (Kompetenzzentrum Digitale Medien, KDM) was founded. It originated from the three

central institutes IT-Center, the library of the university and the audio-visual media center.

Group Level
Here the lecturers have to be willing to integrate "New Media" into their lectures at the beginning. In addition, the lectures have to be adapted to the new conditions in that way that the notebook computers can be integrated usefully into the learning arrangement. This fundamental willingness to use the notebook computers and to adapt the didactical concept is promoted by the building of the KDM on organizational level. Additionally, the portal eCompetence was established for lecturers. Step-by-step instructions for different digital media and tools are at disposal for the users here, there was also built a Best-practise-Pool of already tested scenarios that can give useful guidance and suggestion.
Within the lecture the lecturer has to consider different didactical decisions upon the use of the notebook computer. Not every form of notebook computer usage appears to be sensible in a learning arrangement [see 5]. Didactical and methodical innovations have to be made to integrate the notebook computer as a tool for individual learning processes into the lecture or seminar. While didactically planning the meeting lecturers have to state the aim of the integration of the notebook computer and what expectations they link with it resp. what potentials are gained through it. The goal is to consider the notebook computer as one tool next to others while planning a seminar. Particularly phases with self-directed learning and working as well as phases of cooperative work seem to suit the use of notebook computers at the university.
In our opinion the new media mainly support improved possibilities for visualization, new forms of communication / cooperation and interaction as well as a higher flexibility. The tools and communication media shown in table 2 are offered on the group level. Some of those were developed at the university Duisburg-Essen. These are aimed to support cooperative work in the described scenarios. The tools can be distinguished between support of synchronous and asynchronous working processes.

Synchronous	Asynchronous
Cool Modes	BSCW
Note IT	Newsgroups
Passenger	E-Mail
Lab.OR	mailing lists
Chat / ICQ (awareness)	

Table 2 Synchronous and asynchronous Tools and media for communication in the project eCampus

As addition to meetings e.g. mailing lists or newsgroups can be used and help at building a *Community* that ideally contributes to a discussion far over the meeting itself. The built Learning-Communities [see 6] then give input back into the next meeting.

Individual Level:
Prerequisite on the individual level is also the readiness of the individual to invest into the required hardware (especially notebook computers and WLAN-card). Moreover the student is expected to use times between classes and other spare-time on the campus for learning activities.

This readiness is supported by the subsidized supply with notebook computers and the help from the IT-Center of the university, as mentioned above. Moreover, the attraction of the offer is increased by the almost all over access to the internet via WLAN and notebook computer working places were installed at a lot of places on the campus.
To give the students the chance to use spare-times, they have to have the necessary software (e.g. Microsoft Office products) to generate texts and presentations directly on the campus. Additionally, the access to special software is helpful, e.g. one that changes processes into animations or to evaluate questionnaires with help of SPSS oneself. The KDM offers in this context trainings for students for all accessible programmes, too.
On the other hand, it is useful if lecturers process their contents of the seminars as electronic scripts (e.g. as pdf) and offer them as download at a suitable place. These scripts can – in addition to their presentation - contain additional information (e.g. audios, videos or animations) from the meeting.
The offer of online learning material in a digital library, as was built within the projects of the federal ministry of science and education, is an important field of topics to initiate self-directed learning activities of students.
On the individual level, the use of a notebook computer helps to improve flexibility at first. This means for the students e.g. to use spare-times better for themselves by preparing for seminars, get resources from the internet and the digital libraries or work with applications [see scenario library].

EXPERIENCES

In the framework of the project eCampus Duisburg the students were asked about their experiences with the use of a notebook-computer. Here some first results are shown that were evaluated at the beginning of the project, because the final questioning of the students is not yet finished.
Two essential questions that are looked at more closely in the following are:
"What for do students use their notebook computers in the eCampus seminars?" (the eCampus seminars are the seminars that explicitly tested the employment of notebook computers in the setting of this research project.)
The second question which is of great interest for us is:
"What for do the students use their notebook computers outside the seminars?" This question is important, because the campus get a greater role than before in the concept of an NBU, as shown above.

