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Learners' Requirements on E-Learning Platforms from a Technical Perspective Supported by a Survey-Based Study

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Abstract

Blended learning with a high percentage of e-learning content has been recently gaining in popularity for people studying academic subjects in parallel to working in part-time or even full-time jobs. Courses with high amounts of e-learning content allow a very flexible and individual structuring of the learner's time schedule, which is mandatory for students with a full-time job in parallel. But this group of students typically has further strong demands on higher education institutions: Large parts of the campus life have to be mapped to electronic solutions to satisfy their needs.

In a previous publication (Moser et al., 2014) we have shown that the typically used web-based e-learning tools are not powerful enough to offer all of these services. For this reason, we developed a so-called *Virtual Desktop* solution, which offers cloud-based self-organization of students and supports them with e-learning content. The virtual desktop has been further extended to allow an integration of tool-based e-learning and virtual labs which both are very important, when it comes to advanced master's courses in engineering and computer sciences.

In this paper, we are going to present further technical advances of our e-learning platform with an in-depth focus on the technical realization under efficiency aspects. We also present a survey-based study, which is used to find out how and where our students learn and in which way they might benefit from our technical solutions. This is necessary to examine the amount of effort that should be spent for the different requirements.

Keywords: blended learning; e-learning platform; learning environment; cloud-based e-learning; virtual desktop; virtual lab; master's courses; engineering courses.

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I. Introduction

E-Learning in higher education has been gaining in importance during the last decade, which is due to several reasons: On the one hand, modern technology offers new studying techniques which can be seen as a complement to traditional lectures, seminars and exercises. For example, multi-media content can be used to illustrate complex matters, training on demand offers an individual and learner-oriented way to acquire in-depth knowledge and today's learning management systems allow an individual registration and automatic analysis of a learner's progress. In the last years, electronic devices, which can be used for mobile learning, became quite ubiquitous, which makes e-learning more and more attractive. On the other hand, modern technology and a high rate of innovations lead to a fast-changing world, which can be observed very well at the people's workplaces. Continuously changing technology results in a strong demand for life-long learning in our society, which leads to the fact that an increasing number of people have the necessity to explore academics in non-typical forms, for example by pursuing a college or university degree extra-occupationally. Therefore, universities and other institutions of higher education are required to offer specialized courses, which can be studied completely or almost completely by distance learning. E-Learning is one of the main enablers for a good distance learning experience. In this paper, we focus on using e-learning as an instrument for extra-occupational distant students.

Traditional learning in higher education is typically strongly linked to the students' physical presence at the university campus. Students attend courses like lectures, seminars, laboratories or exercises. Besides the transfer of knowledge, a university campus has some additional functions: It gives students the ability for social interaction between each other and with the lecturers. Students form learning groups and they learn to solve difficult problems in teams, as well as to organize their schedules and exams. They also have access to computer labs or, depending on the subject, to specialized laboratory rooms. Lecturers get feedback by direct talks. When e-learning techniques are used to set up courses for distant learners, there is a major challenge to map all of the typical campus functions to the e-learning platform. Common learning management systems (LMS) focus too narrowly on the transfer of knowledge from teacher to the student, while the other mentioned functions of a university campus are not available. The limits of today's common LMS are reached quite quickly as soon as it comes to engineering courses. Engineering courses commonly do not only contain a lot of mathematics, but also lab courses. Very often, there are practical exercises where students have to work with specialized software tools (e.g. simulations) or even with specialized hardware or do experiments.

In this paper we are going to present an extension of an LMS by a set of tools to satisfy a distance learner's needs better than an out of the box installation of an LMS. At the same time it is necessary to find out how well the tools address distance learners' requirements in their everyday lives, as setting up and maintaining additional tools can be expensive. Therefore it is required to do early measurements of the benefit the students actually have from offering additional tools. For this reason, we conducted a survey among our distance learners to find out what they really need, what they use and what their technical equipment is.

