Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Information Engineering

Diploma Thesis

Workflow System Supporting Education Process

Kseniya Bortnikova

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

Kseniya Bortnikova

Informatics

Thesis title

Workflow system supporting education process

Objectives of thesis

The goal of this thesis is analysis, design, implementation and testing an information system supporting education process. This software will work with data about miscellaneous time-based students' teaching blocks taught by visiting professors. Each student has to attend lectures and pass through a final test. This is performed several times in the semester. The info contained in this system provides a decision basis for obtaining a credit. Select the best implementation environment and realize this goal.

Methodology

The functional requirement model will be created first. Then, a conceptual analysis of a data model and workflow process will be designed. Final implementation will be in some standard software framework. Following software engineering standards will be used: UML and Ambler's approach to the SW development.

The proposed extent of the thesis

60 – 80 pages

Keywords

workflow, information system, learning management, student projects

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Recommended information sources

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W.M.P. van der Aalst and K.M. van Hee. Workflow Management: Models, Methods, and Systems. MIT press, Cambridge, MA, 2002.

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The Diploma Thesis Supervisor

doc. Ing. Vojtěch Merunka, Ph.D.

Supervising department

Department of Information Engineering

Electronic approval: 29. 11. 2016

Ing. Martin Pelikán, Ph.D.

Head of department

Electronic approval: 29. 11. 2016

Ing. Martin Pelikán, Ph.D.

Dean

Prague on 28. 03. 2017

Declaration

I declare that I have worked on my diploma thesis titled "Workflow system supporting education process" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on _____

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Workflow System Supporting Education Process

Abstract

The Diploma Thesis provides detailed analysis as well as modeling, management and implementation solutions for specific educational activity (study block process at Czech University of Life Sciences), where multiple participants with various roles use predetermined teaching and learning techniques (education workflows) in the context of Moodle LMS capabilities.

Methodology of research supposes installation, learning and using Craft. CASE modeling tool as well as Moodle LMS version on local server.

Results of the work proposed some teaching and learning improvements through the construction of efficient workflow for teaching and learning by automation education processes executed manually (study materials providing, online knowledge testing, attendance checking, survey participation).

The final results of this work might be considered as useful to the CULS teaching board and management by means of Moodle LMS further development can bring changes to the university at managerial, academic and technical levels.

Keywords: Workflow, Workflow Management, Information System, E-Learning, Learning Management System, Moodle, Course Management, Teaching and Learning Activities, Study Block.

Systém Workflow Podporující Vzdělávací Proces v Moodle

Abstrakt

Diplomová práce uvádí detailní analýzu, stejně tak, jako modelování, management a implementaci řešení pro specifickou vzdělávací aktivitu (proces studijního bloku na České zemědělské univerzitě), kde několik účastníků s různými úlohami používá předem určené výukové a studijní techniky (vzdělávací workflows) v kontextu možností Moodle LMS.

Metodologie výzkumu předpokládá instalaci, studium a používání Craft. CASE modelovacího nástroje, stejně tak, jako LMS verzi Moodle na lokálním serveru.

Výsledky práce nabízejí některá zlepšení výuky a studia prostřednictvím výstavby efektivního workflow pro výuku a studium automatizací vzdělávacích procesů, provedených manuálně (poskytnutí studijních materiálů, online testování znalostí, kontrola docházky, přehled o účasti).

Konečné výsledky této práce mohou být považovány za užitečné pro akademickou radu a management ČZU prostředky dalšího rozvoje Moodle LMS, který může přinést změny na univerzitu v manažerské, akademické a technické úrovni.

Klíčová slova: Workflow, Management Workflow, Informační systém, E-Learning, Systém řízení výuky, Moodle, Řízení kurzu, Výukové a studijní aktivity, Studijní blok.

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1 Introduction

The intensity of use of e-learning techniques to support all the variety of education processes in academic institutions is increasing rapidly in recent decades. Universities and colleges might customize functionalities of any from the significant number of learning management system to accomplish specific academic needs and requirements. At the same time, the use of principles and best practices from Business Process Management and its supporting technology (workflow) in context of e-learning systems adoption and development seems to be a logical technical choice for management of a learning process.

Moodle Learning Management System is widely deployed and utilized in academic institutions today. However, the universities constantly expand the scope of academic activities to compete for students and for funding that requires persistent development of new ICT solutions in context of existing information systems.

The situation is similar to Czech University of Life Sciences (CULS), which is case study for this work. Study Block learning activities introduction decisively brings educational benefits to students as well as it helps to achieve strategic goals of the University.

The Thesis is composed of 7 chapters which are organized as follows: In Chapter 2, objectives and methodology of this work are discussed; In Chapter 3 a literature study on the crucial aspects of learning management systems is presented; In Chapter 4 teaching and learning systems at CULS are introduced; In Chapter 5 the results of conceptual analysis and modeling are proposed; Chapter 5 also provides proposed Moodle implementation of the case study is covered; Results and Limitations of the study are the subjects of Chapter 6; Conclusion is given in Chapter 7.

2 Objectives and Methodology

2.1 Objectives

The main objective of the Diploma Thesis is modeling, management and implementation of information solution for the flow of activities and events in a study block education process, where multiple participants with various roles use e-learning techniques and media types in the context of Moodle LMS. Generally speaking, the work focuses on e-learning workflows management.

The Thesis has a number of partial goals. The first goal is to understand the importance of e-learning in context of academic institutions using as well as specific role of workflow approach as applied to e-learning processes.

The second goal is to analyze the current role of Moodle at CULS. This information is fundamental in assessing whether implementation of solution for study block in Moodle is needed in the university's teaching and learning environment.

The third goal is to formulate requirements for e-learning solution for study blocks based on data model analysis with respect to workflow structure of teaching and learning activities.

The fourth goal is to provide framework to administrators and teaching board and other faculty stakeholders on how Moodle using can improve the teaching and learning of study blocks.

In response to this, a Moodle module for a particular study block is created as a case study, the underlying features are tested.

2.2 Methodology

The research process for this thesis work is divided into three substantial phases. The first phase involves literature review with background information on E-learning, learning management systems and Moodle environment. This phase also includes analyzing the materials on the CULS information systems and a role of Moodle at the University. The second phase involves requirements formulation, conceptual analysis of data model and workflow and modeling using UML. The third phase provides implementation of the case study, which involves creation of study block for Databases and Knowledge IS course module in Moodle. Therefore the study proposes some improvements to the current course teaching and learning environment.

3 Literature Review

3.1 Introduction to E-Learning

In a general sense e-learning is as technology-based learning in which learning materials are delivered electronically to remote learners via a computer network (27, pp. 75-79).

Over the last decade, the e-learning techniques became an accepted form of education across the different education types. The fact of widely using the e-learning techniques in academic institutions on different levels gives an obvious opportunity for teachers and students to perceive the educational process in effective manner.

As Aparicio and Bacao (2013) argue, using the e-learning techniques allows teachers to change their roles from information source to facilitators who can help and support academic intentions of a student. (2, p.2) Student role is also changing from passive listening, note taking, and memorization to activities that situate learning in the context of solving real-world problems. (1, p.2)

In order to meet the demand for quick and high-quality learning the information systems came up the considerable way: many e-learning systems had been developed.

There are two main types of e-learning information systems on the current market that vary in their development and business principles. Systems of the first type are developed on the commercial basis and are close-source software products. These software products are developed for profit and commercial purposes by professional developers. Systems of the second type are developed as open-source software systems. These products are developed in an special purpose mode; the software products are distributed for lower license fees by networks of large volunteering group of computer programmers. (18, p.10) .The most popular and widely distributed systems of the second type are ILIAS, Moodle, Sakai. In case of using open-source systems, lower costs might be offset by higher developing and implementation costs. Nowadays open-source e-learning systems had obtained substantial popularity in comparison with the close-source e-learning systems (18, p.10.)

The following chapter of the thesis will provide the detailed discussion of the e-learning systems and their features.

3.1.1 E-Learning Systems

The definition of an E-learning is given by Busuttil-Reynaud and Winkley (2006) for JISC e-assessment glossary: “ E-Learning is a process of learning that is supported by the use of ICT (e.g. the Internet, network, standalone computer, interactive whiteboard or portable device). Also used loosely to describe the actual content delivered on-screen, and the more general use of ICT to contribute to learning processes.

Analyzing the chronology of E-learning it can be concluded that the concept was not the first attempt to the use for a computerized system that facilitates the learning process. E-learning concept development originally had started from the Computer-Assisted Instruction concept, that is a self-learning technique, usually offline, involving interaction of the student with programmed instructional materials. (30). Computer-Assisted Instruction concept points to using of the information technologies as a tools to assist and promote instructions. The concept includes tutorials, trainings, simulations and problem solving approaches to present topics, and they test the student's understanding. According to Ralston and Reilly research (2000), the concept of Computer-Assisted Instruction originated from 1955 as a result of the way of teaching problem solving.

In comparison with Computer-Assisted Instruction concept, e-learning systems have also provided the technological and functional driven focus due to the fact that Internet capabilities grew in overcoming time and space issues.

As it was discussed in number of sources, e-learning concept was initially focused on two main development directions. The first one was based on tasks completion and subsequently more focused to the students. Another one direction of was the concept of online (Internet-based) e-learning that can be determined as learning that occurs partially or entirely through the World Wide Web. Online learning produces an information or knowledge available to users disregarding time, space and location barriers. Further, e-learning development covered the virtual classroom concept that is a teaching and learning environment where participants can interact, communicate, view and discuss presentations, and engage with learning resources while working in groups, all in an online setting (28).

Subsequent simultaneous development of e-learning and web-technologies allows to support learning in a more personalized and flexible way. In other words, recent achievements of networking created a wide spectrum for the e-Learning industry through the technological development and standard practical applications. Primarily it concerns a direction of distribution of media contents of different formats irrespectively of participant's time and location: it might be accessible anywhere, anytime and to anyone.

E-learning systems nowadays give to participants of learning process a range of opportunities. These opportunities include self-paced learning, providing consistent learning materials to students, updating the learning materials easily and quickly for teachers. The resulting effect of such an approach and is usually education costs reduction: it becomes less expensive to organize learning process as a whole. Usages of e-learning techniques could potentially lead to an advanced memorization and a stronger understanding of the subject; while at the same time could be easily managed for large groups of students (10, pp. 333–345).

Investigated sources and researches distinguish the number of components that characterize the system as an e-learning system. According to Krishnamurthy (2012), an effective e-learning system can be assessed as an integrated end-to-end learning system that includes three main components. The schematic representation given by the author is depicted in Figure 1.

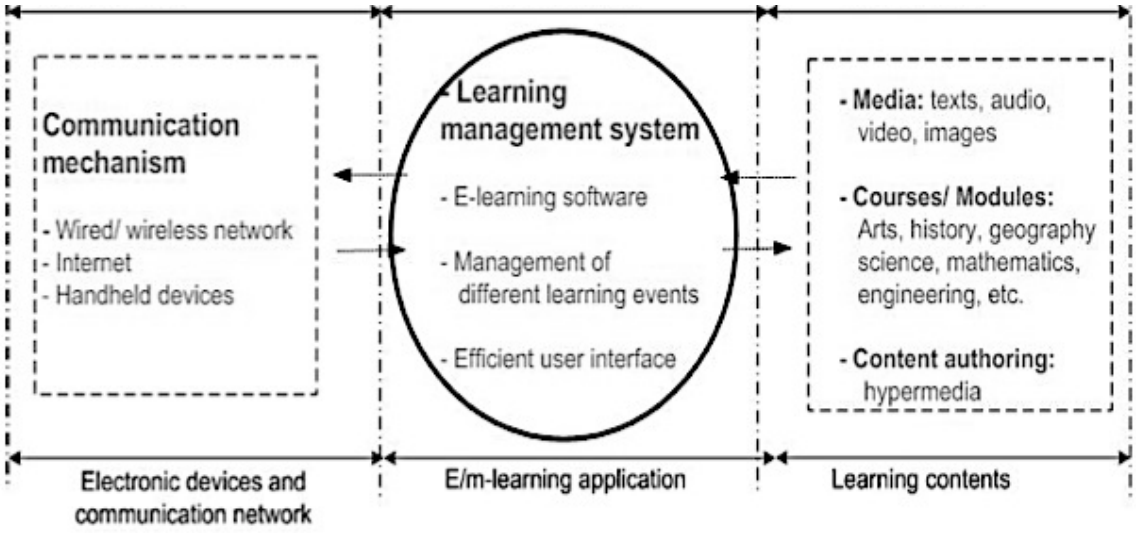

Figure 1 -Components of E-Learning System (18, p. 18)

The first component of effective e-learning system is the learning content. The learning content concept represents combination of pedagogical models and set of resources that participate in every student's learning experience that are correlated with learning outcomes and positive results from the learning experience. Particularly, the learning content of e-learning system includes course materials for different courses and modules.

The second component of effective e-learning system is the content distribution network or transmission network. Content distribution network (CDN) is a collection of network elements arranged for more effective delivery of content to end-users (15, pp. 36-37). The goal of a CDN is to serve content to end-users with high availability and high performance. The content distribution network provides stepless communication mechanism of distributing content to cache or edge servers located close to users.

The third component of the effective e-learning system is a learning management system (LMS). The learning management system can be perceived as a bridge that connects the CDN and learning content in the end-to-end learning system. The Learning Management Systems are not only an integral part of an e-learning system but also form a basis/platform to impart technology-based-education to the learners. There are several LMS's available and the most popular ones includes Moodle, Blackboard, Dokeos, Sakai, Blue apple, ILIAS, Adobe acrobat e-learning suite and several others.

The detailed description of LMS as an important part of the e-learning system is the subject of the following chapter.

Another view for understanding the e-learning system is given by the study of Gautam and Tiwari, (2016). The authors consider an effective e-learning system as a unit of five components:

- **Audience Component.** The importance of this component is explained by the fact that the student is a decisive element in the process of developing e-learning system. The interests and needs of the student have to be determined at the earlier steps of the development and analysis. The analysis of student duties is intended to find out also the basic structure of the other four components of the e-learning system.

- **Course Structure Component** that represents the way how the course is designed within e-learning system. Course structure represents the result of face-to-face course conversion to an e-learning format. For successful development of this component the number of items have to be accurately considered: the logics of modules aggregation, size of modules, interactive concepts and graphics incorporation. Eligible course structure helps to explain ideas and concepts efficiently.
- **Page Design Component.** The component represents how a course page is organized. This is crucial to the learning process since it has a huge impact on the learning experience of a student. Simple and intuitive navigation is necessary for better engaging of the student. The goal is not to distract the student by complicated and dominated layout, graphics or text. The goal is to retain the interest to achieve the learning goals.
- **Content Engagement Component** refers to manner of interaction of the student interacts and content of the course.
- **Usability Component.** When interacting with e-learning systems this component issues become essential. The usability implicates the necessity of content and application testing in the context of the system.

The schematic representation given by the authors is depicted in Figure 2.

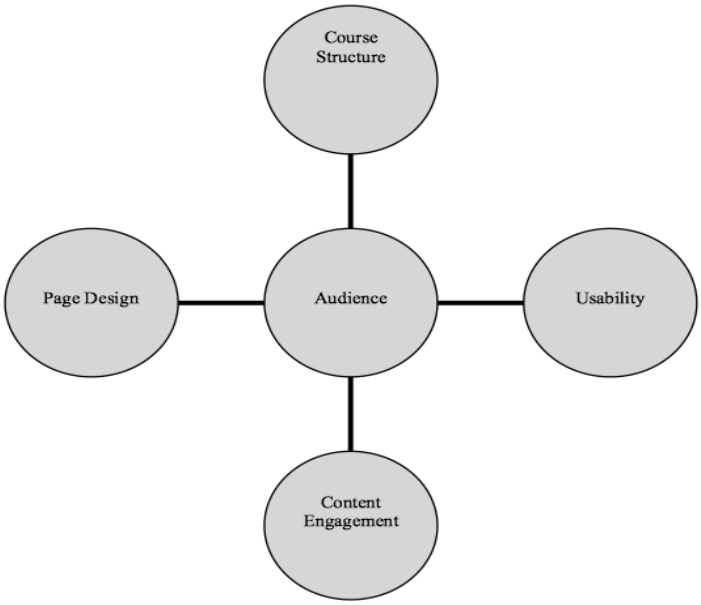

Figure 2- Components of E-Learning System (14, p.14)

3.1.2 E-Learning Trends

Since the globe e-learning becomes increasingly viable and accessible, it is crucial to provide description of some e-learning perspectives and trends. These trends will give a representation to how e-learning and learning tools will be shaped in the future (20, p. 29).

Blended learning. The blended learning (that is also referred to as hybrid learning*)* is a combination of traditional (face-to-face) and online learning in a manner that the one supplements the other. As an example of blended learning adaptation, a student might attend classes in a real-world classroom setting, and then supplement the lesson plan by completing online multimedia coursework. (20, pp. 34-35). While some academic institutions use blended learning techniques irregularly, others might serve blended learning as a principal teaching method within their educational plan. Tools and platforms that complement this trend include LMS and rarely mobile devices .

