

The seamless integration of virtualized lessons with a fully automated workflow into the LMS VMC/Moodle of the Medical University of Graz

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Key words: *eLearning, blended learning, fully automated virtual lessons*

Abstract:

In 2002 the Virtual Medical Campus Graz (VMC), the eLearning portal of the Medical University of Graz (MUG), was launched. Since 1 Oct 2010 the primary learning management system is VMC/Moodle. It currently holds more than 10,600 unique learning objects, and serves more than 4,300 students from three studies. We introduce the concept and its technical implementation of virtual lessons within the study of the diploma study human medicine. Once the eLearning content is created, the process is fully automated from the teachers' point of view. This includes generation of the virtual lessons for the enrolled students and the transmission of grades to our central course administration system MEDonline. No further administrative interaction by the teachers are needed. Teachers can fully concentrate on continuously updating of the virtual content and can answer questions, which students might have during execution of the virtual lesson.

1 Introduction

Since the introduction of a new modular based curriculum for human medicine in the year 2002 the Medical University of Graz (MUG) fosters its blended learning concept via its portal Virtual Medical Campus Graz (VMC) [1], [2], [3]. With start of winter semester 2010/11 the MUG successfully introduced a new primary learning management system (LMS) VMC/Moodle, which is now the third generation of LMS – after the LMS VMC 1.0 and Join2Learn - provided by the MUG for its students. VMC/Moodle as the primary LMS of the MUG currently serves more than 4,300 students from three studies and holds more than 10,600 unique learning objects. Within this paper we want to focus on one specific part of VMC/Moodle: on the diploma study human medicine and the implementation of fully automated virtual lessons.

2 Integration into organisational workflow & VMC/Moodle

The curriculum for human medicine consists of modules and accompanying lectures. The entire academic year is organized in six time slots, each with duration of 5 weeks. Furthermore the entire study year is organized in so called tracks, each track holding approximately 100 or 50 students, depending on either 3 tracks or 6 tracks are offered. Usually students apply for one track and remain there. They pass the study year within a track along the 6 time slots. In each time slot one module is offered. Accompanying lectures are offered over one semester with no overlap to the classes of the modules. Within modules and accompanying lectures frontal lectures (participation voluntary), seminars (participation mandatory, group size 24) and exercises (participation mandatory, group size 12) are offered. An example for the 4th study year (7th and 8th semester) is given in Figure 1.

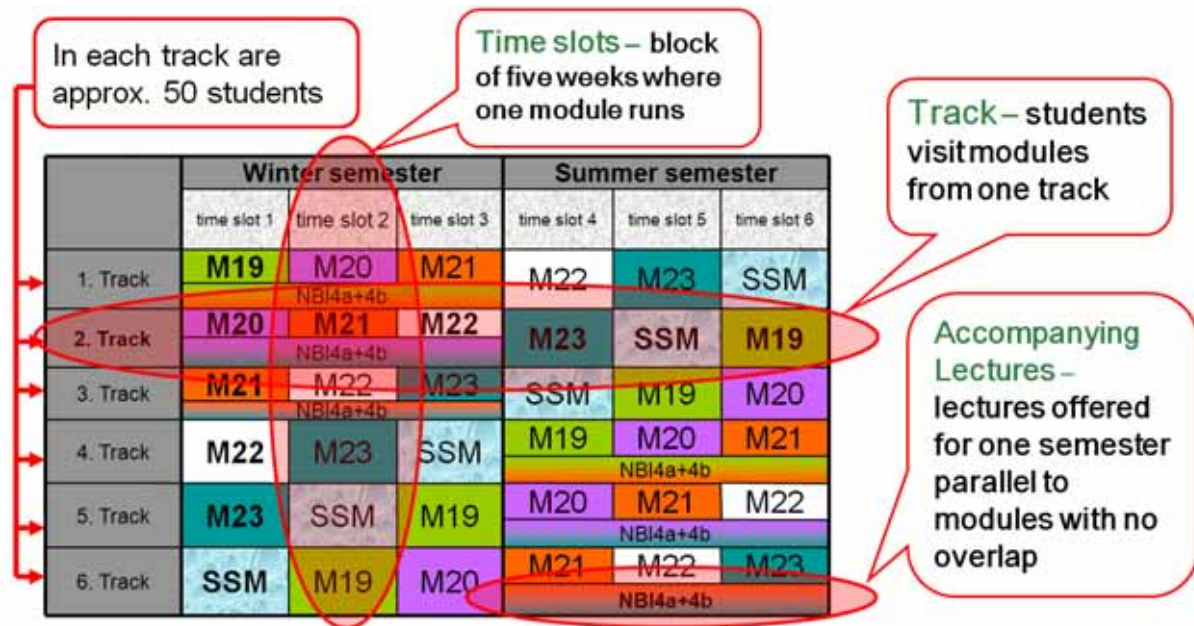


Figure 1: Example for the module based curriculum 7th and 8th semester human medicine