Our organization, the School of Advanced Professional Studies, is a central institution of Ulm University in southern Germany. We offer master's programs for extra-occupational distant learners, i.e. they typically work in part-time or full-time jobs in parallel to their studies. Our study programs are based on the concept of blended learning with a high percentage of online learning (at least about 80 %). We currently offer courses in engineering (Sensor Systems Technology) and in economics (Innovation Management and Higher Education/Science Management). Courses in computer science (Business Analytics) and financial mathematics (Actuarial Science) are currently produced and will start in the next months. All programs lead to a Master of Science degree. At the time, this paper was written, only Sensor Systems Technology and Innovation Management and Science Management were offered. For this reason, our survey is related to students of these subjects.

The paper is structured as follows: In the second section, we discuss the functions of a traditional university campus and we define which functions have to be recreated in an extension of an LMS. In the third section, we introduce the state-of-the-art in today's LMS and show, which functions are missing. The fourth section is used to present our approach. In the fifth section, our survey and its results are described. The sixth section is used for summarizing and giving an outlook to further development.

II. University Campus and the Requirements on E-Learning Solutions

Learning in higher education takes place at a university campus, which intrinsically fulfills many tasks, among them:

- Teaching and learning
- Social interaction between students
- Feedback from students to teachers
- Team Building and formation of learning groups
- Laboratory exercises
- Workflow of semester
- Organization and planning of exercises, exams, laboratories, …
- Access to computer labs, library and further specialized equipment or rooms
- Learning spots
- …

In study programs for distant learners, the university campus as a central institution with its above-mentioned features is typically not available. For this reason, it is required and logical to provide these features to distant learners via web-based platforms. According to (Romiszowski et al., 2004), (Johnson and Johnson, 1989) and (Johnson and Johnson, 1990) this is necessary to prevent e-learning concepts from failing. The features and possibilities to reproduce them for distant learners can be categorized:

a) Accessibility of teaching contents. In its simplest form, this means offering lecture presentations, lecture notes, exercises, references to advanced literature and so on using web technology. This is quite obvious, and it can be easily accomplished by using the features that are provided by a typical LMS for most of the course subjects. Nevertheless, it can become a special challenge with non-existing standard solutions when it comes to courses in engineering or natural sciences. In these subjects, working in laboratories, working with physical systems, like specialized hardware or working with specialized software or tools in computer labs is quite common. Providing at least an approximation for the services, which are typically present in on-campus programs, is necessary.

b) Interaction between students and lecturers or tutors. All forms of feedback from the students like contacting the lecturer or tutor in case of questions, submitting exercises for corrections or grading, giving presentations or discussing a seminar topic must be handled via a web platform. This is possible with the standard features offered by a modern LMS. When it comes to courses where a specialized training is needed (e.g. courses with a lot of mathematical content), additional web-based seminars (webinars) are necessary to demonstrate and discuss correct solutions or solving strategies.

c) Student's presence on a university campus. On-campus students interact socially with each other, which has many positive aspects: Besides having common activities in private life, they meet to discuss study-related topics. They usually form study groups voluntarily to solve more difficult exercises together, which trains the ability to work in teams. This is an aspect gaining more and more importance to prepare students for work-life. To learn together, on-campus students typically meet at specially prepared learning areas, which are, for example, available in campus libraries. The usage of social media is quite common on today's campuses. While at first glance social media platforms might offer an ideal platform to make the above-mentioned campus features accessible for distant learners, they don't provide a direct solution for all of the learners' requirements. To organize private activities between students, social media work quite well, but they generally miss a direct integration into the LMS. For example, the power of social media is below today's technical potential when it comes to working, especially to referencing, discussing or highlighting course materials or to typesetting mathematical formulas. For distant learners the following conclusions can be drawn:

a. The social interaction between distant learners has to be stimulated actively. Therefore, we need both: Technology and teaching concepts to foster an exchange and the formation of learning groups. This means on the one hand, we have to develop and to provide course materials, which can be studied or have to be studied in teams. For example, the results of a study work could be delivered as a team presentation instead of paper work done by each student separately. On the other hand, we have to offer software tools to allow web-based video meetings of study teams and an easy exchange and cooperative compilation of documents. A *shared workspace for collaborative work* is a base requirement for mapping the function of team learning to web platforms.