Collaborative Learning. The e-learning trend and approach where students are able to interact with other students, as well as with instructors. Esentially students collaborate in order to extend their knowledge of a particular topic or subject. This e-learning trend can be carried out either offline or on the web. The collaborative learning is typically realized by means of live chats and message boards. Collaborative learning approach relies on the principle that students enhance their learning experiences by interacting with others and from adopting one another's proficiency. It allows to absorb the ideas, skills and experience of another participants of the course. Moreover, in case of collaborative learning, participants are responsible for one another's response and tasks elaboration that encourages solidarity as well. By engaging in a shared task (project or team assignment) the participants gain the opportunity to obtain also a skills, such as group analysis and collaborative teamwork building skills. Due to the fact that collaborative learning can be organized virtually, the problem of participants attendance is partially solved. Participants who are unable to attend the learning event can take part in collaborative learning through any available tools that don't demand of real-time interaction such as online forums or message boards.

Gamification can be referred as one of the recent trends of E-learning. The gamification approach means using games logics and thinking as well as game-based techniques for solving non-gaming problems. Gamification aim is to inspire learning, entrain students, and motivate activitie participation in problems solving. Moreover,

gaming provides not just knowledge deliverying, but it is the instructional method, that defines the elements for learning in a game situation. Gamification trend in e-learning takes game elements and connects them to traditional instructional techniques that are represented by case studies, stories, and interactive activities. In the context of e-learning, gamification trend is considering more on participants engagement, and objectives less.

Micro-learning. Micro-learning is one of the most popular trend of corporate e-learning environments and systems nowadays. As an approach micro-learning implies learning in smaller steps when participants receive the certain amount of knowledge that help to advance toward their educational goal. Activities that are micro-learning are based on short term lessons, projects, or coursework that is designed to provide the student with bits of information. (20, p.30). The micro-learning can be described as the situation when teacher rather than trying to teach a student about a comprehensive topic all at once, separates aspects of the topic into smaller lesson plans and learning tasks. The micro-learning approach can provide a wide range of benefits to both teachers and students due to the fact that micro-learning brings educational benefits without participant's overwhelming. Micro-learning gives students and teachers the opportuinity to accumulate interrelated information in short forms, which can contribute them to understand it much more effectively. The micro-learning can be referred as the effective solution for the situations when students might not have enough time to devote to a deep course. Typically this approach is better applied when participants need to get the information rapidly. Micro-learning can be carried out in a variety of ways. The apploach can be applied on-the-go using most popular forms as emails, online posts, short multimedia videos. The short chat sessions also can provide e-learning students with the short information blocks that are important for them to achieve their educational goals and to expand their overall knowledge base.

Video Learning. Video learning trend can be referred as one of the faster growing trend of e-learning. This is implied due to the fact that faster internet connections and the increasing use of mobile devices (such as mobile phones and tablets) with video capabilities means that using video in the e-learning process has become commonplace. Video learning brings a whole new dimension to teaching methods: the teacher can show step-by-step processes the students need to follow to complete a task. Hence, the course content that involves a level of practical skills becomes demonstrative. Demonstrative

aspects of the course, in turn, will definitely provide benefits in comparison with teaching materials that are explained in text and static images. Videos using also promotes to add a feeling of personalization to a course.

3.2 LMS in the context of E-learning

The Learning Management System (LMS) is referred as a system that automates the processes of management, administration and reporting of all activities related to education within certain academic institution. These systems can be also named as Course Management Systems (CMS) or Virtual Learning Environment (VLE).

The e-learning platforms that are typically large, complex, and expensive monolithic systems, and requiring training of department members, are referred as Learning Management Systems (21, p. 20).

The principal functions of the LMS are as follows:

1) **Management function.** This function covers the designing of time schedules for courses and classes, importing and making available (publishing) courses to the participants, developing a list of resources available, resource management in context of academic institution (classrooms, technical equipment, projectors), course fees managing as well.

2) **Tracking function.** The function of LMS (which is also referred as monitoring function*)* that means tracking the educational process by recording data related to the learning process for each individual student, monitoring students behaviors in context of LMS using during their learning sessions, monitoring the educational process costs. This function becomes especially important for long term using of the LMS.

3) **Reporting function.** This function of LMS supposes report preparation with various types of reports. The most important are reports on the studying results, student satisfaction, as well as the range of administrative reports. Reporting function solves the problem with accessing to information that would be difficult to gather manually.

Learning management systems nowadays offer a wide functionality and features in a single system. The functionalities of LMS are conventional to divide to basic and user levels. Basic LMS functionality includes authentication module, users and group management, resource management module that implies uploading and downloading of

content functions, search functions. User-level functionality of the LMS includes a range of management functions such as enrollment, statistical and grades management. On the user level, LMS also offers functions of web page creation and editing, forums and chats using, calendars, quizzes, facilities for surveys, contact forms and e-mail notification.

Learning Management Systems can be built on different platforms, in most cases Java, PHP, .Net and they are combined to a database such as MySQL, SQL Server or PostgreSQL.

The crucial point to consider about the LMS adoption is whether to use a deployed solution or a hosted system.

A Deployed Solution System (also referred as Internal System) will be generally set up on computers within institution premises and behind institution firewall. This type of solution might incur additional costs, as the setting up of the system is likely to be accomplished by institution own efforts rather than remotely. In some cases, an installed system may require more efforts for maintenance and support than institution is able to provide. Thus far the institution needs to create or hire an IT team with relevant skills to support the system. A deployed solution suppose to have a greater initial cost since the institution needs to consider the software and installation costs, but these costs might be more effective in the long-term period.

With a Hosted Solution System (or SaaS) the system actually runs on external server: the external organization provides server load or maintenance. The system will be set up by external provider, which is also responsible for backups oneself. The provider might also offer a simple interface to schedule institution's own backups. With a hosted system the institution will have less costs initially (without software purchase costs and without installation fees) and limited technical problems. However, over the years the institution statistically will spend lager costs than if disburses for an installed LMS.

Currently, the usage of Learning Management Systems is accepted over many academic institutions such as schools, colleges and universities worldwide. Speaking about the factors of success for a LMS, primarily meaning is that the e-learning site has to be easy to navigate, well organized and must contain high quality material. The successful LMS should provide a solution of everyday tasks including the distribution of new material and sending, receiving and grading assignments. A well-designed LMS will ensure that

those tasks are unsophisticated and that its users can easily utilize all the necessary features that are an important part of the e-learning process.

In addition to the effectively adopted learning management system, institutions cosequently need to operate content management systems (CMSs) for public content. This fact resulted in functionality duplication, increasing administrative costs and additional maintenance requirements (21, p. 21-22).

In context of this Master Thesis, Moodle LMS is considered as the platform to implement and analyze potential benefits of the e-learning decision. The reason is the Moodle LMS supports the information solution for teaching and learning at University of Life Sciences in Prague. The following two chapters of the thesis will provide the basic overview of Moodle environment and the description of the features and traits that are connected with the Moodle for CULS, the information solution at the University of Life Sciences.

3.3 Modular Object-Oriented Dynamic Learning Environment

Moodle abbreviation states for Modular Object-Oriented Dynamic Learning Environment.

Moodle is one of the first open source e-learning platforms that had been developed and released on 20 August 2002 by Australian educator and computer scientist Martin Dougiamas. The initial goal was to help educators to organize the program of online courses with a focus on interaction and collaborative construction of content, and it is in continual evolution (29).

Nowadays the Moodle Project Development is assisted by the collaborative work of open-source programmers all over the world. However, the Moodle Project is officially headed and coordinated by Moodle HQ. Moodle HQ is Australian company that cosists of thirty developers, which are financially, supported by a network of eighty four Moodle Partner service companies worldwide (29). Moodle had 58,207,428 users as of 2nd June 2012 (29).

The main focus of the Moodle Project points to creating the course content and delivering this content to learners providing interaction and collaboration as the important criteria.

Moodle is designed to provide highly extensible and customizable information solutions. Therefore modifying the core libraries might create problems with upgrading Moodle versions.

3.3.1 Moodle principles

Moodle creators and developers position their product as the e-learning environment that follows strong pedagogical principles. The pedagogy is referred as the ability of being a teacher and generally concerns to strategies of instruction, or a style of instruction. Pedagogy and software design are closely connected in e- learning approach by means of the fact that software configuration can potentially help or obstruct the teacher in teaching process.

The Moodle core consists of Courses. The Courses in turn contain Activities and Resources. As the examples of activities are the following: forums, databases, wikis, glossaries, assignments, SCORM players, quizzes and others. There are more than twenty different types of activities available in Moodle and each of them can be modified and adapted in accordance with learning process requirements. Using this activity-based model, Moodle allows combining the activities into particular and reasonable sequences and groups in context of specific learning process.

From the technical point of view, Moodle is structured as an application core, surrounded by number of plugins of different types to provide specific functionality. That means Moodle installation can immediately be used to for teaching and learning activities. Further, Moodle site need to be adapted for a specific purpose by modifying the default configuration and by installing additional plugins or removing standard plugins. Moodle is designed to be highly extensible and customizable without modifying the core libraries, as doing so would create problems when upgrading Moodle to a newer version.

3.3.2 Moodle core

Moodle Core provides the infrastructure and supports the important concepts that all the plugins will require to work with. The concepts are the following:

- **Courses and Activities.** A Course in Moodle is a sequence of activities and resources that are grouped into sections. Courses are organized into a hierarchical set of categories within a Moodle site.

- **Users.** Anyone who uses the Moodle system is referred as Users. User needs to be enrolled into course with a given role to participate in Course.
- **Course enrolment.** Enrolment grants the possibility to participate in course as a student or teacher to Moodle system user.
- **User roles in Moodle**. Roles that are assigned to users provide them with a prescribed set of capabilities in given context.
- **User's capabilities in Moodle.** Capability in Moodle is associated with User Role and represents a description of the particular Moodle feature.
- **Context.** The Context concept in Moodle represents a symbolical space, that is for example a space of courses, activity modules or blocks.
- **Permissions.** Permission concept in Moodle represents the value that is determined for a capability of particular role. As an example the permissions such as “allow” or “prevent” are basic for Moodle System.
- **Creation and editing of user profiles**. User Profile is created at the moment the user creates an account in Moodle System. For account creation the user has to fill in the personal details for profile form. The permission to edit the profile remains for the user at any time after account creation in Moodle System.
- **Groups and cohorts.** Cohorts conception assumes that all members of a cohort have to be enrolled in a Course by one common action (manually or synchronised automatically.
- **Enrolments and access control.** The User’s access permission in Moodle System is limited by the group and role settings

3.3.3 Plugins

As it was mentioned earlier Moodle environment provides a plugin mechanism for the purpose of functional extension and customization during system adoption. Referring to Moodle abbreviation, using of plugins expresses the modularity principle of Moodle LMS.

Plugins represent the adaptable tool selection that allows Moodle developers to extend the features of the Moodle system. There are more than hundred of plugins created for Moodle that broaden the distinctive features of the core Moodle's functionality.

In fact, a Moodle plugin represents a folder of PHP scripts (including also CSS, JavaScript, and other scripts if necessary). Communication between the Moodle core and the plugins occurs by looking for particular entry points. The entry points are defined in the file *lib.php* within the plugin.

The crucial point to mention is that plugins in Moodle are of specific types. In other words, different plugins (for example, an activity and authentication plugins) interact with Moodle core using different APIs that is specific to the type of functional capabilities the particular plugin provides. There are functional capabilities that are common to all plugins such as installation, configuration, upgrade, permissions and others. These functionalities are handled universally across all plugin types.

Adding the new functionality to Moodle in most cases means writing one of these types of plugin. That is the most intrinsic and maintainable way for Moodle developers. In case if the standardized plugin types does not satisfied the needs of institution, the local type can be used.

As of April 2015, there are over 1,000 plugins available for Moodle with over 7 million downloads (29). Most additional plugin scripts that have been shared publicly are listed in the Moodle Plugins Directory.

The standard plugins for the Moodle system are:

- **Course formats.** Control formats plugin type provides control function of the manner how the structure of course, a sequence of activities grouped into sections is presented to the users. Course formats live in the course/format folder.

- **Authentication plugins.** The Authentication plugins are used to adjust the manner of users logging in. Moodle System allows managing usernames and passwords internally. The control might be also performed using authentication data stored in LDAP or another database. Optionally, Moodle system allows using a number of single-sign-on schemes.
- **Enrolment plugins.** The enrolment type of plugins regulates a procedure of users' enrollment to particular courses. As well as the authentication monitoring, this procedure might be synchronized with another system, possibly a student information system at the university or school. Alternatively, Moodle System might track enrollment internally.
- **Repository plugins.** Repository plugins are responsible for the set of methods that allow users to get content (files) into Moodle System, either by uploading from their hard drive, or by getting the file from another location on the Internet. The examples of external application for content storing are such software systems as Drop Box, Google Docs, or Flickr.

3.3.4 Other components of Moodle System

Along with number of plugins Moodle system provides the following individual components:

- **Activities and resources.** Activities and resources relate the most fundamental individual components of the Moodle System. These components compose a course and represent the principal instruments for teaching and learning. The most basic examples of resources in Moodle System are pages, links and IMS content packages. Activities category is among the largest types of plugin in the context of the code size. As an examples of activities are assignments, forums, wikis and quizzes.
- **Blocks.** Blocks term in Moodle System represents small bits of interface functional capabilities that might be added to pages. The substantial number of blocks provides supplementary representation of data stored and modified outside of the system.
- **Themes.** Themes category of Moodle elements is responsible for visual and graphical representation of the system. The complete visual representation of a Moodle web pages as well the style of a particular course, or the

number of courses in a category, can be modified using different themes at different system levels. Themes set represent the standard method how to provide aesthetic changes of Moodle application, separating visual presentation from content and functionality.

- **Translations.** Due to the fact that Moodle System is internationalized, the institution can get language packs for required language; currently Moodle has been translated in over 100 languages. Language packs are downloaded and installed via the Moodle administration screens. Moodle System provides the option for administrators to change manually any of the standard user interface strings if the terms used in the installed language pack are not appropriate.

3.3.5 The Moodle database

The Moodle database is quite comprehensive; it contains cumulatively more than 250 tables. The integral database is an aggregation of the Moodle core tables and the tables that belong to each connected plugin.

In spite of the large-scale structure, the database is intelligible. This feature is achieved as a matter of fact that the tables for particular plugin consistently are linked to each other as well as with a number of Moodle core tables.

3.3.6 Mobile versions of Moodle

Moodle using on mobile devices is determined by the fact that the most of Moodle themes are based on responsive web design. Moodle mobile app, that is developed is available in most popular and widely used mobile app stores such as Google Play, App Store (iOS), and the Windows Phone Store.

3.3.7 Moodle Deployment and Interoperability

Users can download and install Moodle System on a Web server. The most widely used example is Apache HTTP Server. A number of database management systems, such as PostgreSQL, are also supported for using with Moodle.

Prefabricated combinations of Moodle system with a Web server and database are available for uploading for Microsoft Windows and Macintosh. Other automated installation approaches are provided: Debian package, TurnKey Moodle appliance, Bitnami installer, Installatron "one-click install" service.

Certified Moodle Partners bring other Moodle services such as hosting, training, customization and content development.

Moodle using does nor require any modification of operating system that supports PHP and a databases, including webhost providers. Such operating systems are then Windows, OS X, Unix, Linux, FreeBSD, NetWare and some others. Moodle also provides import features that allows using importing quizzes or entire courses from Blackboard or WebCT.

3.3.8 E-learning standards support in Moodle

There are the number of e-learning concept standards that had been adopted in Moodle. The most important examples are the following:

- **SCORM.** SCORM abbreviation stands for Shareable Content Object Reference Model. The model provides a collection of standards and specifications for developing, packaging and delivering high-quality training materials for online learning courses. SCORM defines the information transfer between server side LMS and client side content. It means that SCORM compliant tools has been determined for delivering and maintaining learning course contents that can be reused, searched, offer more durable and can be easily accessible through compliant web-based learning systems. SCORM compatibility leverages investments to e-learning courses development by ensuring that compliant courses correspond with the "RAID" concept: courses have to be reusable, accessible, interoperable and durable. The two versions of SCORM standard are released currently. Moodle System is SCORM 1.2 compliant: it passes all the tests in the ADL Conformance test suite 1.2.7. The subsequent version of standard (SCORM 2004) is not supported in Moodle.
- **IMS Content Packages**. IMS (Information Management System) is a body that helps to define technical standards for e-learning material. A content package is used in e-learning approach to determine some learning content or for

assessment that might be delivered. Actually it represents a standard way of describing learning content that is possible to be interpreted by range of applications. IMS content packages allow to export learning content from digital repository or LMS and import it into another LMS. IMS content packages keep a report that describes the transferring information in the content package and its structure. At the same time, the IMS Content Packaging Specification concentrates on the packaging and transporting of information resources, but doesn't identify the nature of this information. Content Packaging version 1.2 is is standardized by ISO/IEC. IMS Global defined the most prevalent content packaging format, which uses an XML manifest file that contains metadata for a group of related files that are part of a set or associated unit. The learning content might be included in the zip file in case the learning content is an HTML or media that can run independently, or it might be referenced as a URL within the manifest. The IMS format is used by SCORM to define the specifications packaging format: every sharable content object (SCO) is defined by a content package. IMS Content Packages might be imported into Moodle. The Moodle Book activities in turn might be exported as IMS Content Packages.