Within the diploma study human medicine eLearning is an integral part of the curriculum. Currently about 6% - this corresponds to 272 lessons á 45 minutes - of this study are fully virtualized, meaning that students can learn this content without having to attend any face-to-face classes. So students have a significant amount of flexibility to organize their study individually and to decide for themselves where and when they want to learn.

These fully virtualized parts are called “virtual lessons” and have to contain at least online studying material and an online quiz, a so called web based training (WBT). The purpose of the WBTs is to check, whether the students have reached the learning objectives of this virtual lesson. Even though the LMS VMC/Moodle offers a huge amount of different types of quizzes, only those types are allowed within virtual lessons which can be evaluated by the system fully automatically without any interaction needed from the teachers. Hence currently we allow for WBTs multiple/single choice questions, gap filling questions, numerical questions and matching questions.

As virtual lessons are an integral part of the curriculum virtual lessons must be executed by students within the time the virtual lesson is offered in order to proceed with their study. This is similar to normal seminars and exercises, where students have to fulfil a certain degree of presence in order to get a grade. However in difference to face-to-face lectures virtual lessons provide the flexibility to execute them at any time within the duration the module/accompanying lecture is offered.

Since students must execute the virtual lessons this implies quite high demands on the technical implementation in terms of performance, availability and reliability. The technical realization of the execution of virtual lessons is a fully automated process and – according to our knowledge – unique. It is discussed in the next two chapters from the users’ and technical point of view.

2.1 User View

If a teacher wants to virtualize one of his classes one single preparation step has to be performed. Together with the department VMC he authors online learning material and WBTs within the LMS VMC/Moodle. After the eLearning content of the virtual lesson is finished it will be synchronized within MEDonline [4], the central lecture and exam administration system for all studies of the MUG. The virtual lesson is now available for being planned. Technically a unique ID is generated for the virtual course within VMC/Moodle, which is transferred together with the title to MEDonline during synchronization. This “connects” the two systems MEDonline and VMC/Moodle.

From now on the process is fully automated and starts with the planning of the virtual lectures within the study year utilizing MEDonline. Even though virtual lessons are specifically tagged within MEDonline, they are treated as all other lectures within the system. Similar to normal lectures also each virtual lesson has a start date. For virtual lessons this is the date, from where the WBT parts of the virtual lessons are automatically generated within VMC/Moodle and presented to all students who are currently enrolled for the module where the virtual lesson is a part of it.

In Figure 2 an example for a virtual lesson within MEDonline and a part of its virtual content within VMC/Moodle is given. In the left bottom a lecture from MEDonline “sv1: Spezielle angiologische Therapieverfahren bei Arteriopathien” is listed, on the right upper side the associated virtual lesson in VMC/Moodle (containing the WBT) is shown to which the lecture in MEDonline is connected via the unique ID. In the MEDonline view also the type “virtuell” (virtual – identifies this lecture as a virtual lecture) and the starting date of the virtual lecture (3.3.2009 – 3 March 2009) can be seen. As explained before this is the date from where the virtual lecture will be presented to students within VMC/Moodle who are enrolled for this virtual lesson.