b. The prevlance of *social media* must be used to enable an easy access to learning materials and study teams. This means that a direct link could be established between the functions of social media and the functions of a modern LMS. At the same time, protection of data privacy has to be guaranteed according data privacy acts. Students who pay a study fee usually demand that their data do not leave the institution. At least we cannot require them to use existing social media. Nevertheless, we can learn from social media that the ease of use and the ubiquity are important factors for acceptance.

c. On-campus students traditionally have physical places where they work for their studies. Such places usually are learning areas on the campus (e.g. at the campus library) or at a personal work desk at home. As mentioned above, our programs for distant learners typically address people who have a part-time or full-time job in parallel to their studies. For this group we can observe differences regarding the form of their physical work places. They typically learn at varying places, for example: In free time slots at work, perhaps also together with colleagues, in trains or busses while commuting between home and work place or at home at the evening hours. Different work places lead to the necessity to have access to all study-related materials online, whenever and wherever one has the possibility to start learning. All contents must be accessible on demand and completely independent of the devices (smart phones, tablets, netbooks, notebooks or desktop computers) used for access. This is not only related to the official course materials provided by the LMS, but also to the materials, annotations and notes the students develop or add. To satisfy these requirements, we propose that all materials, including the ones produced by learners in phases of self-studying or in team learning sessions, should be stored centrally at the institution and made easily accessible for all kinds of devices. The approach of *cloud computing* allows cloud storage services to be integrated into an LMS. At the same time, one has to consider aspects of data protection and data privacy. To bring the concept of cloud computing in line with data privacy, we suggest operating the cloud service by the university itself.

d) Organizational affairs. Besides the above-mentioned aspects of a university campus' features, there are organizational affairs, which must not be neglected. For example, in on-campus programs, the point in time of an exam is often coordinated jointly between lecturers and students to avoid conflicts with other courses. Groups for team learning form themselves in a face-to-face mode. For distant learners, organizational processes, which often run intrinsically and silently in on-campus study programs, have to be explicitly analyzed. When necessary, they have to be made available for distant learners using web technologies. For example, extra-occupational students require that information about dates of exams can be integrated into their daily used calendar application.

We can summarize that a typical university campus comes with an extensive amount of functions of completely different manners. Based on our experience with extra-occupational learners, we conclude that a modern learning environment is web-based and tries to clone all of the campus' functions as well as possible. In concrete, we require a highly flexible cloud-based solution, which stores all types of contents and allows an easy content management while respecting data privacy. The LMS has to be part of the cloud solution. We also demand that especially roaming learners with a variety of electronic devices can access all types of content everywhere.

In this section, we defined the demands that we make on a modern learning environment for distant learners. In the next section, we present the state of the art in e-learning and especially the capabilities of today's LMS.

III. State of the Art in E-Learning

The market for e-learning tools has been growing massively in the last decade. The most popular 100 tools used for e-learning purpose are maintained in a freely available list by (Hart, 2015). The tools can be divided into various categories. For instance, there are authoring tools, which are used in the workflow of media production. When analyzing the state of art in e-learning software, we focus on web-based tools used for interacting with the learner: the learning management system (LMS), sometimes also named virtual learning environment (VLE). An LMS is typically a web-based tool used for management and delivery of teaching and learning content, for supporting the learner in self-training sessions, for checking and tracking a learner's progress by using quizzes and so on. Typically, they are technically based on Web 2.0 technologies such as presented by (Downes, 2005) and (Downes, 2007). These applications address a subset of the above-mentioned requirements described in Section II, but by far not all. Especially cooperative learning as described in (Liesebach et al., 2001), the usage of specialized tools and the concept of a virtual desktop are not present.