- **Learning Tools Interoperability.** Learning Tools Interoperability (LTI) is a specification that is developed by IMS Global Learning Consortium. LTI represents a standard manner of integrating rich learning applications with educational platforms. The applications in this context might be remotely hosted and provided through third-party services. Moodle System applies to the External Tool activity for acting as an LTI consumer as standard, and applies to the plugin for acting as an LTI provider.
- ***AICC HACP.*** The AICC HACP standard has been developed and was primarily used by the Aviation Industry Computer-Based Training Committee (AICC). The standard determines the procedures of externally calling authored content and packages assessing. AICC content packages are supported in Moodle 2.1 and later versions.

4 University Information Systems

This chapter reviews the information systems at CULS and provides their description. Just like any academic institution, which is technically evolved, CULS has a variety of systems which support teaching, learning and university management processes.

4.1.1 University Background

Czech University of Life Science provides a number of study programms for different degree levels at six faculties. The object of analysis is then a faculty of Economics and Management (FEM) that offers university education in bachelor, master and doctoral programmes. From the point of view of the position within the group of economically oriented faculties of the public universities in the Czech Republic, FEM is ranked among the largest ones (there are more than 9,200 students enrolled).

4.1.2 University Information Systems

CULS students and employees can utilize a number of specific information systems for the purposes of their studies and work completion. These systems are aimed to provide studying process participants with necessary tools that help them to handle their tasks in the best possible way. All the variety of University Information Systems are managed by the CULS administrators which are the members of OIKT (Division of Information and Communication Technologies).

The University information systems together provide management, administration and delivery of teaching and learning functions. The description of University Information Systems and their functionalities are used are listed in the table that follows:

Table 1-CULS Information Systems

Name of the IS	**Web-address**	**Functionality description**
University Information System (UIS)	IS.CZU.CZ	The most important IS for teachers and students. UIS grants to students access to assigned schedules and grades, provides registration option for compulsory and optional subjects, signing up for exams,

		access to personal information. It also allows requesting for scholarships, provides function of managing fees associated with studies.
Moodle CZU	MOODLE.CZU.CZ	Moodle is a university-wide e-learning system that is designed to support learning process for teachers and students. Moodle includes courses with study materials and the range of functionalities that help to support studying process.
Students Portal	STUDENT.CZU.CZ	The portal for students that gives an access to information about important dates of the academic year, course syllabuses, university contact information and academic instructions, information about scholarships, part-time jobs and job offers. The portal also provides access to a list of classmates with contacts and a searching opportuinity for other CULS students.
Student e-mail	xLogin@studenti.czu.cz	Each student of the University has an access to personal e-mail account. The account is presented in a format of xLogin@studenti.czu.cz (Username for login). In the Office 365 settings each student can select the interface language.
NetStorage	netstorage.czu.cz	The system enables Web access to public and private folders

Dotaznik	dotaznik.czu.cz	A system for creating online questionnaires, that is used to hold students surveys
Dreamspark CULS	dreamspark.czu.cz	Learning software for students with subjects of Department of Systems Engineering
Infozdroje SIC	infozdroje.sic.czu.cz	access to electronic databases of licensed articles of CULS
Aleph	aleph.czu.cz	The portal that enables remote access to the library at SIC CULS
Intranet	Intranet.czu.cz	The system for managing personnel and internal documentation for CULS Employees

4.2 Moodle using at the University

The Faculty of Economics and Management that are the field of interest in the context of Master Thesis is the largest at Czech University of Life Sciences Prague. The faculty provides a range of courses that are, by their main point, a suitable environment for the implementation of the LMS. The faculty has a significant number of students and teachers. Every academic year the faculty offers a number of core courses which are teaching by a classical method. These methods of teaching and assessment remain significantly time-demanding for teachers. (25, p.283)

The implementation of Moodle System at CULS was undertaken as a major initiative to addresses the key ICT objectives and in 2009, the CULS Prague launched Moodle.

In the first period, the use of Moodle was mainly focused on the development of e-learning supported examination modules for mentioned core courses. The main goal of implementation was to speed up and objectify the examination process during the examination period. (25, p. 284).

The second stage that was focused on the comprehensive courses development on the Web platform began in 2011. Since August 2012 CULS Prague has been using Moodle as the key learning support system.

Since 2012 Moodle CULS has been providing electronic classes for every year of the Bachelor and Master Studies in which updated e-learning programs are presented. From the administrative point of view, Moodle using provides a tool for consolidation of the mutual communication of university employees, external stakeholders and students of the department.

As it was mentioned earlier the university also hosts other educational support systems, which offers the range of functionalities for communication and administration of educational processes. The activities that are covered by these systems (namely, UIS system) are course and exams registrations, lecture and exercise schedules.

Moodle Learning Management System serves, as an important improving feature of the communication in context of learning as well as Moodle is an effective educational tool of the University management at Czech University of Life Sciences in Prague.

Despite the successfulness of using Moodle implementation in CULS Prague for enriching the studying processes there are still few numbers of challenges due to the fact that University trying to integrate specific studying activities to studying programs. One of these specific activities is a Study Block.

4.3 Workflow management in context of E-learning

A workflow is an administrative business process, i.e., as a business process that delivers services or informational products (6, p.2). From the empirical point of view the business process need to be considered as workflows that can be supported by Workflow Management System (WfMS). The main purpose of WfMS is to support the definition, execution, registration and control of business processes (26, p.263). Practically, WfMS looks after delivering the exact piece of work to the exact resource at the exact time. The WfMS provide this function on the basis of a data model of the business process. This data model is namely a workflow definition where all tasks of particular business process are distinguished and represented in context of their strictly determined dependencies. The workflow definition also includes the information about the type of resource that is required to execute the following task in path.

In recent years many companies use workflow approach as an effective tool for achieving the key business processes reorganization (re-engineering), since efficient workflow management allows to automate and support the company's business processes effectively. There is also a constantly increasing interest in exploring the opportunities for applying a workflow as a supporting technology of Business Process Management for management of a learning process in e-learning systems. The intuitive approach is to use best experiences, practices and principles of BPM in context of e-learning systems that seems to be a logical technological choice for management of a learning process (22 p. 35).

The first limitation arises from the fact that LMS nowadays are mostly not suitable to model all the variety of educational forms that are the parts of teaching and learning process. However, some recent developments use the BPM technologies and workflow conception successfully. For example, Avgeriou (3, 2003) proposed a new approach to e-learning environments design, which is based of IEEE 2001 standard. The research implies that e-learning process is specified as a business process with the help of tools oriented to business process modeling (Unified Modeling Language). Cesarini (10, 2004) presented a complete solution from modeling to real time execution of learning workflows. The created models are represented using XLANG language.

For the purposes of this work it is needed to determine the ways and means for specifications of study blocks teaching and learning processes as well as the methods in which the learning processes will be delivered.

5 Practical Part

5.1 Modelling

To understand the scope of analysis and to allocate the problem domain the modeling of the whole studying process at the University was needed. The modeling was realized using CRAFT Case software.

5.1.1 Craft. CASE modeling tool and C.C method

Craft. CASE uses the UML standard for software systems modeling activities.

Craft.CASE is a business process analysis tool based on a C.C method. The C.C method, which has been developed over 25 years ago using a mathematical background, should be perceived as object-oriented method. That basically means that each element of the real world (that is referred as subject) has a certain behavior. The C.C method is concentrated on the understanding how to improve a course of BPA project without lacking something significant. The C.C method implies a number of reasonable steps that are tested and verified as a determined sequence. Following the C.C method allows the modeler to test processes consecutively even if the problem is complicated.

Based on C.C method, the Craft.CASE is a tool that guides the user to the final modeling goal stepwise. A useful and innovative feature of Craft.Case modeling tool is simulation functionality. The ability to simulate the process allows understanding and analysing in a logical manner. Simulation feature gives also an opportuinity to present and visualise process progress. The Craft.CASE allows to modeler creating consistent models through constraint and validity checks, while drawing and simulating diagrams. Craft.CASE uses the UML standard for software systems modeling activities (13, pp 139-142).

The possibility to interconnect data through various modelling stages makes Craft.CASE context-sensitive. Craft.CASE stresses pre-implementation stages of system development and is not primarily appointed for software code generation. The main purpose is business and software modeling. This is the reason for strong demand on consistency, simulation, cross-reference checking and other features.

The Craft.CASE software is made with support of the research project MSM-6046070904 of the Czech Ministry of Education for the Faculty of Economics and Management, CULS in Prague.

5.1.2 Models.

Sketch Diagrams

Sketches section contains the diagrams of first problem space representation that is not strictly formal. Although sketches have no model types specifications and constraints, the information contained in them is very important and valuable for later work progress. Sketches are used for graphically recording the whole problem space assignment.

The first sketch (Figure 3) describes the primary associations between main participants of the studying process.

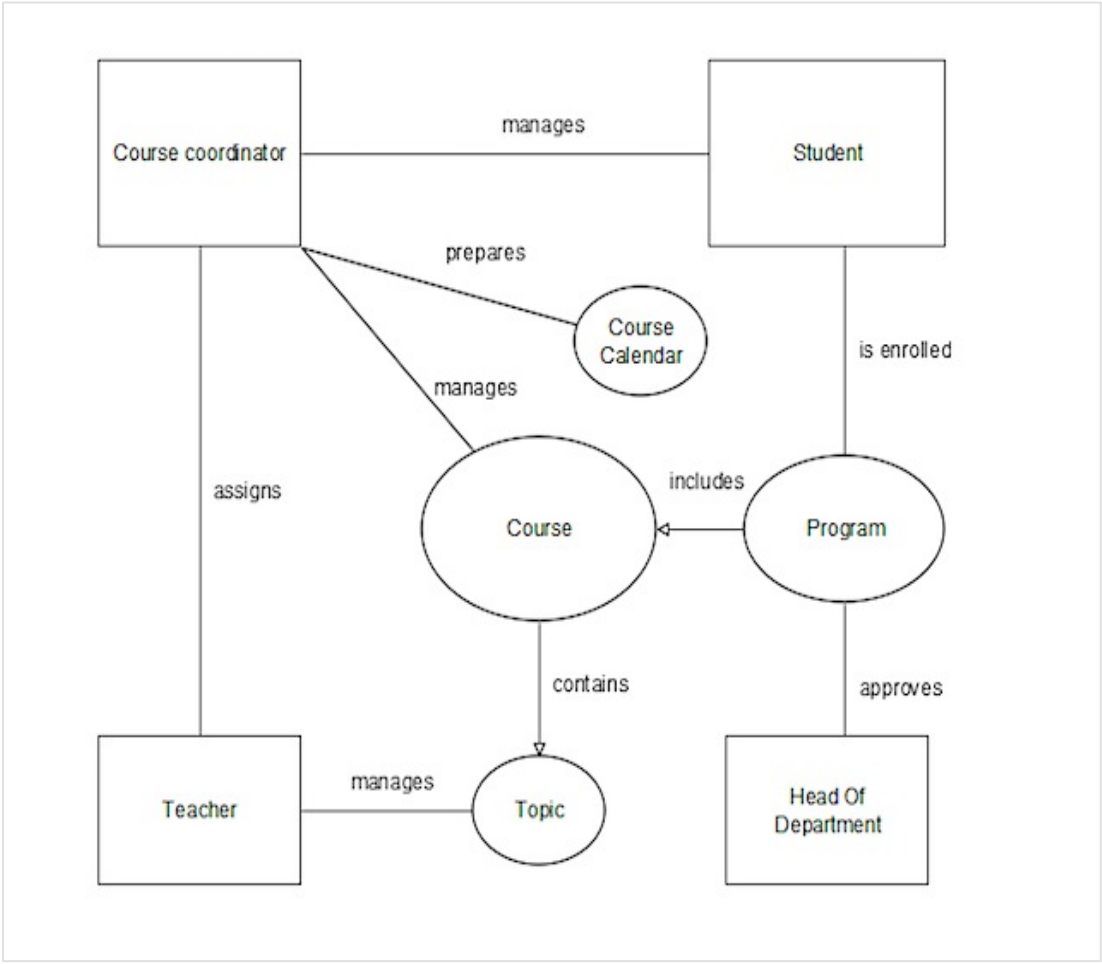

Figure 3 - Participants Associations Concept. Source: author

The second sketch diagram (Figure 4) represents the studying process structure. The studying progress is connected with ECTS-credits receiving after the academic course completion. The academic course completion procedure includes the standard academic duties. The important feature of studying process in the University of Life Sciences is availability of Study Blocks sessions as a part of studies. Study Block Sessions are teaching by guest professors from the cooperating universities. Participating in Study Blocks sessions is a necessary requirement for all students of the University to be credited and might be further examined.

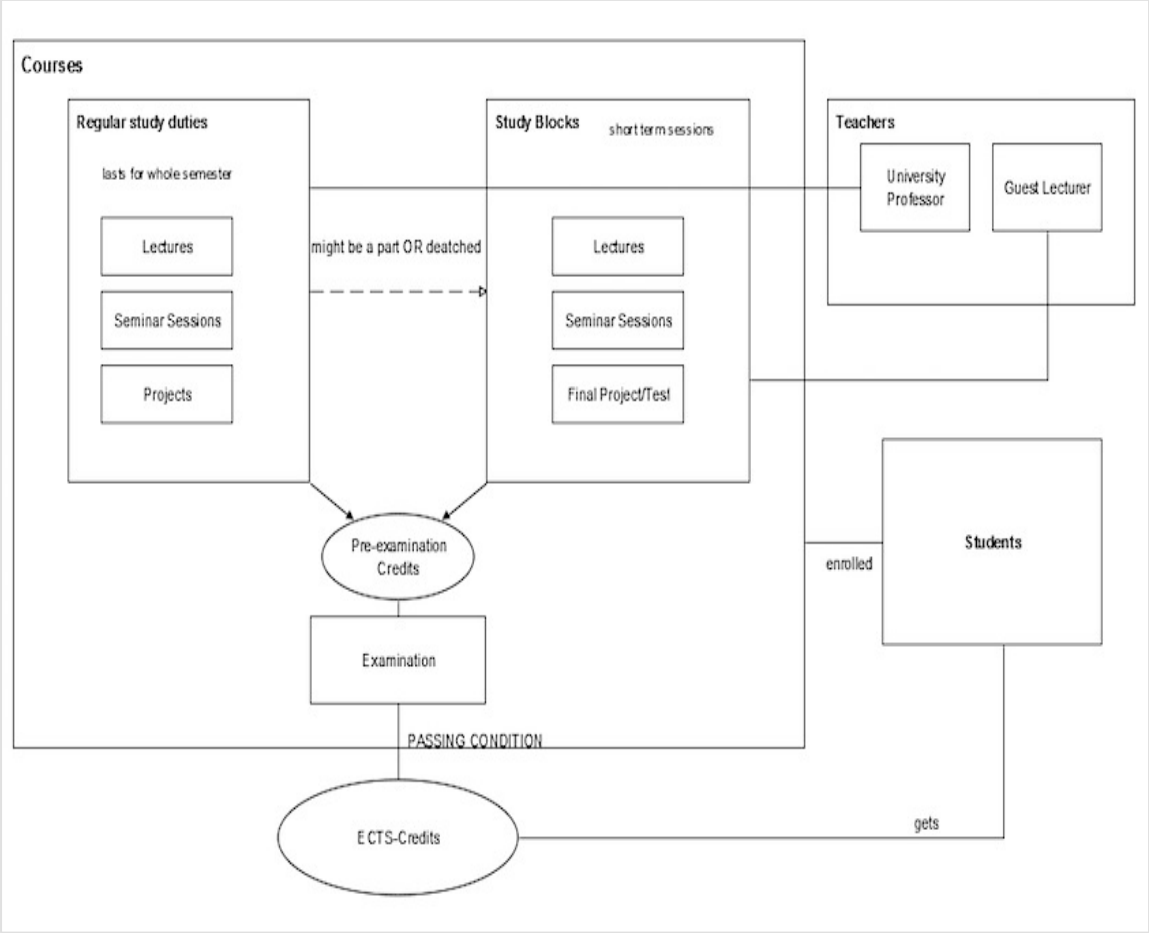

Figure 4- Studying Process Concept. Source: author

The following step of the studying process modeling is a structure description that includes the main participants, hierarchies as well as the main process functions and possible scenarios.

Structure. Participants

The structure modeling of the university teaching, learning and administration processes includes the detailed description of the subjects involved in studying and their behaviour. As the subjects of the project the hierarchies and participants are distinguished.

The Table 2 represents the description of the main studying process participants.