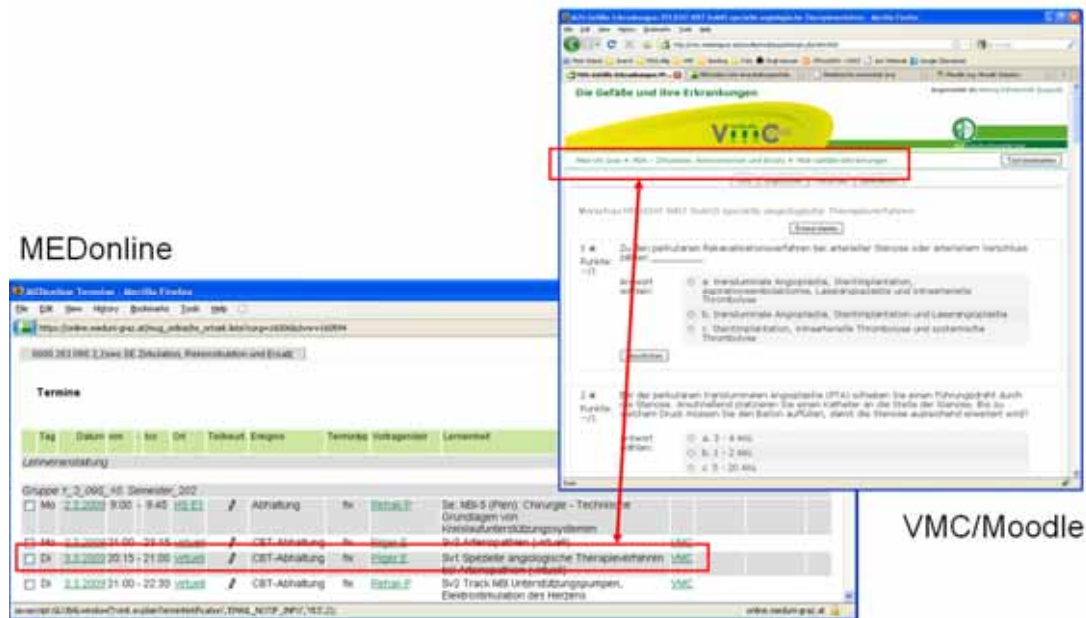


Figure 2: Corresponding virtual lessons in MEDonline and VMC/Moodle

The end dates for the virtual lessons are not within MEDonline and hence have to be provided manually to VMC/Moodle. However, there exist two general rules from which at least a semi-automated process could be derived and programmed in order to set the end dates by the system, which can then be manually overwritten by the department VMC in case a different end date has to be set. These rules are: virtual lessons which are part of modules, are generally offered over one time slot with a duration of 5 weeks. Virtual lessons which are part of accompanying lectures are offered over one semester. For the management of the virtual lessons an own administration user interface was developed which is given in Figure 3.

This interface allows employees of the department VMC to comfortably administer the virtual lessons. It gives an overview of all virtual lessons and their start and end dates. Furthermore it allows manually hiding and showing certain virtual lessons, to show the synchronization time with MEDonline, to manually synchronize with MEDonline data and to manually transmit grades of virtual lessons to MEDonline.

MOMOS Kursadministration: Mo 10.01.2011 - nur AKTIVE Kurse! (heute)



id	course	startdate	enddate	set vis.	set cron	last cron	update dates	update students	send grades	unenrol students
21	M 23 - Spezifische Verletzungen und deren Versorgung (Se - virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
22	M 23 - Fallbeispiele (Ue - virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
26	M 26 - Sv1 Algorithmen zu Diagnose und Therapie, Med (virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
27	M 26 - Sv1 Der Patient nach Organtransplantation, Chir (virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
28	M 26 - Sv1 Der Patient vor Organtransplantation, Chir (virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
29	M 26 - Sv1 die rekonstruktive Leiter, Chir (virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
30	M 26 - Sv1 Embolie, Med (virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
31	M 26 - Sv1 Herzinsuffizienz, Kardiomyopathie, Med (virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
32	M 26 - Sv1 Hypertonie, Hypotonie, Med (virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
33	M 26 - Sv1 kardiogener Schock, kardiologische Intensivmedizin, Med (virtuell)	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol
34	M 26 - Sv1 Klappenvitien, chirurgische Fallbeispiele, Chir	Mi 15.12.2010 00:00	Mi 02.02.2011 23:55			Mo 10.01.2011 00:15	Mo 10.01.2011 00:21	Mo 10.01.2011 00:22	Mo 10.01.2011 00:17	unenrol

Timemachine
HEUTE | Morgen | Gestern

Kurs Anzeige Filter
 Aktive Inaktive
 cron.1 cron.0

Set Visibility
 AKTIVE | ALLE
 INAKTIVE | ALLE

Set Cron
 AKTIVE | ALLE
 INAKTIVE | ALLE

Update Dates
 CRON* | ALLE

Update Students
 CRON* | ALLE

Send Grades
 CRON* | ALLE

CRON* wird NUR für Kurse mit cron = EIN ausgeführt!