The idea of cloud-based e-learning per se is not new. In the last few years, other research groups started using the concept of cloud computing for e-learning: (Selviandro and Hasibuan, 2013) show how commercially available cloud-services can be used to provide e-learning services. This could be interesting for institutions of higher education who cannot afford to operate server infrastructure. (Oludipe et al., 2014) propose a self-implementation that offers cloud services to their own students. This paper is quite interesting because the authors provide courses for natural sciences, which are quite similar to engineering courses with respect to their requirements.

IV. Cloud-Based Virtual Desktop

Our cloud-based setup has been elaborately presented in (Moser et al, 2014). For this reason, rather a short summary of the components and their interaction is given in this section. The e-learning platform we developed is an integration of the following open-source tools:

- *OwnCloud*[1] is the central application where our students log in to. OwnCloud is an open-source tool that offers cloud storage services. This means that all learners and all teachers have an amount of data storage space, they can share documents with each other based on course-related or module-related pre-defined groups or completely individually. OwnCloud can be extended by plugins: For example, we use *OwnCloud Documents* for a cooperative editing of documents or *OwnCloud Calendar* to provide a feature-rich calendar solution to our students and teachers. Pre-defined calendars are offered for our courses and modules and can be subscribed by the students and teachers. Subscribing to calendars on typical calendar apps is supported. This allows us to map large parts of our organizational campus aspects to the electronic platform. There are specialized synchronization apps for iOS, Android and desktop synchronization clients for Windows, OS X and Linux. The OwnCloud instance we operate is hosted locally at Ulm University. This is an important advantage regarding data protection and privacy. We do not rely on any external cloud service and therefore we do not give our students the

[1] http://owncloud.org

necessity to create an account at an external service.

- The popular LMS *Moodle*[2] is used for the traditional distribution of e-learning content, e.g. lecture notes, teaching videos, for doing quizzes and for submitting written exercises to the tutor. The students can self-control their progresses in Moodle. We integrated MathJax[3] into Moodle to allow the usage of LaTeX and MathML code in Moodle text. This is crucial for engineering-related courses. We developed a fully-responsive theme for Moodle based on Bootstrap. This enables an easy to use look-and-feel on all kinds of devices and screen resolutions. We point out that all of our modifications do not touch Moodle's core, but are implemented as themes or plugins. This is an important measure for reducing the maintenance work (e.g. when upgrades are necessary).

- The popular forums software *phpBB*[4] is used to provide a discussion board for each module and also generic boards for common topics. Also the forums software supports LaTeX and MathML code in forum posts.

- Online courses with challenging mathematics and engineering contents, require that individual tutorials take place from time time. These tutorials are typically done using web conferencing technology. In this case, we decided for using the open-source software *BigBlueButton*[5]. It allows recorded and unrecorded sessions and can be directly integrated into Moodle as an activity. It can be easily linked to our central user database. On a mid-ranged server, BigBlueButton can easily handle web conferences with up to 80 participants. The screen sharing functionality, which is part of BigBlueButton, allows our tutors to do their online courses for example in a room which is equipped with an electronic whiteboard. So even mixed courses are possible: Students who come from the Ulm area can attend the tutorials in an attendance form and other students can follow the same content at their computers. BigBlueButton has also been successfully used for communication between students during group work or in exam preparation sessions.

- The *Remote Tool Service* is a tool which enables our students to connect to a virtual computer by using their browsers only. Technically it is implemented by using the open-source software *Guacamole*[6] in combination with a Linux-based and a Windows-based terminal server. Guacamole maps the procedure of

[2] http://moodle.org
[3] http://mathjax.org
[4] http://phpbb.com
[5] http://bigbluebutton.org
[6] http://guac-dev.org

accessing the terminal server to JavaScript/HTML5. This means that students or teachers using a modern web browser (Google Chrome, Mozilla Firefox, Apple Safari, Microsoft Edge) are able to access their virtual Linux or Windows desktops directly in a browser window. Plugins (Flash, Java) are not required. This very interesting feature allows the access of specialized tools as they are often used in exercises or labs of engineering courses. For this reason, in our course program Sensor Systems Technology, we could successfully boost the students' activity in tool-related exercises by offering the remote tool service. The effort of installing and maintaining these tools on the learners' computers locally was considered too high for a lot of learners.