Table 2- Studying Process Participants. Source: author

Name	**Description**
Head of Department	The person with significant authority. The responsibilities include leadership, academic planning, responsibility for programs accreditation, financial and quality management. In term of the process modeling, the participant that is responsible for accepting the studying programs and courses, as well as for verifying the guest lecturers and course's syllabuses.
Program Coordinator	The member of Faculty Management. The duties and responsibilities ranges significantly and include students, teachers and courses management as well as schedule and timetable management.
Teacher	In terms of higher education this participant's category includes all the academic ranks involved in teaching process: professors, associate professors, lecturers, assistant lecturers, teaching assistants. The range of duties includes academic leadership, teaching, and research academic activity. In terms of the process modeling teacher's responsibilities include course leadership, teaching duties, syllabus planning and personal schedule management.
Student	The main participant of educational process. The duties and responsibilities include academic integrity and honesty. In terms of the process modeling student is responsible for fulfilling the necessary and sufficient studying requirements, personal information and schedule control.

Study Department	The representatives of Faculty Management. Study department has responsibility to save and update information of students and teachers in, to maintain and update information of faculties, majors and rooms in UIS.

With regard to the functions they accomplish at the University, management of faculties, study department, program coordinators and the teaching board (both guest and regular) can be combined into the group of University Employees (Figure 5). Such consolidation allows to show links between participants of the process with respect to levels they take up in the common University hierarchy.

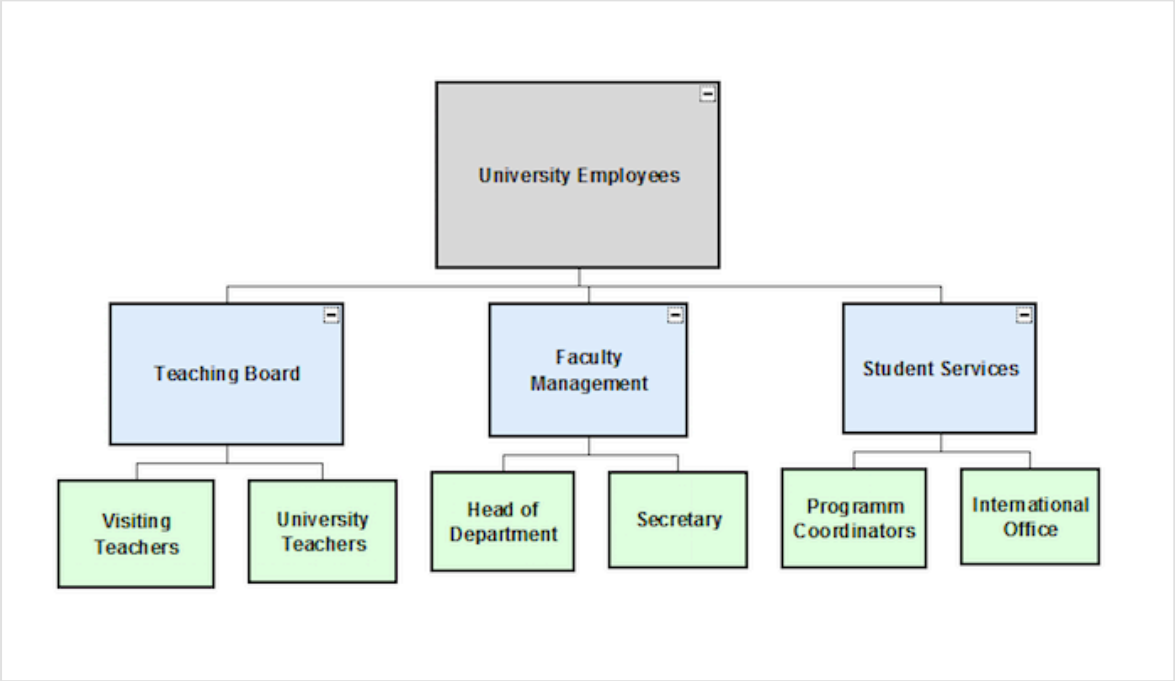

Figure 5- Employees Hierarchy Diagram. Source: author

Figure 6 represents the hierarchy of Teaching Board. Teaching Board consists from both external and internal members that play different roles in specific studying activities, namely Study Blocks Sessions. Hence, using a hierarchical mapping here is appropriate for the modeling purpose.

Figure 7 shows the hierarchy of students. This hierarchical representation gives a mapping of students division with respect of their type of studying. The hierarchical representation is valuable for the particular case since students are the core participants of concerned studying process.

Hence, it is important to distinguish the student group levels and belonging to certain group for the purpose of further process modeling.

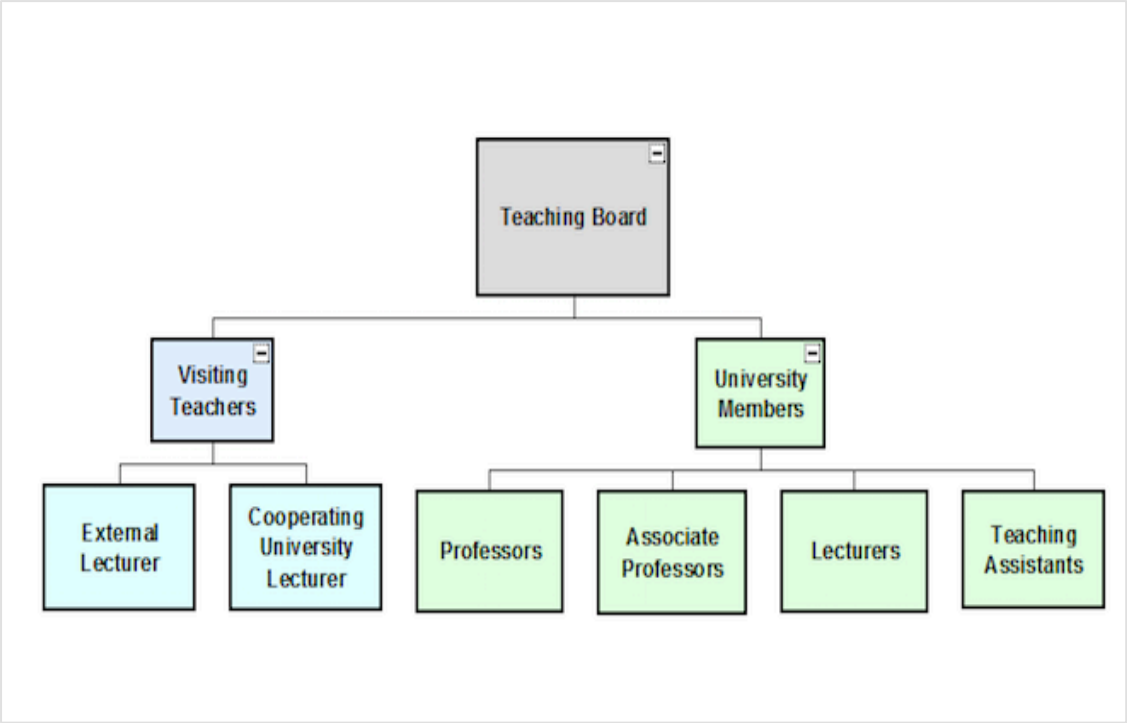

Figure 6- Teaching Board Hierarchy Diagram. Source: author

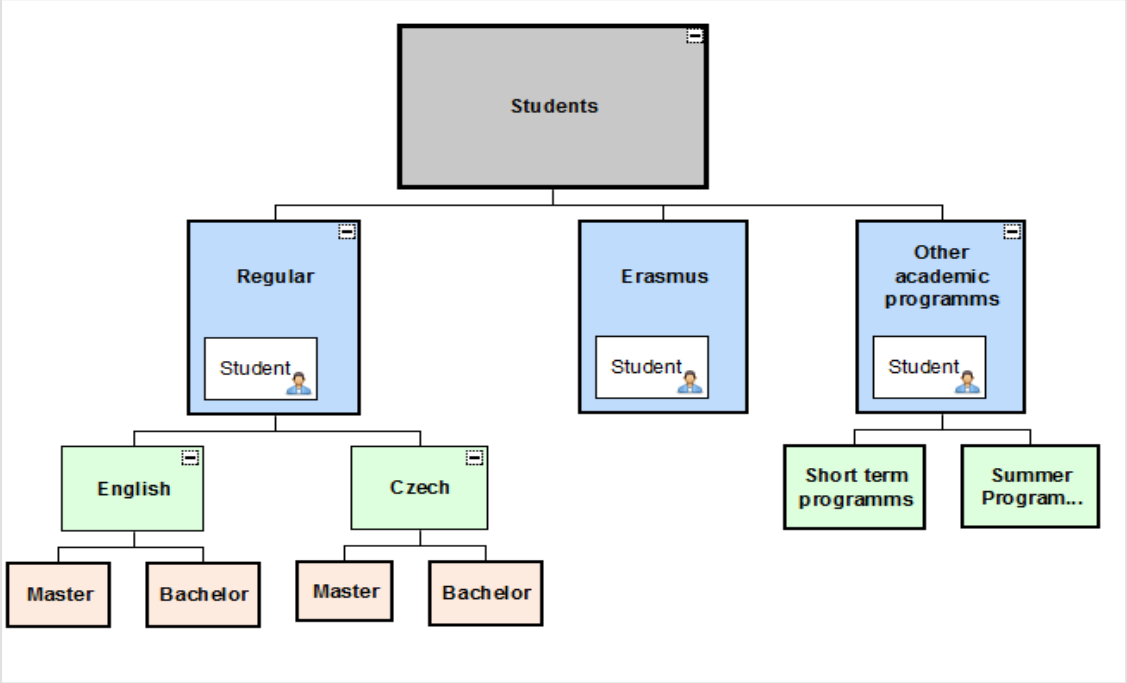

Figure 7- Students Hierarchy Diagram. Source: author

Structure. Functions

University system functions are described according to timing of academic year. An academic year is divided into phases with respect to the sets of specific activities that are strongly connected with particular time period. These activities are also related to different participants associations. It means that during the year the different combinations of participants play more important role in studying process progression.

The primary functions of the University system were divided into smaller studying process functions with name and meaning as follows:

- Pre-Studying Processes
- Studying Period Processes
- Post-Studying Processes

The academic year pre-studying processes include all the activities that are connected with entrance examination period and further enrollment for successfully passed students. The following enrollment processes suppose students and teachers registration in University Information System (UIS) and courses registration. For students of following years of studies the pre-studying processes include courses registration in UIS. The leading active participants for this subset of functions are faculty management, study department and program coordinators. Students and Teachers are represented here as inactive participants.

Studying Period Processes are the central subject of educational process. This group of functions includes all the processes that belong to the academic duties. These are regular classes (lectures, seminars, and exercise sessions), study blocks sessions, pre-examination processes of credit receiving and examination period processes. The main active participants of this time period and, respectively, subset of activities are students and teachers. Program coordinators are also the participants of this time period functions performing management of courses, students and teacher functions simultaneously with study department employees.

Post-studying processes involve mainly the employees of study department and coordinators as active participants. This subset of university system functions implies a range of administrative procedures that take place at the end of each academic year.

These include processes of students and teacher's management credits received controlling procedures, interruption and termination of studies procedures, next year students transferring.

Summarizing the description of the University system's functions, it is important to mention that all of described subsets of functions are internal, that take place within the university without consideration for external university connections.

Figure 8 represents the conception of academic year that is structured with respect to described subsets of internal university functions.

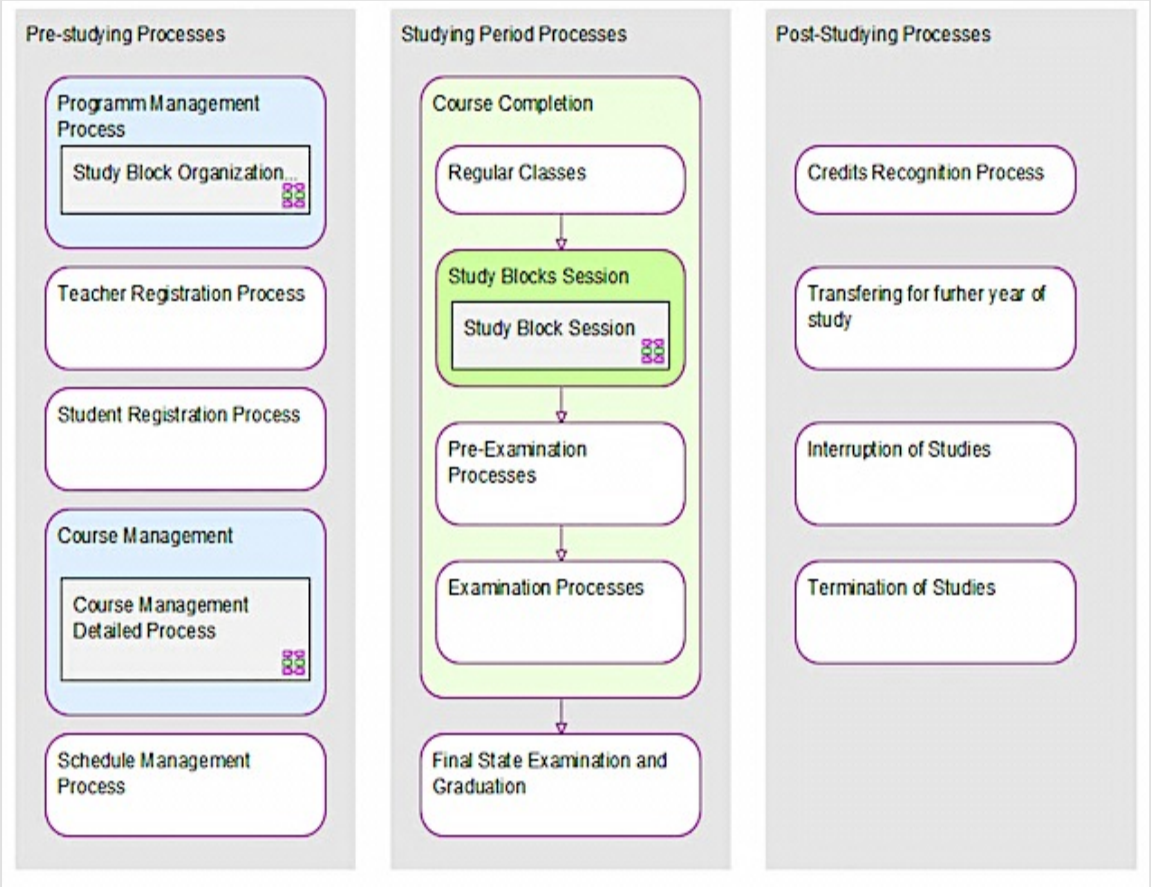

Figure 8- Functional Conception of Academic Year. Source: author

The modeling of structure continues with scenarios framing. Scenarios concept allows describing the set of functions of each group mentioned above more detailed and carefully. Such a phase of functional analysis will help to determine the problem field for further information solution offering.

Structure. Scenarios Description

Scenarios give more detailed characterization of the whole University System processes. For the purpose of consecutive processes description Tables 3-8 are divided into initiation, action and results parts. Initiation means the beginning of the process, the action that initiates the scenario. Result means the end of a process, states of the objects after finishing. This section provides the scenarios description only for the studying period processes since the further work will be focused mainly on this group of processes. Complete list of scenarios created for all internal university functions is included in Appendix 2 section.

Table 3 - Course Completion Scenario Description. Source: author

	Description
Name	Course Completion
Initiation	The Studying Semester starts
Action	Student attends regular classes (lectures, seminary sessions, etc.) that are leading by the University Professors and Lecturers, attends study blocks sessions that are leading by the Visiting Professors, gets pre-examination attendance and academic scores, takes final exams.
Result	By successful fulfilling of the Course Requirements Student gets ECTS credits.

Table 4- Regular Classes Scenario Description. Source: author

	Description
Name	Regular Classes
Initiation	The Studying Semester starts
Action	Student attends lectures and seminars teaching by University's Teachers. Student fulfills Course Requirements that are formulated

	by the Teacher. The requirements include the attendance, homework assignments and/or project completion.
Result	By successful completion of the Course Requirements, Student gets pre-examination credits from the Regular part of the Course.

Table 5 - Study Block Scenario Description. Source: author

	Description
Name	Study Block
Initiation	The Visiting Teacher comes to the University for lecturing
Action	Student attends lectures and seminars that are leading by Visiting Teacher. Student fulfills Study Block requirements that are formulated by the Teacher. The requirements include the attendance, homework assignments and/or project completion. Student finishes the Study Block by writing Final Test that is the main requirement for Study Block.
Result	By successful completion of the Study Block's requirements, Student gets pre-examination credits from Study Block part of the Course.

Table 6 - Pre-Examination Processes Scenario Description. Source: author

	Description
Name	Pre-Examination Processes
Initiation	Student has completed regular Classes and Study Blocks Session in context of the particular Course program.
Action	Lecturer (Course Guarantor, Regular Teacher) checks that Student fulfilled both attendance and academic requirements from Regular classes and Study Block part of the Course.