RUN COMPLETE CRON*

Unenrol Students
 Kurse INAKTIVE | ALLE

Administration
[Erstelle fehlende Kurse](#)
[Fix momos_dates table](#)

Logfiles

- momos-2011-01-10.log
- momos-2011-01-09.log
- momos-2011-01-08.log
- momos-2011-01-07.log
- momos-2011-01-06.log

Figure 3: Virtual lesson management interface from VMC/Moodle

When the start date of the virtual lesson is reached, a task is generated for those students who are enrolled for this specific lesson. Students can access these tasks directly from the first page after their login into VMC/Moodle by clicking on a link called "overview on my virtual mandatory tasks". After clicking on this link a dynamic list is generated of all virtual lessons the student is currently enrolled and which he must execute in order to proceed with his study. For each virtual lesson the name, the end date and the number of trials already performed by the student is provided. If the virtual lesson has not been executed so far, a text indicating, that this virtual lesson still must be executed is displayed.

An example of a dynamically generated list with virtual lessons to be executed by a student is given in Figure 4. Students can now execute the WBTs of the virtual lessons as often as they like until the end of the virtual lesson is reached. The grade is automatically calculated, the best grade reached is stored. Grades are automatically transmitted back to MEDonline every day shortly after midnight. After the end date the virtual lessons disappear from the student overview page and cannot be executed anymore by them. The grade from the best trial is from now fixed in MEDonline and is from there further executed.

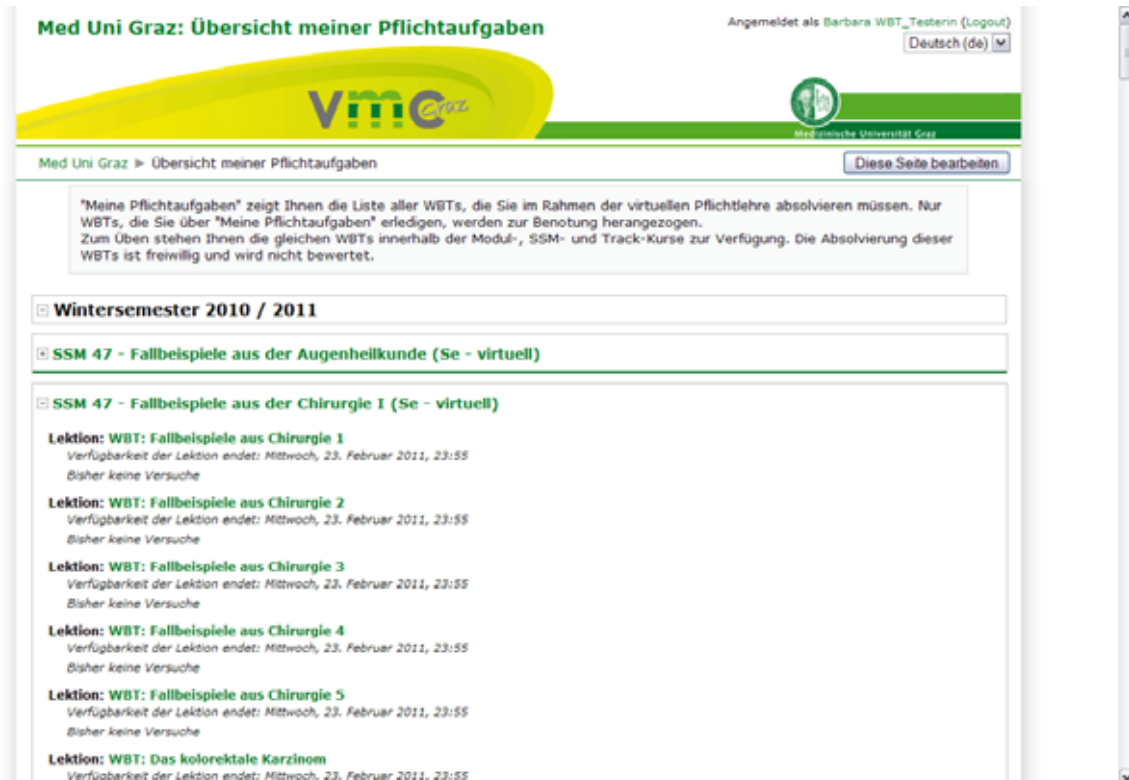


Figure 4: Dynamically generated list of virtual lessons which is displayed to students

With the final transmission of the grades from VMC/Moodle to MEDonline the process of the execution of virtual lessons is finished. It starts again with a new starting date of the virtual lesson and with new students enrolled to it. From the administrative point of view this process is fully automated, hence no interaction from the teacher is needed in connection with enrolment, execution of the WBTs and grading. The teacher can fully focus on continuously update of the virtual lessons and WBT quizzes and to answer individual questions students may have on the virtual content. The entire process is visualized in Figure 5.