The interesting aspect of our platform lays in the combination of the above mentioned tools: A common place for data storage, the ability to do cooperative writing or editing, the ability to start web conferences at any time and a centralized execution of specialized tools combined with an access via browser satisfy the needs of highly flexible students. The concept is to offer all services including the learner's individual progress regarding all types of documents and exercises independently from the place where a learner is currently staying and independently from the device she or he is currently using. For this reason, we call our solution *Cloud-Based Virtual Desktop*.
We have, of course, a common user database in the background. Remote Tool Service and OwnCloud can share common user home directories, for Moodle this is still an open problem. Our whole platform is based on fully responsive themes. This allows a comfortable usage on all kinds of devices and screen resolutions. A more in-depth technical description of our solution has been published in (Moser et al, 2014).

V. Survey

Setting up and maintaining web-based platforms containing novel technology typically causes a high effort: In the set-up phase of a new service a lot of development, programming and integration work must be performed. Additionally, a lot of testing is necessary. After that, additional work is caused by implementing a maintenance concept for the service. Once this maintenance concept is established, the required staff appropriations for a specific service will decrease. An institution's budget for staff and for material expenses is usually the bottleneck. For managing the available resources, it is necessary to find out how much the learners benefit from the offered services. For the aforementioned reason it makes sense to check in the early phases of implementation whether the learners accept the implemented service and how much they benefit from it.
For this reason, between December 2014 and January 2015 a survey-based study was undertaken among 64 students of the extra-occupational *Mod:Master* study program

at the School of Advanced Professional Studies at Ulm University. Mod:Master is the title of the government-funded project under which the study programs *Sensor Systems Technology* and *Innovation Management and Higher Education/Science Management* have been established at the School of Advanced Professional Studies.

V.I. Basic data

Beside demographic data collection, the main focus of this survey was to collect statements concerning the technical equipment of the students in the Mod:Master study program and the use of the virtual desktop learning environment. Concerning the previous topics, 58 extra-occupational students within the Mod:Master courses accessed the associated online-questionnaire. 4 students didn't partake in the survey and 9 questionnaires were only partly filled. The response rate of fully completed questionnaires is 45 or 77.6 %, respectively.

40 participating students (out of a total of 49 participants) reported, that they took part in the course program *Innovation Management and Higher Education/Science Management* and 14 (out of a total of 15 participants) belonged to the course program *Sensor Systems Technology* which is a total of 54 Mod:Master participants (93.1 %) in the online survey. The following non-mandatory details concerning their demographic data were provided by the students: 13 female and 29 male participants took part in the survey. 12 participants didn't refer to gender data. 12 of the students were between 26 and 30 years old. 11 students belonged to the group of 31-35 years-old and respectively to the group of 36-40 years-old participants. The age groups 41-45 years, 46-50 years and age over 50 years were selected by 3 students in each variety.

Asked for their current professional status, their weekly working hours and the support of their employers the students provided the following data: 46 out of 54 students were employees, 6 were self-employed and 2 were job seekers. 24 of these students did work over 50 hours a week. 19 students had weekly working hours between 40 and 50 hours, 30 to 40 hours (3) and two of the students worked between 20 to 30 hours for their job. 22 out of 37 employed students got no support at all from their employer for their studies. 3 students were allowed to use working hours for their studies. Furthermore, students got financial support (3), support for learning materials or other support (sabbatical, days off, job guarantee, no problems to get a day off for study purposes (e.g. exams, attendance seminars) by their employer.