Result	Student is allowed to register for the first Examination term in the Student Information System

Table 7- Examination Scenario Description Source: author

	Description
Name	Examination Period Process
Initiation	Student has pre-examination credit signed in index book and in Student Information System. Student is registered to Examination Date in UIS
Action	Student gets an attempt to fulfill the examination requirement.
Result	By successful fulfilling of the Exam Requirements Student gets ECTS credits

Table 8- Final State Examination Scenario Description. Source: author

	Description
Name	Final State Examination Process
Initiation	No later than 12 months before the intended thesis defense Student is expected to submit Thesis Proposal.
Action	Each Student has to be assigned an academic, the thesis advisor, who advises and guide the student in research. Once the thesis proposal is approved by both the thesis advisor and the program supervisor it will be registered into the SIS. The thesis have to be submitted both by delivering Thesis printed version to Study Department as well as submitted to UIS about a month before the final state exam.
Result	Student finishes high school degree by successfully passing Final State Exams and successfully defending the Degree Thesis. Student gets the academic title.

Structure. Business diagrams

In context of processes modeling the business diagrams represent detailed description of communication between the particular participants. The purpose of communication is to initiate a particular activity. With regard to problem field specification the three business diagrams were created. Since the Study Blocks are specific studying activities of the University, it could be considered as the objects of primary focus of the modeling section of the Thesis. Figures 10-11 represent the Study Block Organization Process and Study Block teaching and learning processes respectively.

Course Management activity diagram is represented in Appendix 1 section. This process is distinctive for universities with native information system and LMS-based courses organization. Course Management activity diagram shows the sequence of specific events of Course organization from the start to registration in University Information System. The participants of the process are The Head of Department, Teacher as well as University Information System.

Study Block Organization Process Business Diagram.

Figures 10 represents the Study Block Organization Process Business Diagram. The diagram shows a representation of steps and activities that take place before direct starting of study block sessions. This activities take place mainly on administrative level, therefore this process cannot is not the subject of e-learning. The participants of this process are The Head of Department, Program Coordinator and Visiting Lecturer. At the end of the process student is involved non-actively.

Study Block Teaching and Learning Process Business Diagram.

Figures 11 represents the Study Block Teaching and Learning Process Business Diagram. The diagram provides the most crucial representation for the further e-learning solution designing, implementation, and management. The Study Block Teaching and Learning process participants are the following.

Lecturer (The Guarantor of the Course). Lecturing professor is a person who usually provides lectures and some seminar sessions during the semester. At the end of semester and after the finishing all the educational duties. Lecturer examines the students and assesse their knowledge after the final exam. Guarantor of the Course might be a Faculty authority who is not lecturing the general course. However, Guarantor of the

Course is always responsible for the course in front of Academic Senate of the University. In context of Study Block Lecturer is involved in process at the final stage. The Lecturer receives results of Final Test as well as the list of topics and questions for final examination.

Guest Lecturer (Visiting Teacher) is a teacher who provides academic leadership during the Study Block sessions. Visiting Teacher is not the regular employee of the University, as well as the member of Faculty. In other words, guest lecturer is not the regular teacher of the course for students. Visiting Teacher is usually a representative of other University, typically abroad. In context of Study Block Visiting Teacher is one of two main participants of education process. Visiting Teacher provides lectures and seminars, organizes class activities and assignments, creates the final test and tests students knowledge at the end of study block. Visiting Teacher is also responsible for final test assessment. Additionally, Visiting Teacher has to provide the list of topics and questions for final examination to Lecturer.

Student has to attend the number of the Courses during a semester. Each Course regularly includes lectures, seminars sessions and practical sessions and sometimes study block sessions. In context of Study Block Student is the second main participant of education process. Student attends study block lectures and seminar session, participates class discussions and activities, and writes a final test at the end of study block. The important requirement for every Student is obligatory attendance of all study block sessions, which are given by Visiting Teacher. Student is also obliged to pass the course finishing requirements: the exam which is assessed by Lecturer of the course.

Program Coordinator role in context of study blocks come to management functions as well as checking students attendance that is one of crucial requirement of the faculty for student to pass the course successfully. At the moment the class attendance is checking in paper-based registration format. Further e-learning solution would probably help to replace or supplement a paper-based attendance registration for student attendance checking.

After the analyzing the whole studying process at the University the problem domain for further work was determined and described. The following scope of the analysis and solution design and implementation is dedicated to Study Block Sessions in context of teaching and learning activities.

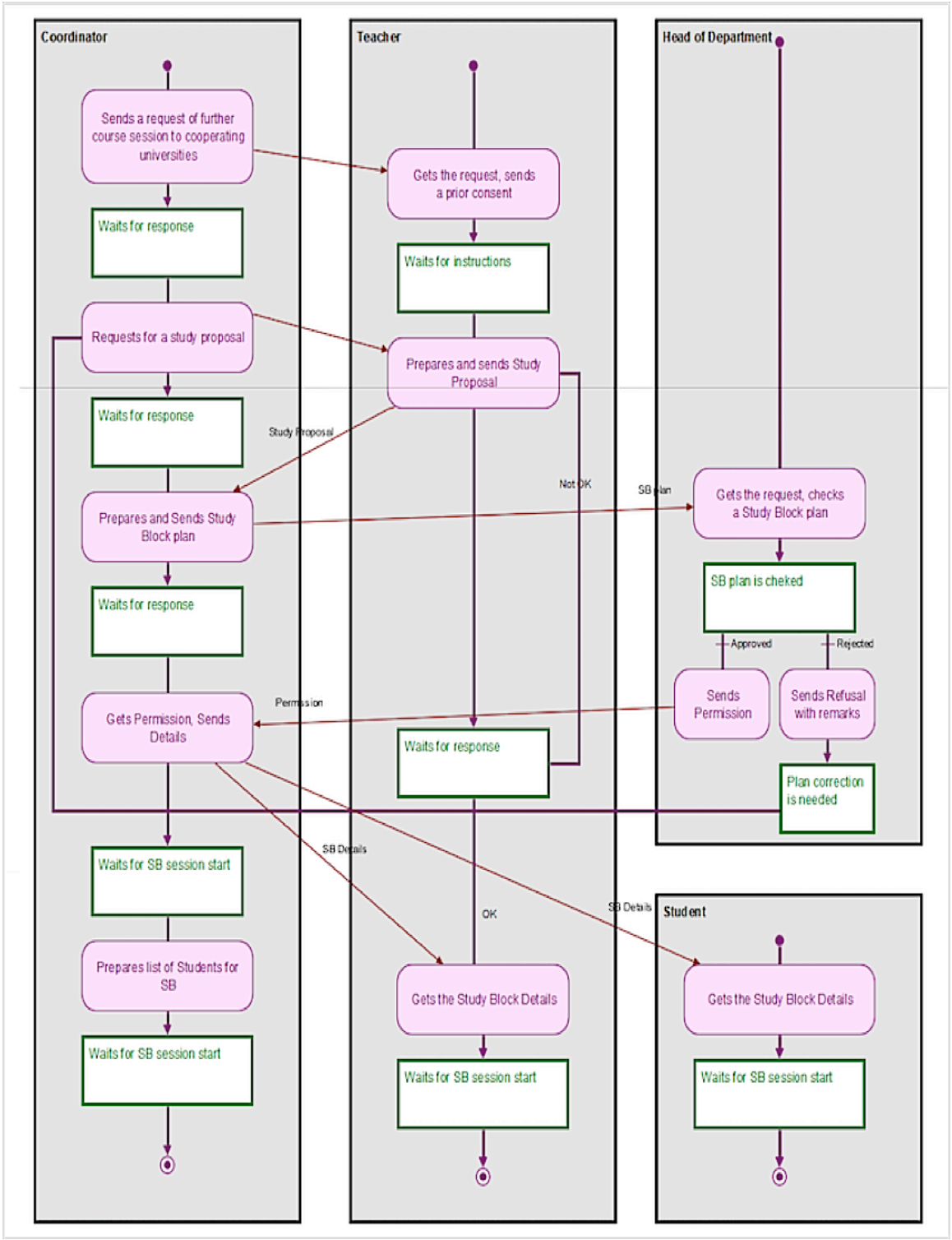

Figure 9 - Study Block Organization Process. Source: author

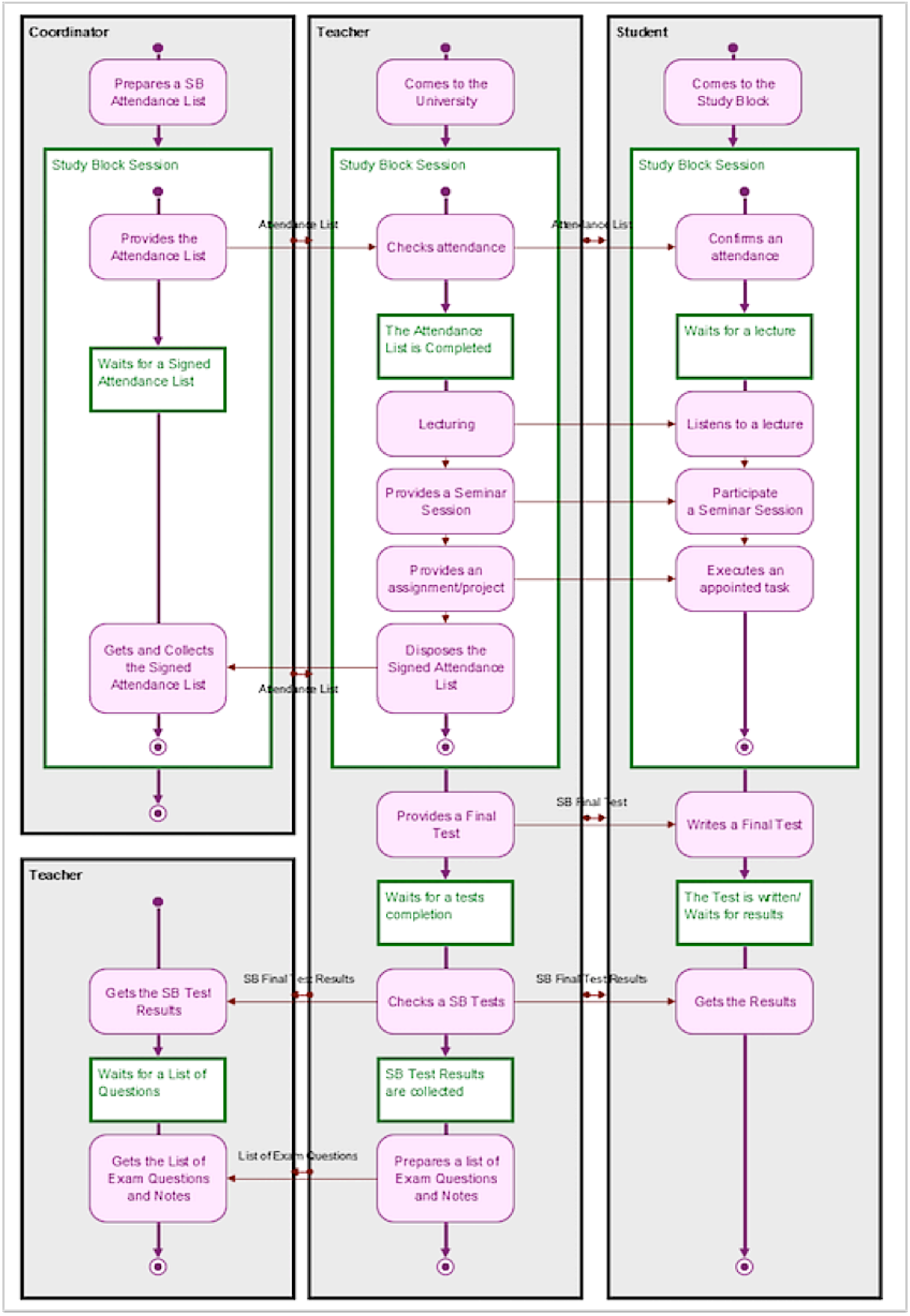

Figure 10- Study Block Sessions Learning Process. Source:author

5.2 Workflow approach implication for Study block

According to Workflow Management Coalition (WfMC), the term workflow focuses on controlling dimensions of a business process, namely on the dependencies among tasks that must be met during the execution of a business process.

For the purposes of this Thesis the e-learning process is specified as a business process with the help of Craft.CASE-the tool oriented towards business process modelling. Consequently for the purpose to apply the workflow approach to the learning process, the study block activity has to keep prominent features of a business process.

The visiting teacher, lecturer, students are the participants of the workflow, the requirements described by means of Craft.CASE modeling diagrams are the procedural rules and they are included into the process definition.

Hence, the workflow approach is applied to study block learning process which can be divided to component workflows of teaching, learning, administration and technological support. The workflow diagrams for participants of proposed e-learning solution of study block activity are represented on Figures 12-14. The description of composite activities for each workflow sub-system is given in Tables 9-11.

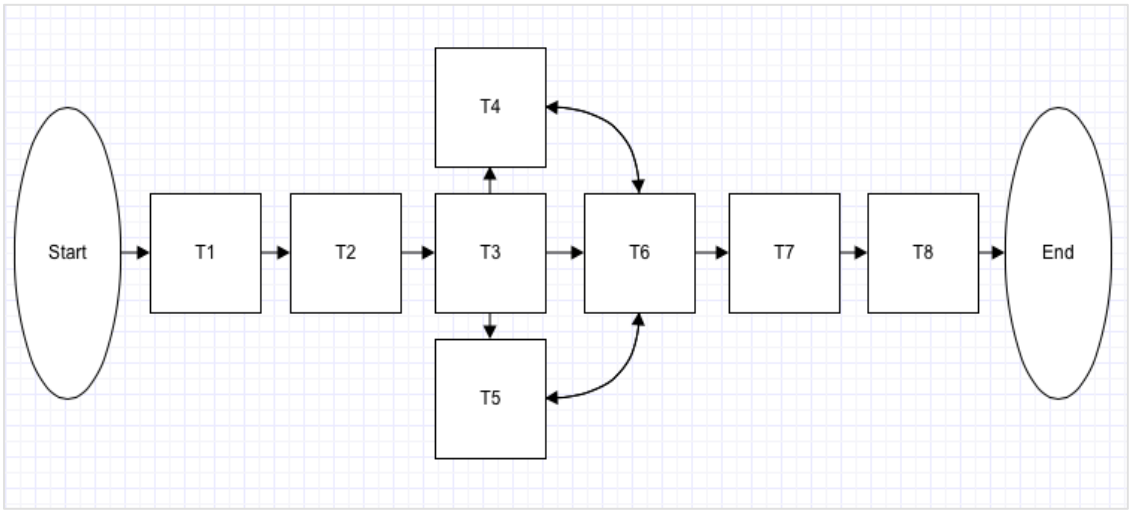

Figure 11- Teaching Workflow Representation. Source:author

Table 9- Teaching Workflow Activities Description. Source: author

Name of state	Activity description
T1	Study Block syllabus creation
T2	Studying materials preparation
T3	Materials delivery
T4	Lecturing
T5	Seminary sessions leading
T6	Learning support
T7	Testing knowledge
T8	Evaluation

Hence, the workflow approach implies that benefits might arise mainly from flexibility and control opportunities that occur during teacher planning of the study block and further choosing appropriate teaching techniques.

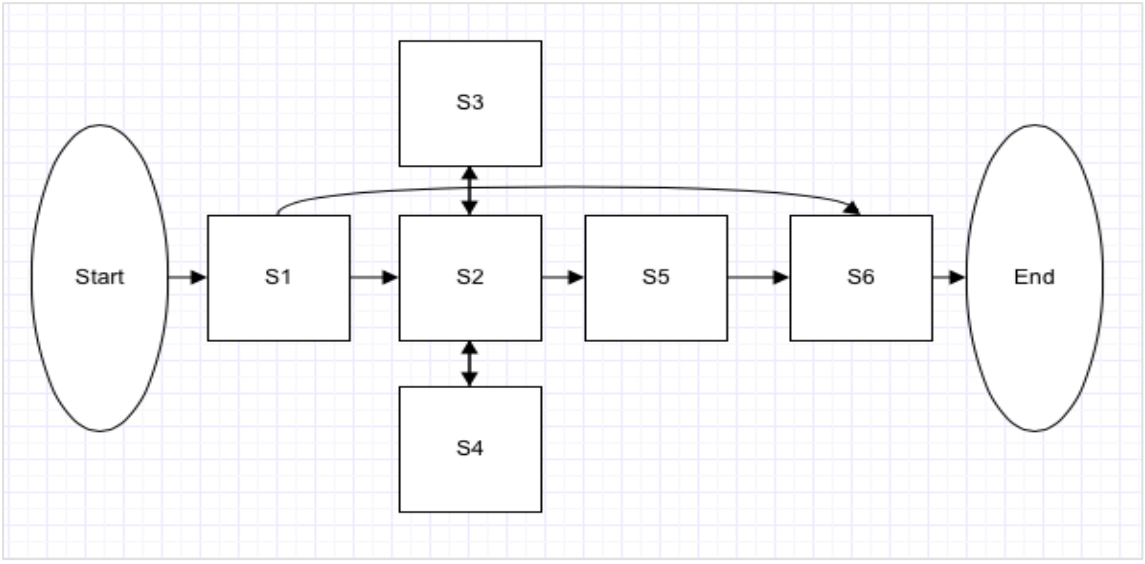

Figure 12- Learning Workflow Representation. Source:author

Table 10- Learning Workflow Activities Description. Source: author

Name of state	Activity description
S1	Attending Study Block Sessions
S2	Accepting materials
S3	Participating class activities (discussions)
S4	Self-learning
S5	Writing final test
S6	Evaluation

For a student, which participates in study block driven by a workflow that is designed by a teacher and administrator, the benefits arise from obtaining the possibilities to customize learning manner while supporting it within the predetermined bounds of feasibility and usefulness.