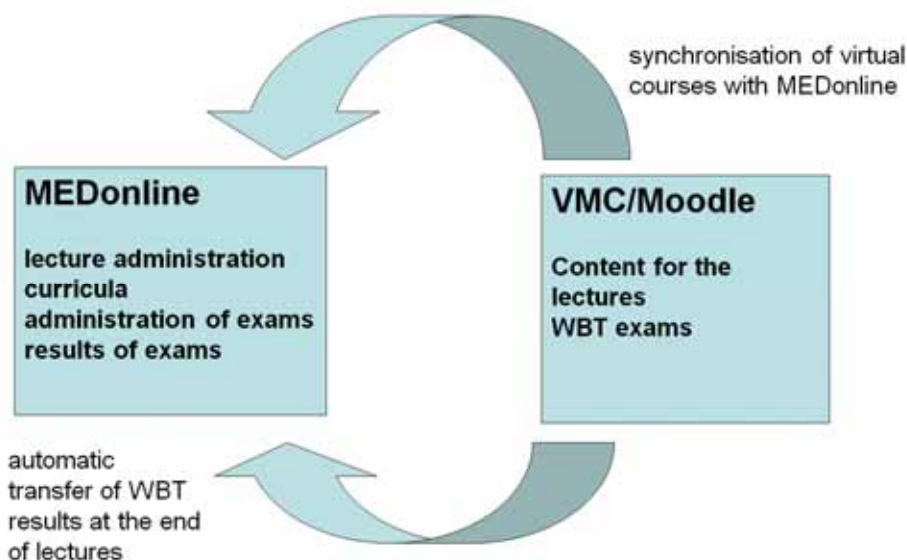


Figure 5: Synchronisation process between MEDonline and VMC/Moodle

For the synchronization between MEDonline and VMC/Moodle a special interface - called MOMOS (**M**EDonline **M**oodle **S**chnittstelle) - was implemented within VMC/Moodle. MOMOS is the active part, where as MEDonline serves on the one hand as a data source providing all necessary information in order to start virtual lessons for individual students, on the other hand it provides a data sink for accumulating all the grades for the virtual lessons. It should be noted that the MOMOS interface is

always the active part in the communication between the two systems hence MEDonline is queried and modified via the MOMOS interface and not vice versa. Technical details in connection with the MOMOS interface are provided within the next chapter.

2.2 Technical implementation

The „MEDonline Moodle Schnittstelle“ (MOMOS) has been implemented in PHP [5] as an admin module for Moodle.

One of the main goals during the conceptual phase was preserving the current organisational workflow using MEDonline to plan courses and assign virtual lessons to specific dates as described in the last chapter.

All relevant MEDonline data could be retrieved through an existing CAMPUSonline Oracle schema called 'CO_LMS'. This schema includes several database views that are used e.g. to map user names to primary keys or get specific course data for a defined student. Another part of the schema is a stored procedure for saving exam results coming from external systems to database.

The connection from MOMOS to Oracle is provided by the PHP OCI8 extension. For accessing the Moodle database standard Moodle library functions are used, providing independence from the underlying database (MySQL, PostgreSQL,...).

The admin modules task is to collect and process this MEDonline data to set the course startdate and visibility, the activity startdates and enddates (quiz, lesson and assignment), enroll and un-enroll students and send grades on a daily basis. The two main challenges for this were the conception of the actual business logic and the very poor Oracle connection performance under PHP.

To avoid the slowdown by long Oracle connection times persistent connections were used and MOMOS functions and data queries were optimized for retrieving large chunks of data minimize the number of Oracle requests. This approach proved to be reliable and fast.

Each course can be tagged for processing by cronjobs automatically, or alternatively be excluded. In some cases manual processing is required for testing or correcting purposes. All actions can therefore be performed manually for individual courses or all courses as well. Filters provided for convenient access to active/inactive and courses selected for automatic processing.

In order to provide safe and reliable automatic processing of 100+ courses and several thousand students on a daily basis, two additional features have been added. All transactions are committed to daily plain text log files. The log files are human readable but also provide syntax for automatic error retrieval. The second feature is called "time machine". The MOMOS admin interface can be set to any date in the past or in the future and can execute all functions for the specified date. This feature is very useful for testing "what if" scenarios in the future or correcting errors e.g. resending grades for students that were un-enrolled manually by accident in the past.