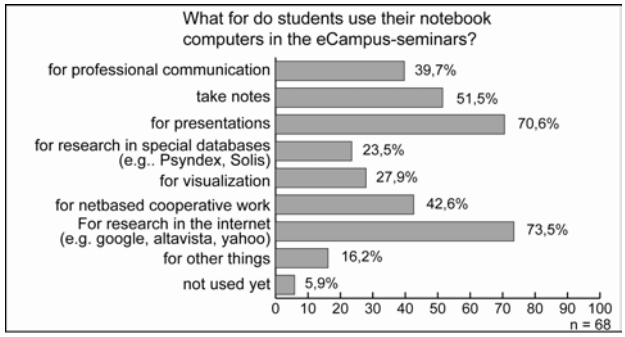

Figure 5: Use of notebook-computers in eCampus-Scenarios

The question about the use of the notebook computer inside the eCampus-seminars was answered by 68 students (Figure 5). More than 2/3 stated to use it for the research in the internet (73,5%). Almost as many use the notebook computer for presentations (70,6%). More than half of the students take notes during the meeting (51,5%). After all 42,6% of the students pointed out to use the notebook computer for net based cooperative work and almost as many (39,7%) use it for professional communication, therefore more than 1/3.
The relatively small number of students that answered this question (n=68) is attributed to the moment of the questioning. The students were just starting to use the notebook computer and had collected only little experience with the use of it. We are very anxious to see the results of the next and temporarily last questioning, because of this reason.

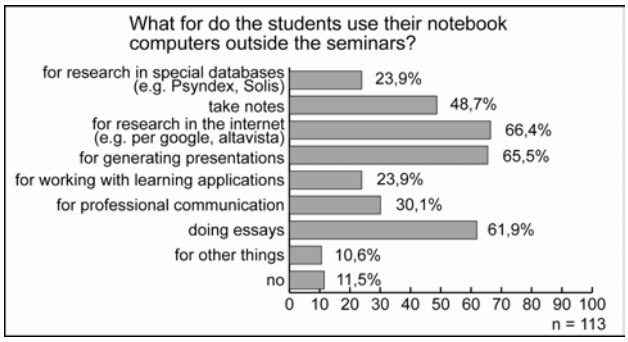

Figure 6: Use of the laptops on the campus

The question about the use of the notebook computer on the campus was answered by 113 students that took part in the project (Figure 6). 2/3 of the students stated to use the notebook computer for research in the internet (66,4%), about as many use it for generating presentations (65,9%), directly followed by doing essays (61,9%). About half of the students use the portable computer for taking notes and 1/3 uses the campus for professional discussion.

CONCLUSION

These results show that the campus as additional place for learning is accepted and used. The greater interaction and cooperation in the seminars could be indicated, too. In this context the results of the future questioning will be very interesting.
In the meantime, the notebook computers have become a typical picture at the university in Duisburg. Everywhere on the campus do students sit and work with their notebook computers. The appearance of students with notebook computer in meetings has become more intensive as well – not only within the supported courses of studies.
We will continue to support this direction in future. For example, students can continue to buy and get their notebook computers serviced directly at the university. We inform new students about possible advantages of an own notebook computer directly at matriculation with a flyer. On the side of lecturers, interest in the use of notebook computers can be noted as well. All lecturers that took part in this research project will continue supporting scenarios with the employment of notebook computer. And above it lecturers that did not take part are getting involved in using notebook computers for their seminars.

It was pointed out that the approach of an NBU like it is existing demands high requirements. To implement the NBU successfully great consequences for the organisation of the university emerge. And at the same time this it the highest risk of the NBU: If the building up of a certain reach at the efforts of reorganization fails, the approach of the NBU will not be successful. In other words: The approach of the "virtual university" can be followed on the level of a chair or an institute; the approach of the NBU demands strategic decisions and following steps at least of a faculty or a location, actually: a whole university.
Because of this, besides the question which potentials are connected to the NBU for studies and learning arrangements, the reflection moves into the foreground, how this can be reached at all and thus the subject of change management. The challenge of the NBU is to organize the changes! Especially universities have the mechanisms to paralyze attempts of systematic innovations by the management or even by the ministry.
The universities will go different ways in the field of the use of digital services. But basically the attempts of an NBU will only be successful if the different services from the areas of teaching and learning, examination and administration, research and publishing etc. come together within an integrated information management. Substantial criterion for the success of these efforts is the question to which extent the structural requirements and the adaptation of processes have been achieved to make the described potentials of an NBU possible. This means organizational changes at universities, as well in the field of organisation of teaching as in the field of services for information, communication and media.

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