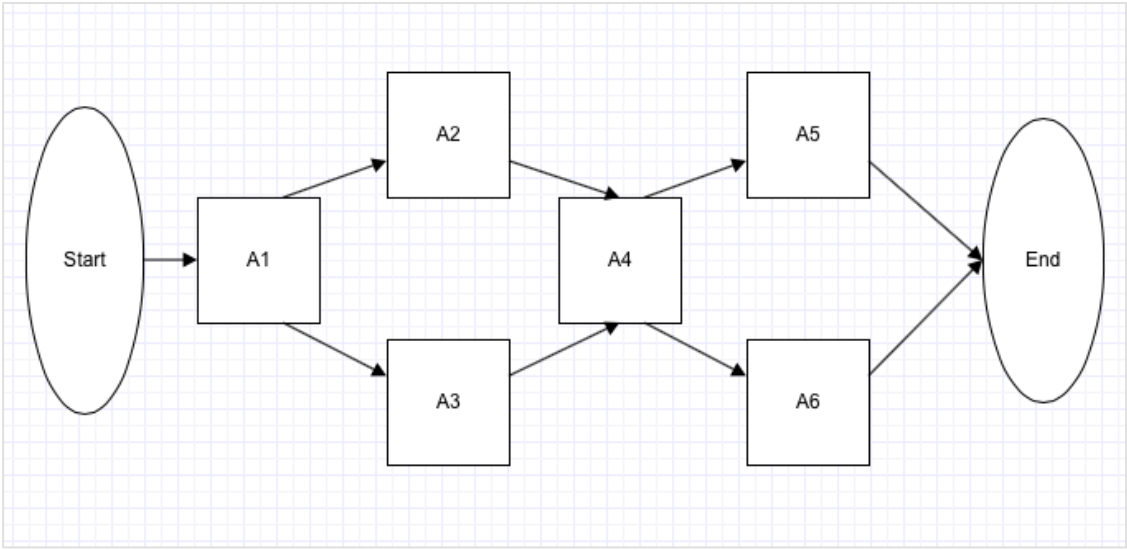

Figure 13- Administration Workflow Representation. Source:author

Table 11- Administration Workflow Activities Description. Source: author

Name of state	Activity description
A1	Enrolment management
A2	Teaching processes support
A3	Learning processes support
A4	Assessments result publication
A5	Students and teachers records management
A6	Other administration functions

The Analyzing and modeling these component workflow systems allows to identify all key activities from these systems. Hence, through developing these activities, the whole study block learning process might be improved. The performance of learning and teaching through understanding this workflow basis of e-learning process has better revealed all aspects of learning, teaching, administration and technological support.

5.3 Case Study Description

5.3.1 Study Block Functional Requirements

As a result of the study block learning activity analysis the crucial requirements for building more efficient learning path were determined. These features need to be covered during the further course creation in Moodle:

- **Study Block content storage**. The realization of this element of the course is a primary aim, which is strictly necessary to support the learning process.
- **Final Test.** As it was mentioned earlier, the final test passing is an obligatory requirement to sit at the final exam from the whole course. Hence, this functionality has to be included to the e-learning course representation.
- **Attendance checking.** The requirement that is relates to all students that are enrolled to the course and therefore are obliged to attend 80% of study block hours to get pre-examination credits.
- **End-of-Study Block student survey.** The functionality that suppose to help the teaching board and study department to get feedback from students within the LMS. Utilizing the information from a survey might help to provide some corrections and improve the learning experience for both teachers and students.

Table 12 represents the list of Moodle elements that will be analyzed in following sections in order to provide the appropriate e-learning solution for study block.

Table 12- Proposed Functionalities and Elements for Study Block Implementation in Moodle. Source: author

Functionality	Type of Moodle Element	Short description
Studying materials storage	Standard Functionality	File types that can be added to Moodle include text documents in different formats, presentations, spreadsheets, zip files, and media files (images, video, audio).

Final Test	Standard Element	The Quiz activity allows the teacher to add and design quizzes consisting of question of different types.
Attendance Checking	External plugin	The Attendance activity allows to manage students attendance in Moodle, replacing a paper attendance maintaining.
Course Assessment	External plugin	The Questionnaire activity is a survey-like type module that allows creating a wide range of questions to get student feedback on course participation.

5.3.2 Case Study Profile

For the purposes of case study implementation it was assumed that the course Databases and Knowledge IS (EIE53E) might be accompanied by the study block session.

Databases and Knowledge IS is a course offered by Department of Information Engineering CULS. It is one of the fundamental courses in master's degree programme in Informatics curriculum. The main objective of the course is to offer students knowledge and experience of using different data models and an algorithms of the procedures applied in the design of modern database and knowledge systems, especially in problems for large organizations and companies.

All the learning materials that are used for the case study as a representative example are composed from the course CS145 Introduction to Databases of Stanford University. The course materials are opened and available at the official web-page of Stanford University.

5.3.3 Databases and Knowledge IS Study Block Specifics

The Study Block session will cover database design and the use of databases in applications, with a short introduction to the internals of database engines. It includes extensive coverage of the SQL. The study block also features database design principles based on dependencies and normal forms. Many additional key database topics from the design and application-building perspective including indexes, views, transactions, and integrity constraints will be also covered. The reading material from lecture notes is optional, but it refers to Database Systems: The Complete Book by Garcia-Molina, Ullman, and Widom. The final test suppose to carry out on May 5th during the last seminar session of the Study Block. To pass the Study Block and receive pre-examination credits for the main part of the Databases and Knowledhe IS course a student needs to answer 70% of Final Test questions correctly. The lecture and seminar attendance is obligarory for all students. The acceptable limit of hours missing is 6 from the whole Study Block Sessions.The fictitious syllabus for the case study is shown in Table 13.

Table 13- Study Block Session Sillabus (Case Study). Source: author

№	Date	Topic	Hours	
1	1/05/2017	1. Course Logistics and Database History 2. SQL: Introduction	6	
2	2/05/2017	1. Database Design: Theory. 2. Database Design: Practicals.	6	
3	3/05/2017	1. Transactions from a User's Perspective 2. Mechanisms for Transactions: Logging and Locking	6	
4	4/05/2017	1. IO Cost Models and External Sort 2. Indexing 3. Access Methods and Operators	6	
5	5/05/2017	1. Joins: A Cage Match 2. Query Optimization	3	
		Research Talk	2	
		Final Test	1	
		Total	**30**	

5.4 Study Block. Proposed Moodle Implementation

Since Moodle is the basic LMS for CULS courses, the next step of study is to create a template of the study block for Databases and Knowledge IS course in Moodle. Using formulation of workflows for teacher, student and administrator from previous section of the Thesis this section demonstrates how Moodle can provide the workflows realization. The results obtained from this section can be motivational and applicable to other courses offered as well. Furthermore, results might help faculty stakeholders in advancing the system functionalities in order to support study blocks.

For the course creation and settings administration the Moodle 3.1 package with included Apache, MySQL and PHP (that are built using XAMPP) was installed to the local server.

5.4.1 Study Block Participants Administration.

As it was determined in analysis and modeling sections of the Thesis, the study block sessions includes students, visiting teachers and lecturers as the main participants of learning process. The students and teachers are assigned to the courses by the Moodle System administrators. The assignment/enrollment is based on the Head of Department and Teaching Board decision.

In the same manner the enrollment process might be realized for Study Block Sessions. The necessary condition for the earlier session organization is timely and accurate reporting the study block materials from the visiting lecturer as well as opportune provision of the information from the study department about the students which have to be enrolled to the study block.

For the purposes of work with the case study it was necessary to create the list of participants who take part in a study block learning activity in Moodle system.

The teaching roles are limited by the visiting teacher and the lecturer in context of study blocks; hence, these users were enrolled manually by the administrator.

To enroll the group of students simultaneously, the cohort concept of Moodle system was used. The cohort is created to denote the fictitious group of students who will participate the study block session (Figure 16).

In order to reduce the timing for registration each student manually, the script was created. The script using allows converting the list of student names and surnames in xls format to csv file with randomly assigned initial registration details (such as usernames, passwords, e-mail addresses). The complete list of users and their details in Moodle system is shown in Appendix 3 section of the Thesis.

Figure 14- The students cohort creating in Moodle. Source: author

First name / Surname	Email address	City/town	Country	Last access	Edit
Abrams Anthony	anthony0y17_@some.email			Never	
Brown Ben	ben1y17_@some.email			Never	
Cowell Chris	chris2y17_@some.email			Never	
Donalds Daniel	daniel3y17_@some.email			Never	
Evans Eva	eva4y17_@some.email			Never	
Ferry Fred	fred5y17_@some.email			Never	
Green Gregory	gregory6y17_@some.email			Never	
Hummel Hailey	hailey7y17_@some.email			Never	
Iris Isla	isla8y17_@some.email			Never	
John Smith	jsmith@moodle.com			5 days 17 hours	
Johns Jack	jack9y17_@some.email			Never	
Kazek Kayla	kayla10y17_@some.email			Never	
Kseniya Bortnikova	ringoringogo@gmail.com			3 secs	
Lively Liam	liam11y17_@some.email			Never	
Murray Martin	martin12y17_@some.email			Never	
Nolan Nancy	nancy13y17_@some.email			Never	
Oldman Olly	olly14y17_@some.email			Never	
Pitt Peter	peter15y17_@some.email			Never	
Roberts Russel	russel16y17_@some.email			Never	
Stone Susan	susan17y17_@some.email			Never	
Taylor Tom	tom18y17_@some.email			Never	
Tomas Adam	tadam@moodle.com			Never	
Villey Veronica	veronica19y17_@some.email			Never	

Figure 15- Complete list of users added to Moodle system. Source: author

5.4.2 Managing Roles for Study Block Session

Moodle includes a number of predefined roles. These standard roles are suitable for some educational setups, but most institutions require modifications to the roles' system in order to tailor Moodle to their specific needs (23, p. 138).

As it was mentioned in theoretical section, a role in Moodle has permissions for a range of actions that can be carried out in Moodle. The system administrator is allowed to edit any scope from 350 different capabilities associated with a role.

The description of standard roles and the names that are used internally in Moodle are listed in the Table 14. Managing and defining overall role capabilities might be done by a Moodle administrator.

The roles of Administrator, Course Creator, Teacher and Non-editing Teacher as well as the role of Student are defined manually in Moodle System for the purposes of this work. Guest role as well as Authenticated User role are not defined in the context of particular case study.

Table 14- Standard roles in Moodle. Source: author

Role	**Description**	**Short Name**
Administrator	Administrator has complete access to the entire site and to all courses.	admin
Course Creator	Course creator creates new courses and also might teach in them.	coursecreator
Teacher	Teacher is allowed to do any actions within a course: for example, to change activities and to grade students.	editingteacher
Non-editing Teacher	Non-editing teacher is allowed to do the same actions as the Teacher except altering any activities.	teacher

Student	Student is able to solve disposed problems that include activities as well as to use allocated learning resources.	student
Authenticated User	Additional role that is defined for user for non-permanent logging in. The role is used by Moodle System internally.	user
Guest	Guest has fewest set of privileges.	guest

In a context of this work an administrator is at the same time a course creator. An administrator is able to create new courses, whereas all other roles defined are denied the right.

The crucial point of rights administration in the context of the Thesis concerns to the specific activities and resources that need to be available either for teaching board or for students and course guarantor.

The right to see the feedback element (End-of-Study Block Student Survey) is supposed to be available exceptionally to the students. This right implies using accompanying feedback functionality in Moodle by the students that are enrolled and finished the study block session consequently. The lecturer right then presumes the ability to review the feedback from students, except the right of editing this information. Study department thereby get and collect the survey data about the study block participation.

The lecturer has no rights to edit any study block element but only review and collect the information received by visiting lecturer and students. Hence, the guarantor of the course will have the rights of the non-editing teacher role in context of study block.

The Figures 17-19 represent the representations from Moodle System that show the roles definition for visiting teacher, guarantor of the course and students.

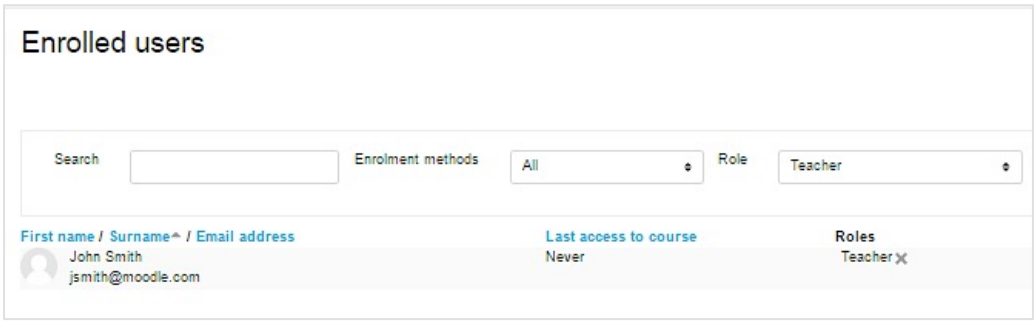

Figure 16- 'teacher' role setting to visiting teacher. Source: author

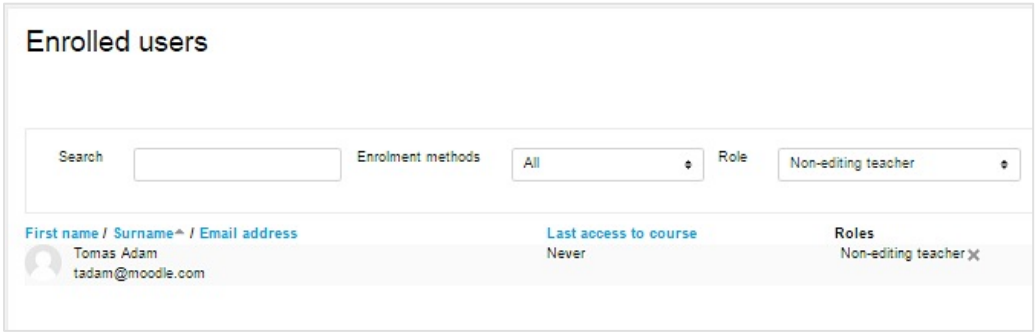

Figure 17- 'Non-editing teacher' role setting to lecturer. Source: author

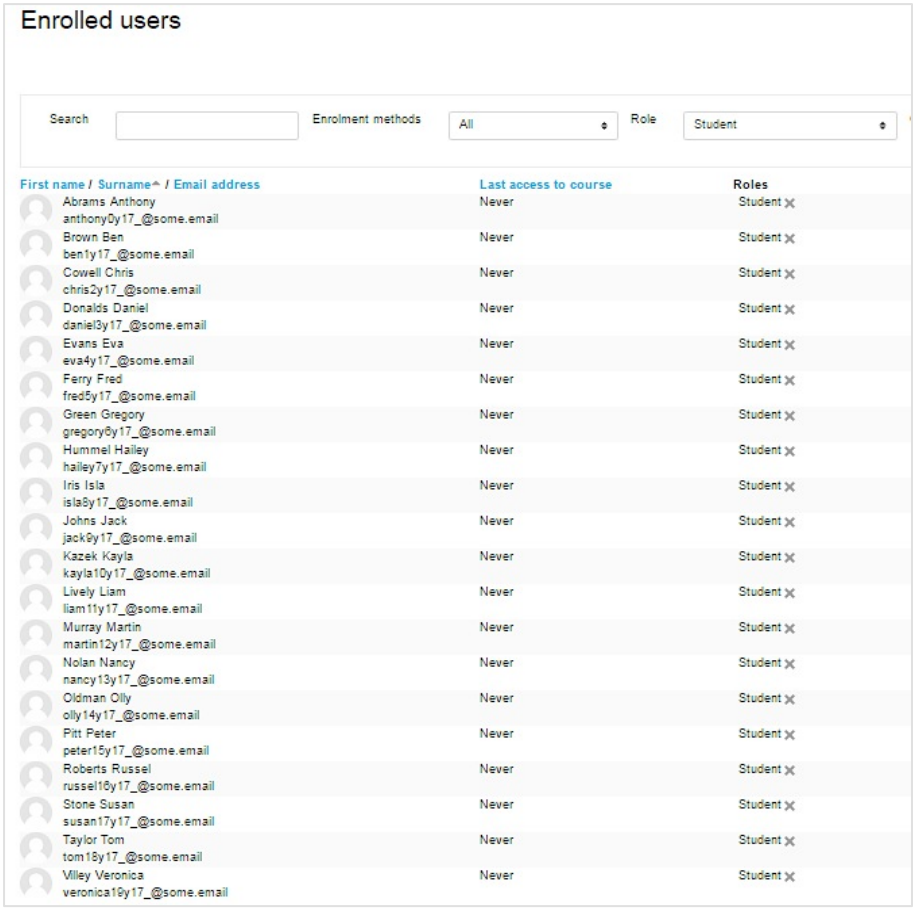

Figure 18- 'Student' role setting to students group. Source: author

5.4.3 Course Content Settings for Study Block Session

The course materials of different types of resources might be loaded in Moodle System. The content can be represented by document files HTML or text format, books, PowerPoint presentations, links, files and folders resources.