V.II. Places used for Learning

Asked which places they use for learning (multiple responses were allowed): 44 (out of 45) students specified their home as their setting for learning. 27 participants have a separate room or office, which they use for learning. 12 students answered with other rooms of their homes. Only 7 students did learn at their working place (2 out of them only during break) and 9 students did learn at a place outside their home or job: at the library (5), at university (2), at a fellow student's home (1) or in different places (1). 15

students used mobile learning on business or private trips or on their way to work. Some participants provided answers that are more detailed: They learnt while being on the train (11), as passengers on a plane (3), in a car (2) and one student memorized learning content during sports activity (1). 30 students did not use mobile learning at all.

Asked for their favorite location for learning (multiple responses were allowed), 39 students voted with “yes” (6 voted with “no”) for places at their home. They preferred learning in a separate room or office (22), at a separate desk (4), their bed (2) and their bedroom (2) the kitchen/dining room (3), the living room (3), their bed (2) and their bedroom (2) and in the basement (1). One student provided the answer that her favorite learning place depended on her learning phase. Only one student preferred learning at her office at work. 3 students named their favorite spots for learning outside their home or work (library (1), university (1) and changing places (1)). Seven students preferred mobile learning on their way to work or during business traveling (6) one student found most favor in learning outside. 44 students agreed with the statement that they could learn at their preferred learning places without disturbance. Four students did not agree with that statement because of disturbance by family members (small kids) (2) or a too small housing (1). One student did not give any reason for the disturbance.

V.III. Technical Equipment Available for Learning

V.III.I. Available Devices

We asked the students for the technical devices that have been available at their learning locations (multiple answers were allowed). The results are depicted in Figure 1 and Figure 2. The students also answered the following details: Other technical equipment students used at their homes: e-book reader (1), ear protectors (-37 dB) (1), headphones (1), printer (2), fax machine (1) paper and pencil (1). One student specified other equipment with “confidential”.

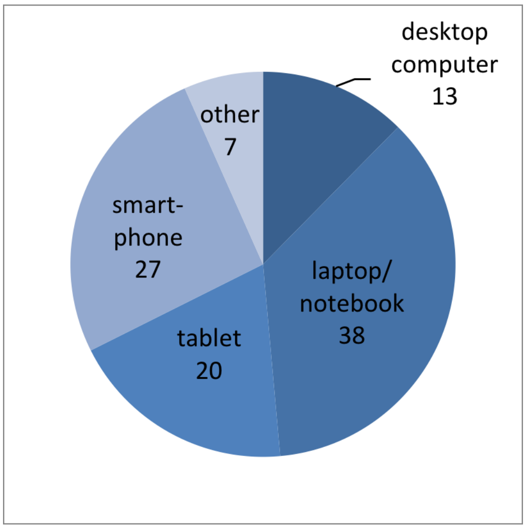

Figure 1: Technical Equipment Available at Students' Homes (n = 44)

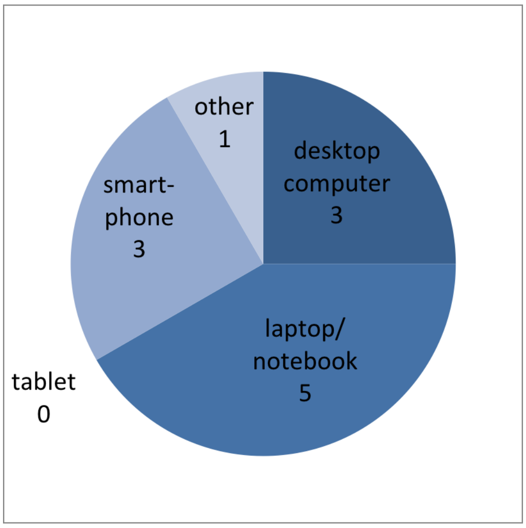

Figure 2: Technical Equipment Available at Students' Work Places (n = 44)

One student used his ear protectors at work. At learning locations outside their home or work, students used desktop computers (4), laptop/notebook (6), tablet computers (2) and smartphones (5) for learning.