The MOMOS admin interface also provides an easy visualization of the system status. If all columns are highlighted in green all actions of the last cronjob were performed successfully. Errors are highlighted in red, warnings or status off in orange.

The "overview on my virtual mandatory tasks" is a modified version of the MyMoodle page that only displays courses linked with MOMOS. Due to the occasionally high number of courses (40 and more) the list is alphabetically sorted for better clarity.

3 Experiences

With the introduction of VMC/Moodle as the primary LMS on 1 Oct 2010 124 virtual lessons were offered within VMC/Moodle containing all in all 258 WBTs (119 Moodle-quizzes und 139 Moodle-lessons). Since then 1712 students enrolled in 12 different modules/tracks completed these virtual lessons and all in all 162,192 grades have already been submitted to MEDonline without any serious problems.

Due to the fact that virtual lessons must be executed by students within a specific time period in order to proceed with their study we had very high demands on VMC/Moodle in terms of stability, availability and performance. As it can be seen in Figure 6 the monthly access rate from its start on 1 Oct 2010 is approximately 100,000 accesses a day, one peak reached even 130,000 accesses a day.

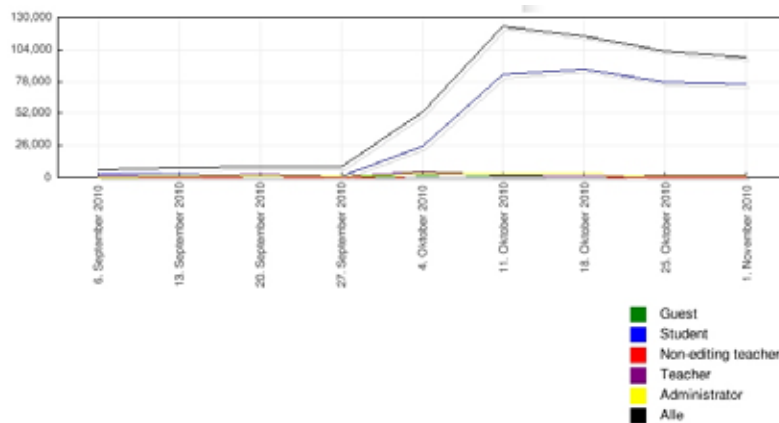


Figure 6: VMC/Moodle access statistics since its introduction on 1 Oct 2010

Nevertheless, the system neither seriously crashed since its start nor lacked from performance problems. Only once we had to perform a more extensive maintenance on the cluster configuration and for this purpose one of the servers had to be shut down. However, the active/active cluster configuration granted availability all over the time, and despite only one server of the cluster was online no performance problems could be discovered so far.

Since we did not have the specific Moodle know-how for implementing the MOMOS interface in house we decided to outsource it to a company [6] specialized in the implementation of Moodle modules and which also already had experiences with connecting Moodle to an external and separated course administration system. However, the MOMOS interface was designed and implemented in close cooperation with a technical expert from the MUG and so we can now react very fast in case any unexpected behaviour appears in connection with the MOMOS interface and the virtual lessons. So far only minor issues appeared and could be solved by us without being dependent on the support of the external company.

4 Conclusions and Outlook

We introduced the concept and its technical implementation of virtual lessons within the study of the diploma study human medicine. Since the process is fully automated teachers can fully concentrate on continuously updating of the virtual content and can answer questions, which students might have during execution of the virtual lecture. Additionally, as most of our teachers are physicians, this process saves their valuable time resources, thus allowing more intensive bedside teaching.

We decided to outsource the implementation of the Moodle specific interface to MEDonline to an external company specialized on Moodle. This decision was not easy, since we did not want to be dependent on an external company in case any unexpected issues arise in connection with the interface. It turned out to be very important to have at least one technical expert also at the MUG side who designed and accompanied the development of the interface.

The active/active cluster configuration of our VMC/Moodle LMS is according to our knowledge quite unique all over the world. We did the set up in close interdisciplinary connection with the MUG-IT department, with several pilots. For the set-up and maintenance technical in-house experts are absolutely necessary. The cluster turned out to be very stable and provides also enough performance even when one node goes down.

In December 2010 the first stable version of Moodle 2.0 was released. Moodle 2.0 provides some radically new concepts including a new file system, new layout, and intelligent learning paths, just to mention some of them. We are still observing closely the developments and currently plan to migrate to version 2.0 earliest with winter semester 2011/12. Especially in connection with the migration of our implementation of the virtual lessons and the MOMOS interface we expect some challenges.

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