Study Block materials relate to instructional items that the visiting teacher uses to deliver educative information to students. For the particular case study, the content corresponds to lecture notes, book resource and reading articles.

The total study block is separated to equal sections in accordance with duration of sessions. The duration of daily session in the context of case study amounts to six academic hours during one calendar day. Hence, Moodle course structure implies occurrence of six sections. Five sections herewith contain studying materials for each day and two study block daily sessions (morning and afternoon sessions). The sixth section is hidden from students (Student Role). The sixth section supposes to contain the materials that visiting teacher (Teacher Role) provides to lecturer (Non-editing Teacher Role) for the purpose of further assessing of students knowledge achieved during the whole course completion. Namely, the sixth section of the course provides the section to upload resource that is list of possible topics from study block that will be used for final exam.

Study block sections are provided by description of the topics that will be covered during the particular day of study block. Each section contains the lecture notes in PowerPoint format that can be downloaded from the course page by each student.

The first section additionally includes the activity that supports attendance control that is implemented by using the Attendance additional plugin.

The fifth section of the study block includes Quiz Activity for final test realization and Questionnaire element for the purposes to conduct End-of-Study Block Student Survey.

The more detailed description of included elements, activities that are customized for the purpose of using for study block will be given in the following sections of the Thesis.

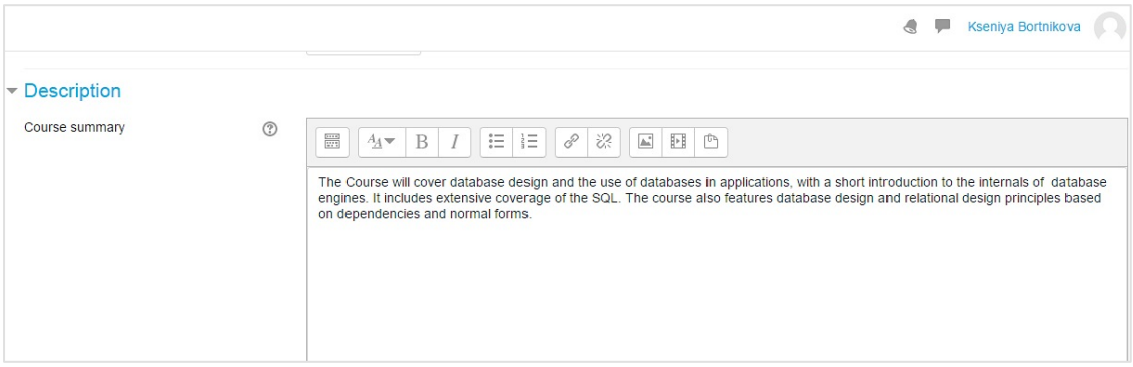

Figure 19- Study Block Description settings in Moodle. Source: author

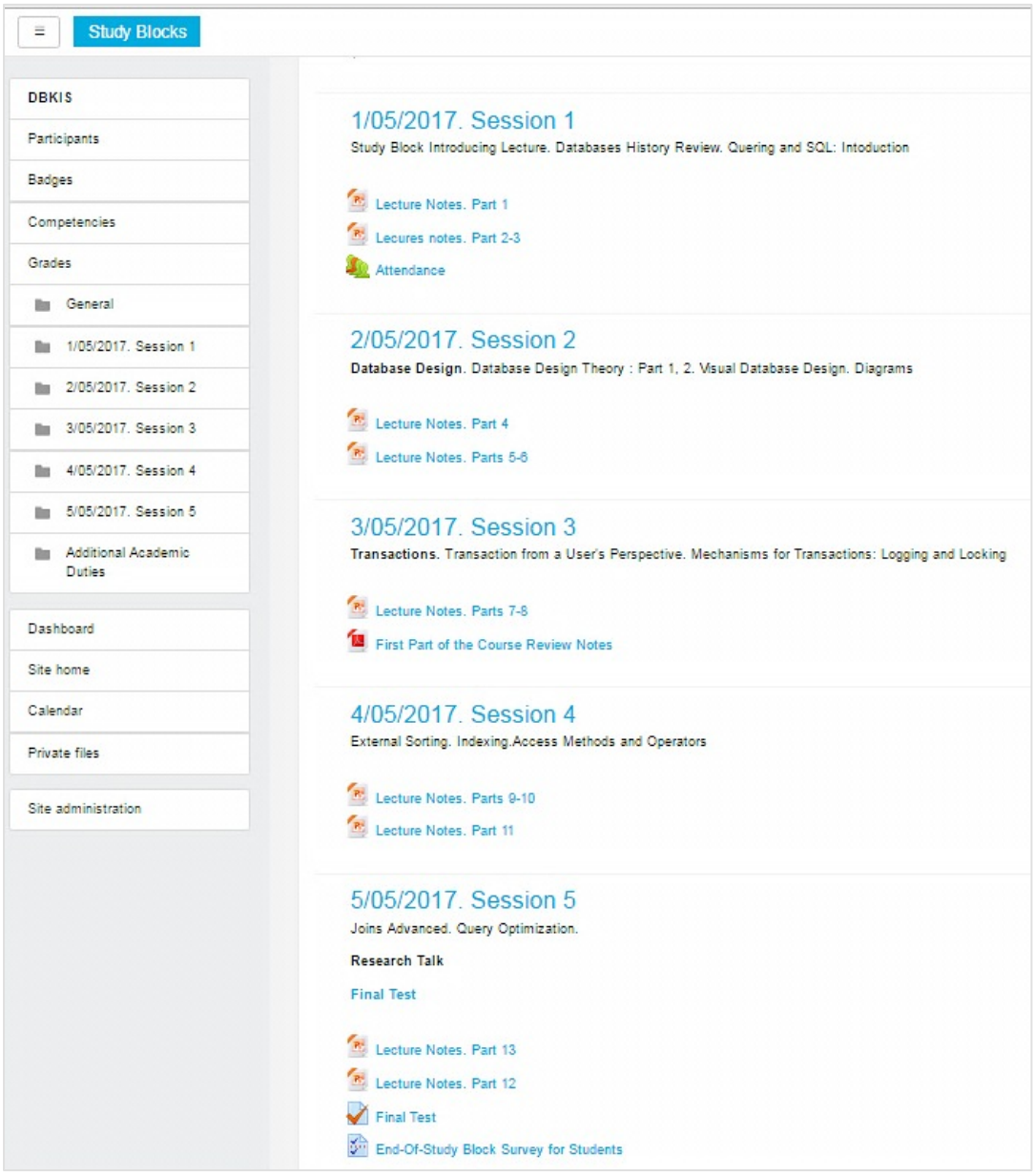

Figure 20- Study Block organization structure. Source: author

5.4.4 Final Test Settings

The final test requirement was enacted using Quiz activity in Moodle system.

A Quiz activity in Moodle is an adaptive tool that teachers or administrators can customize in numerous ways. This specific functionality presents a possible way for further course improvements.

Creating the quiz for final test was performed in a two-step manner. In the first step, the quiz activity that is called Final test in Moodle System was created. The test settings, which specify the rules for interacting with the quiz, were customized next. In the second step ten questions (two of them are of the short answer type, the rest eight are the multiple choice questions) were added to the quiz manually (Figure 22).

The settings for these questions were customized in order to meet the educational and representativeness requirements:

- Every question has a single-answer and equal weight in the final result
- Every question of the Final Test is located at the new page for the convenience of students. This option in settings allows not slipping students attention to multiple questions at once.
- For successful passing the final test the student need to achieve the result of seven correct answers from ten.

The complete list of Quiz activity settings is shown in Table 15.

Table 15 - Quiz settings for Final Test in Moodle. Source: author

General settings	
Name	Final Test
Description	The Final test consists of 10 questions. 8 of them are multiple choice type, only one answer is correct. 2 of them requires only the short answer To pass the final test you need to answer to 7 questions correctly. You have a single attempt to pass the Final Test.

	Your time limit is 10 minutes. Good Luck!
Timing	
Open the quiz	5th of May, 2017, at 1 PM
Close the quiz	5th of May, 2017, at 1-20 PM
Time limit	10 minutes
When time expires	Attempts must be submitted before time expires, or they are not counted
Grade	
Grade to pass	7.00
Attempts allowed	1
Layout	
New page	Every Question
Navigation method	Free
Question behavior	
Shuffle within questions	Allowed with deferred feedback
Extra restrictions on attempts	
Require password	Password is required
Require network address	Network address is required
Overall feedback	

Grade boundary	• Grade boundary - 70% (all students who receive 70% or higher grade): Great job! You are passed. • Grade boundary - 69% (0%-69% grade): Review Study Block materials and request the Course Guarantor for additional test attempt

Figures 22 and 23 represent Final Test structure and Final Test details description in Moodle. The representation of each question organization in Moodle is provided in Appendix 5 section.

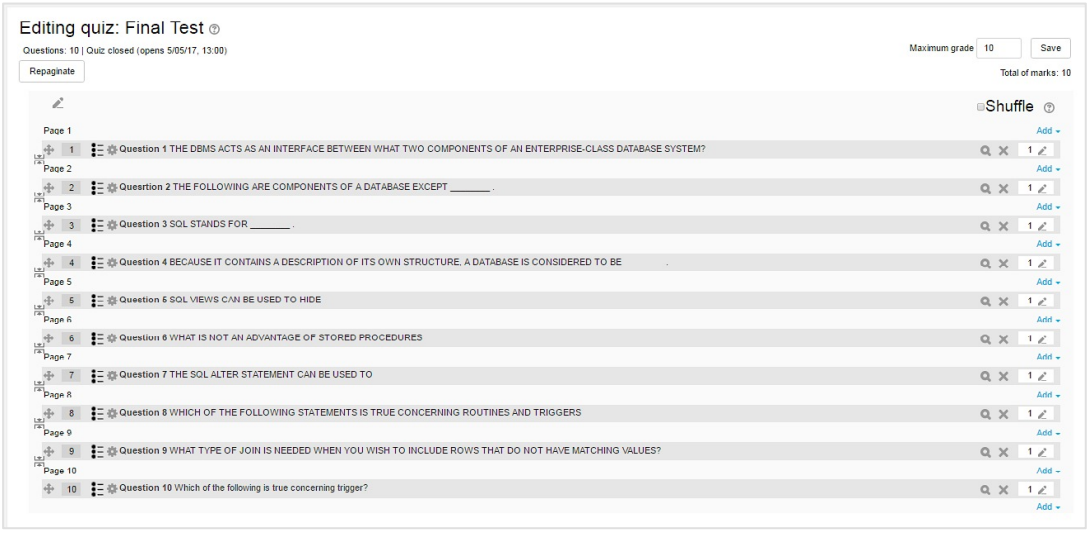

Figure 21- Final Test structure in Moodle. Source: author

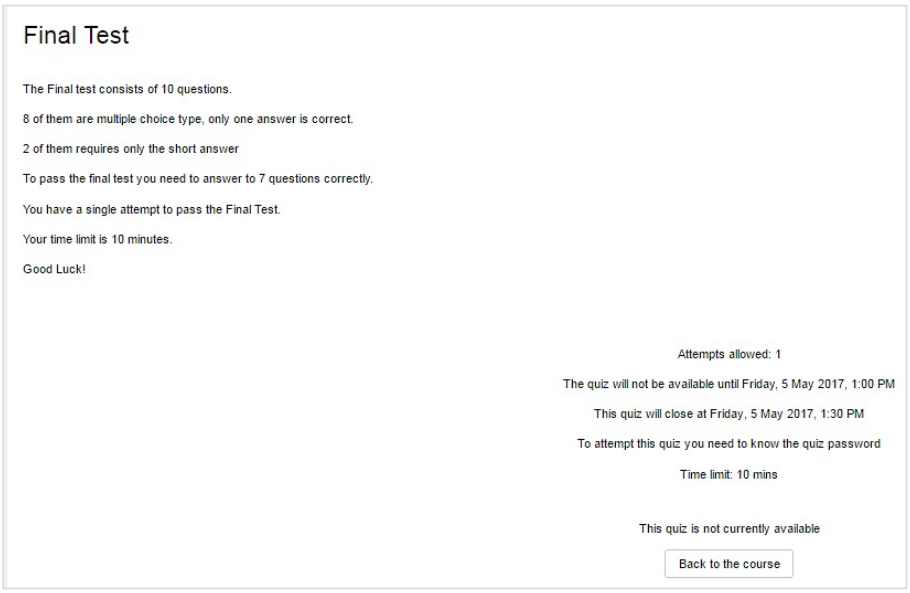

Figure 22- Final Test details description. Source: author

5.4.5 Potential problem with Final Test organization

The potential problem arises from the fact that one login is issued for students for the whole Study Block duration period and they can change the password by themselves. The students get access to the final test in the classroom under the teacher control. However, it can happen that during the testing in the classroom, the student is currently logged in not only from the classroom computer, but also externally. That possibly might be a sign that somebody executes the appointed tasks for student (multiple access with different IP addresses for one user).

Hence, the test organizational goal is to protect a process of final test holding from academic cheating. The task can be partially solved by using Moodle functionality. There are three security protection options:

- Access restriction for simultaneous logging from the same user account
- Setting the password on the test
- Access restriction to the test on the IP address

The second option supposes that the teacher or the Study Block Instructor might independently enter the password on the PCs before the students will start testing. Thus, those who don't know the password won't be able to enter the test. Password specification implies that then participants have to enter the same password before they are allowed to make an attempt on the final test. This protection option is useful only for a selected group of students to access to the quiz. The teacher might change the password immediately and confidentially soon after the test starting as alternative option. It won't prevent those who already began to take a test, but others won't be able to enter even if they managed to learn the previous password.

The third option implies that if the classroom IP address is known, then it is possible to set restriction on the address. Hence, nobody except sitting in a classroom will be able to take the final test. Using Moodle test settings it is possible to restrict access for a testing to particular subnets by specifying a comma-separated list of IP address numbers. The option is useful if it is necessary to be sure that only students in the classroom are able to access the test.

5.4.6 Question bank

There is an additional requirement to the study block instructor at the final stage of the study block. Visiting teacher needs to prepare and provide the lecturer with the set of questions from the topics covered during the study block. Some questions from this list will be eventually used as a part of the final exam for the course.

The solution that is proposed to cover this requirement in Moodle is to use Question Bank. The Question Bank element in Moodle is a database of questions from which assessments or quiz activity can be created. Hence, this option may also be used for uploading and storing the list of question for final exam. Using the question bank feature the study block instructor can create a specific category for editing and storing final exam questions or topics (as it is shown for the case study). The categories in a question bank might be limited to being used on different levels of Moodle system. The category might be available on the site, course or quiz level. The questions can be added in a category by a teacher or course administrator via an export process.

For the purposes of case study realization the Final Exam Topics category was created and filled in with the list of topics. The topics are added as description elements to the question bank of the study block (course level). The description type of elements is not, strictly speaking, a question in Moodle system. This element displays text without requiring an answer that is an appropriate representation considering the specifics of the study block teaching process. Figure 24 represents the description type element creation as content of question bank in Moodle. Figure 25 shows List of Topics Settings in Question Bank.