As the spread of mobile devices has risen during the last years, we especially asked for the technical equipment, which is available for mobile learning. The results are depicted in Figure 3. When asked about special or additional devices, two students provided the answer that they used their lecture notes. Asked for technical equipment used in other learning spots, one student who used sporting activity to memorize learning content provided the answer that he used a smartphone and a tablet computer during that learning activity.

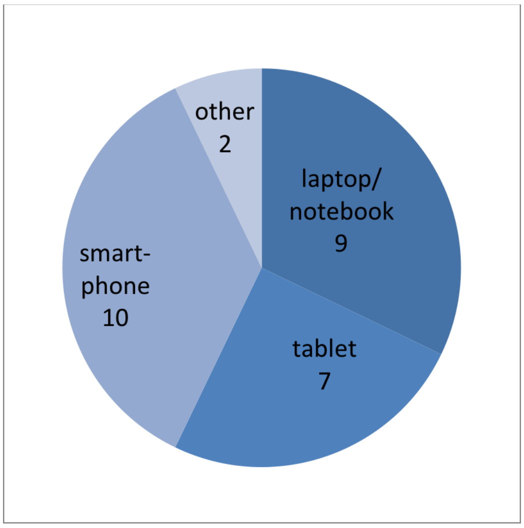

Figure 3: Technical Equipment Available for Mobile Learning (n = 43)

Neither the students using a desktop computer nor the ones who used a tablet computer or a smartphone provided an answer which operating system they did use.

V.III.II. Internet Access

Besides the devices used for learning, it is also important to gather information about the students' internet connectivity. Especially in a cloud-based approach, the connectivity can be crucial. We asked the students for information about the data throughput of their predominantly used internet connection when working in a wired or WLAN-based environment (e.g. at home or at the work place). The results are depicted in Figure 4. In the case of a required internet connection in a mobile learning session, one has typically to come back to cellular networks. To estimate the available data rates, we asked the students about their predominantly used connection type in mobile learning sessions. The results are shown in Figure 5.

We also asked how satisfied the students in general have been with the learning environment. 37 out of 45 students were fully satisfied with the communication tools provided in the learning environment.

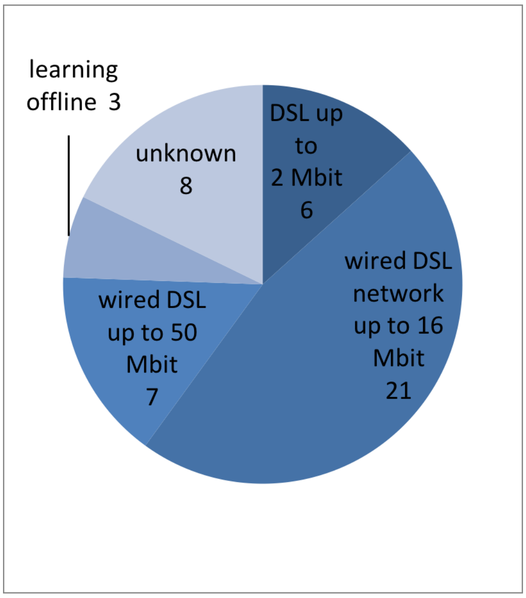

Figure 4: Predominantly used Connection Type via Landline/WLAN (n = 45)

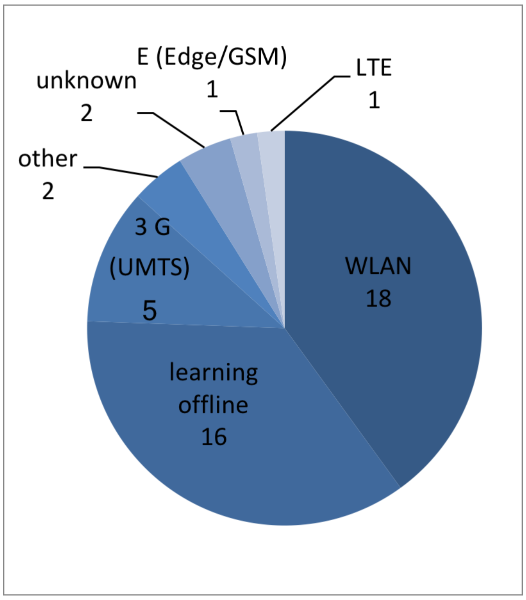

Figure 5: Predominantly used Connection Type for Mobile Learning (n = 45)

V.III.III. Overall Communication

Eight students (7 students within the Innovation and Scientific Management course and 1 student out of the Sensor Systems course) suggested further improvements of the learning environment. The following aspects have been criticized:

- Missing tool for cooperative work compared to the whiteboard of the tutor (1),
- lack of individualized communication tools (e.g. for group work) (1),
- missing a single sign-on solution (1),
- missing consistent presentation of learning content in each module (1),
- missing an opportunity for a live chat (1),
- lack of a better possibility to assign communication to a specific module which was declared to be difficult via Moodle (1),
- usage of learning environment was too complicated because of problems with switching between different services provided within the environment (2),
- too less attendance meetings in order to build networks (1).

V.III.IV. Usage of Additional Tools or Web Resources

31 students did not use further communication tools besides the provided learning environment. 13 students out of the innovation and scientific management courses did use the following additional tools: mailing lists (2), e-mail (7), WhatsApp (4), Skype for screen sharing and group conferences (2), text messages via smartphone (1), telephone (1), Dropbox (1). One student participating within the sensor systems courses provided

the following answer that he also uses Microsoft OneDrive for document management, WhatsApp to message other learners and Facebook to organize meetings.

V.IV. Usage Frequency of our Learning Environment's Components

Table 1 shows the usage frequency of the components our learning environment has been offered.

How often did you use the following tools provided on the learning environment	Answers provided by students (n=45)				
Tool	often	from time to time	seldom	never	not available in my course
Download of learning material	36	8	0	0	1
Watching video tutorials	29	14	1	0	1
Answering multiple choice quizzes	13	13	10	1	8
Communication via Big Blue Button with fellow students	2	4	6	29	4
Communication via Big Blue Button with the tutor	10	4	2	26	3
Communication via Big Blue Button with the lecturer	7	4	3	27	4
Etherpad	1	3	2	35	4
Forum (communication with fellow students)	4	12	15	14	0
Forum (communication with the tutor)	5	12	14	14	0
Forum (communication with the lecturer	5	9	14	17	0
Cloud-based up-/download of documents	7	9	7	22	0
Calendar	7	6	9	23	0
Technical discussion board	6	8	14	17	0
Organizational discussion board	6	13	13	13	0
Board for announcements	12	17	9	7	0
Remote Desktop	2	7	4	13	19
Remote Desktop (Matlab)	2	7	4	13	19

Table 1: Usage Frequency of Components

VI. Conclusion and Outlook

The presented survey shows us two important aspects: On the one hand, the majority of students is content with the offered services. This is also supported by the fact that the number of additionally used external web services like Dropbox is quite low. On the other hand, there is always room for further improvements and enhancements: For example, a better instruction of our learners about our platform's features might allow an even more frequent usage of tools, e.g. Big Blue Button as a communication tool with fellow students is definitely available in all courses, which is a contradiction to the user feedback which is shown in Table 1. We still lack the integration of a social media-like communication tool an we are also working on web-based simulations helping to make specific aspects in engineering courses better understandable. While the Remote Tool Server offers a very powerful platform to execute arbitrary programs, for some teaching aspects it can be more feasible to have additionally small web-based simulations which can give direct feedback to the LMS to enable individual learn paths. Both, the technical equipment and the internet connectivity our students have access to are quite good. Nevertheless, offline usage of e-learning content and an app-based synchronization could be an interesting aspect for mobile learners.

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