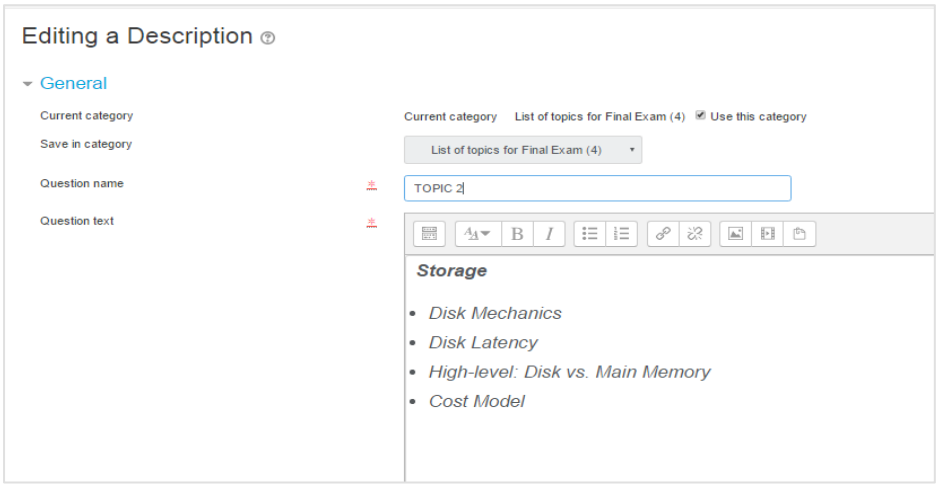

Figure 23- Topic element creation in Question Bank. Source: author

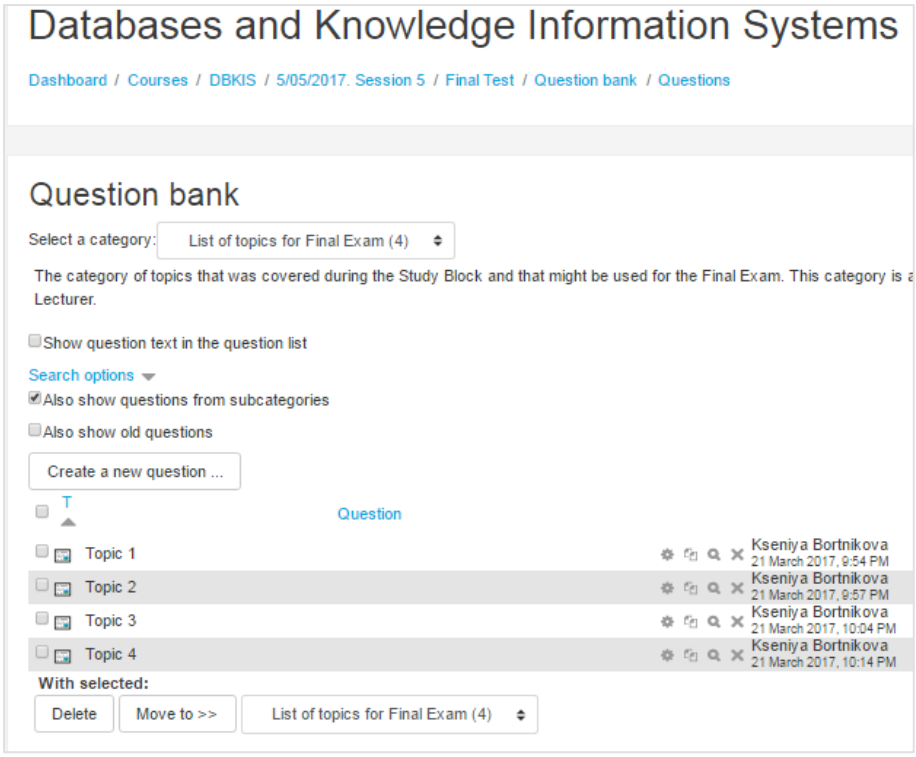

Figure 24- List of topics settings in Question Bank. Source: author

5.4.7 Students Survey (Questionnaire Module)

From the last experience of study blocks carrying out in the University it was revealed that not only the student's work during the sessions need to be assessed, but also the opinions on course activities from students need to be gathered. The main purpose of student's feedback is to improve the real knowledge contribution and to make the learning process easier, more interesting and effective. Including the students feedback option the whole course will allow to the regular teacher and to the Faculty Board to form a critical view on the whole process of course teaching and to determine the organizational and academic strengths and weaknesses.

For the purpose of student's feedback collecting the special plugin (Questionnaire) on Moodle was installed and attached.

The Moodle Questionnaire is a survey type of activity. It allows creating a range of questions to get student feedback on a course or activities. The purposes of using Questionnaire module differs from the functions of Quiz activity. Questionnaire supposes not testing or assessing the student, but gathering data from students.

This additional activity is basically the final feedback survey and it features a list of seven questions that are addressed to the students who have participated the study block in the academic semester. For the University the final study block feedback surveys are required in order to obtain opinions from students on some aspects relating to the offered study block and the course.

All the surveys are currently managed through the Dotaznik Online Survey system. However, for the case of study block, it might be more efficient way to provide final feedback survey in class, right after the finishing the study block session that is structured through the Moodle System.

The Moodle Questionnaire module was created and tested for the purpose to assist with standard format questionnaire, which correspond to the university format. The university feedback questionnaires are quite simple and it normally contain a combination of closed (grading) and open ended (essay type) questions.

The End-of-Study Block Student Survey is organized in the following manner as it is described in Table 16.

Table 16- Questionaries' description in Moodle. Source: author

General settings	
Name	End-Of-Study Block Student Survey
Description	The survey consists of 6 grading and 1-essay type questions. For grading questions please choose from 1 to 5, where: 1- Strongly disagree 2-Disagree somewhat 3-Neutral 4-Agree somewhat 5-Strongly agree

Figure 26 provides the representation of questionnaire question creation in Moodle.

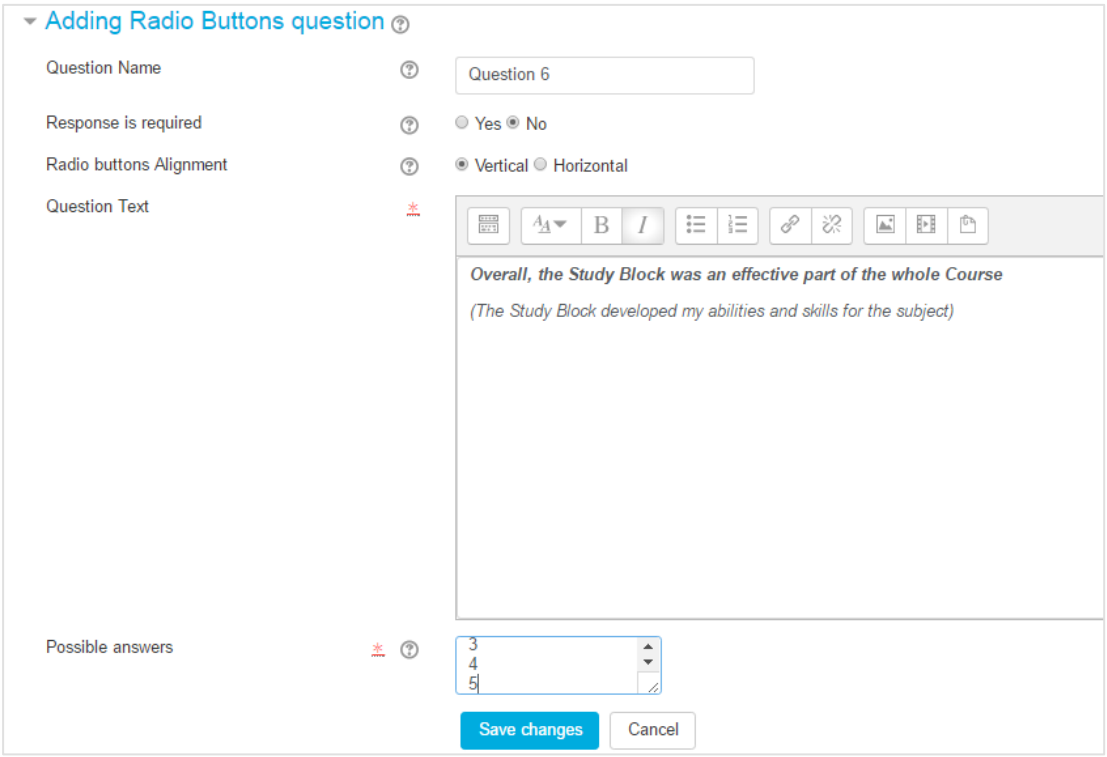

Figure 25- Student survey settings in Moodle. Source: author

Figure 27 provides the survey structure representation in Moodle.

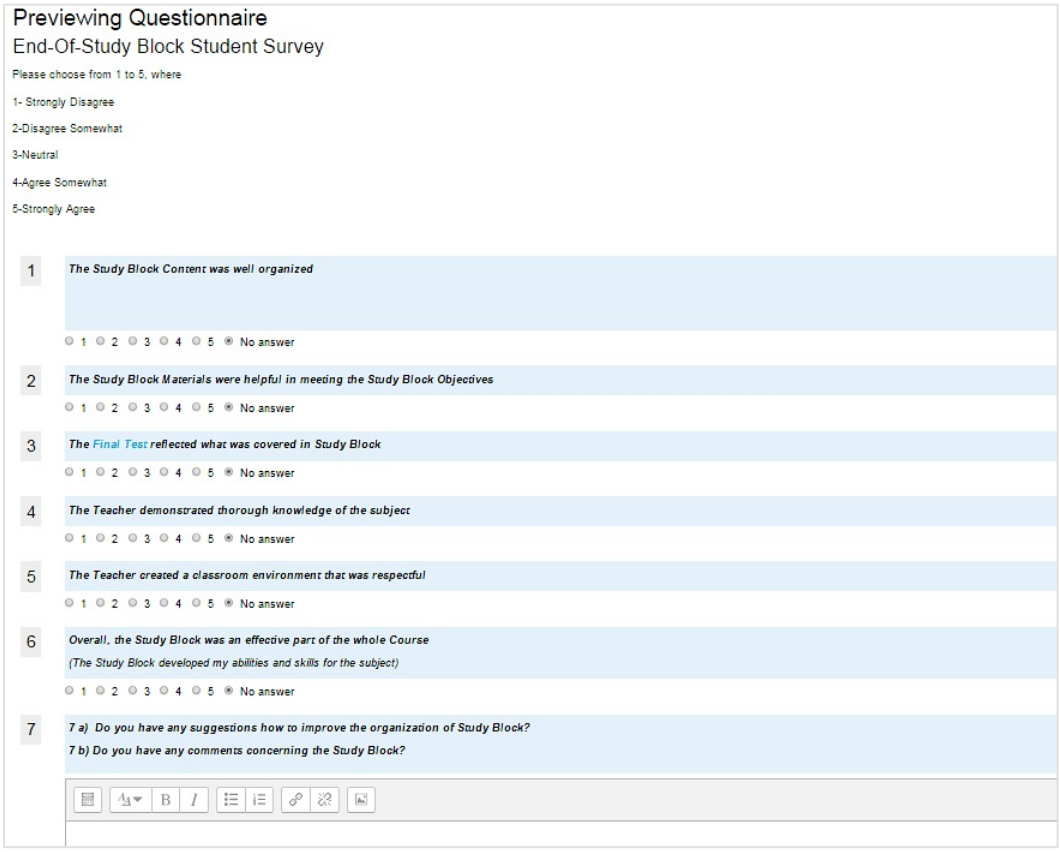

Figure 26- Student survey organization in Moodle. Source: author

5.4.8 Attendance Settings

The following crucial requirement for successful completion of study block and the whole course is student's attendance. It is obligatory to attend 80% of study block sessions hours for every student who participates the course. Hence, a student is required to attend at least 24 from 30 hours in the context of proposed case study.

Moodle Attendance plugin is a customized solution for managing attendance of students. The activity allows administrators and teachers to maintain a record of attendance. Using Moodle to check students' attendance will lead to replacing or supplementing a paper-based attendance registration. The solution is suitable for study block since this education activity is an example of blended-learning: students are required to attend lectures and seminary sessions.

The attendance activity in Moodle allows the teacher to assign a grade for the students attendance. The teacher or administrator can set the frequency of sessions

(number of days per week and timing of each session). Sessions in Attendance module might also be configured to allow students to record their own attendance.

To take attendance list at the end of the study block, the visiting teacher or course guarantor can click on the "Update Attendance" button: the attendance list will be presented with a names of all the students that are enrolled to study block along with comments. Both visiting teacher and lecturer are provided with permission to download the attendance for the study block in Excel format or text format.

The proposed solution for the case study consists of checking the morning and afternoon sessions attendance. Morning Session amounts to 3 hours and 30 minutes with the 10 minutes break at the discretion of the Study Block instructor. Afternoon Session amounts to 2 hours and 30 minutes with the 10 minutes break at the discretion of the Study Block instructor.

Figures 28-32 show the process of attendance module adapting for study block purposes.

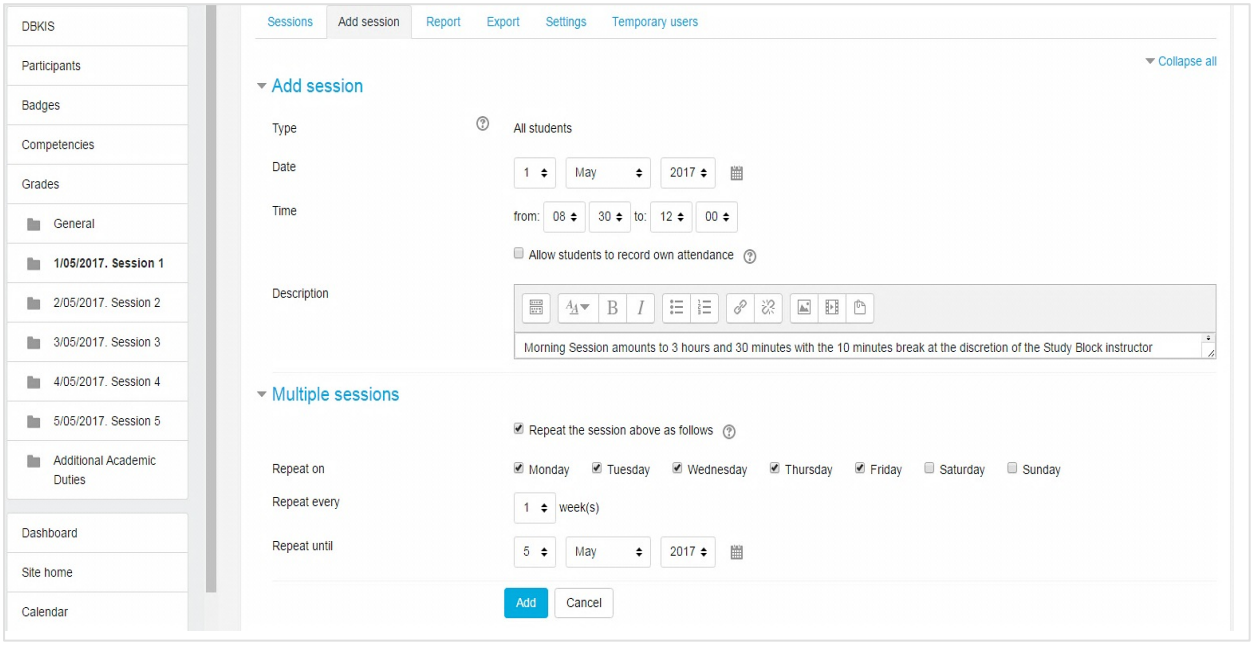

Figure 27- Morning session settings in Moodle. Source: author

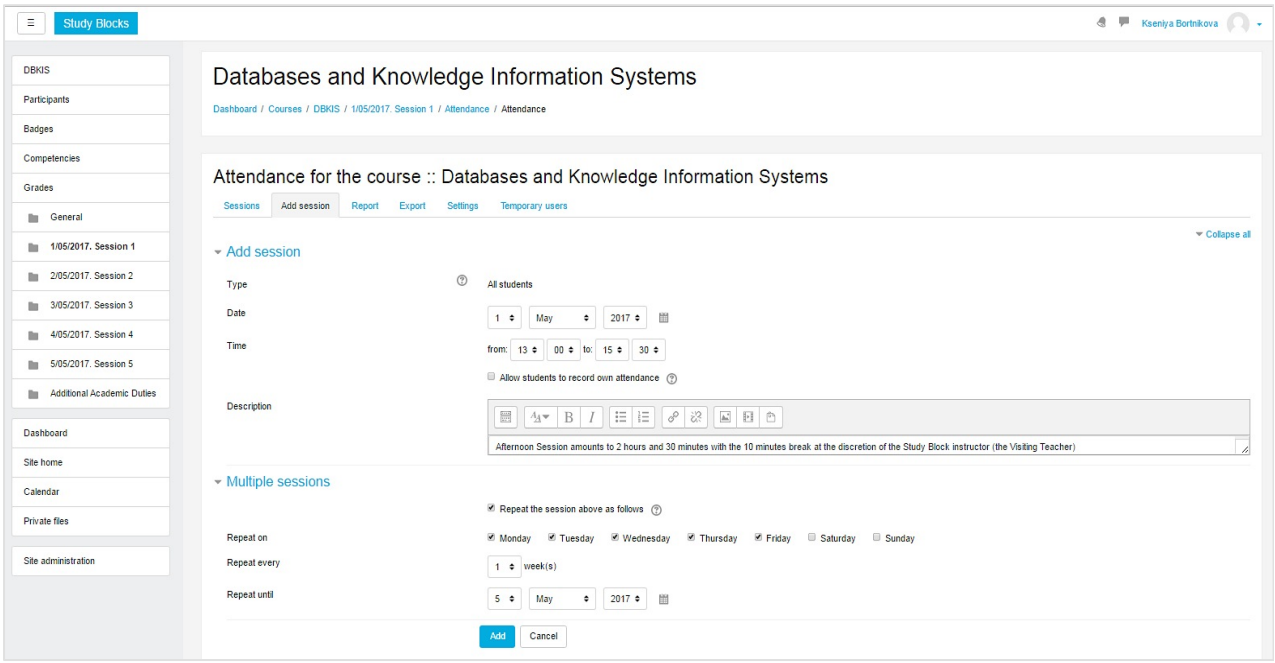

Figure 28- Afternoon session settings in Moodle Source: author

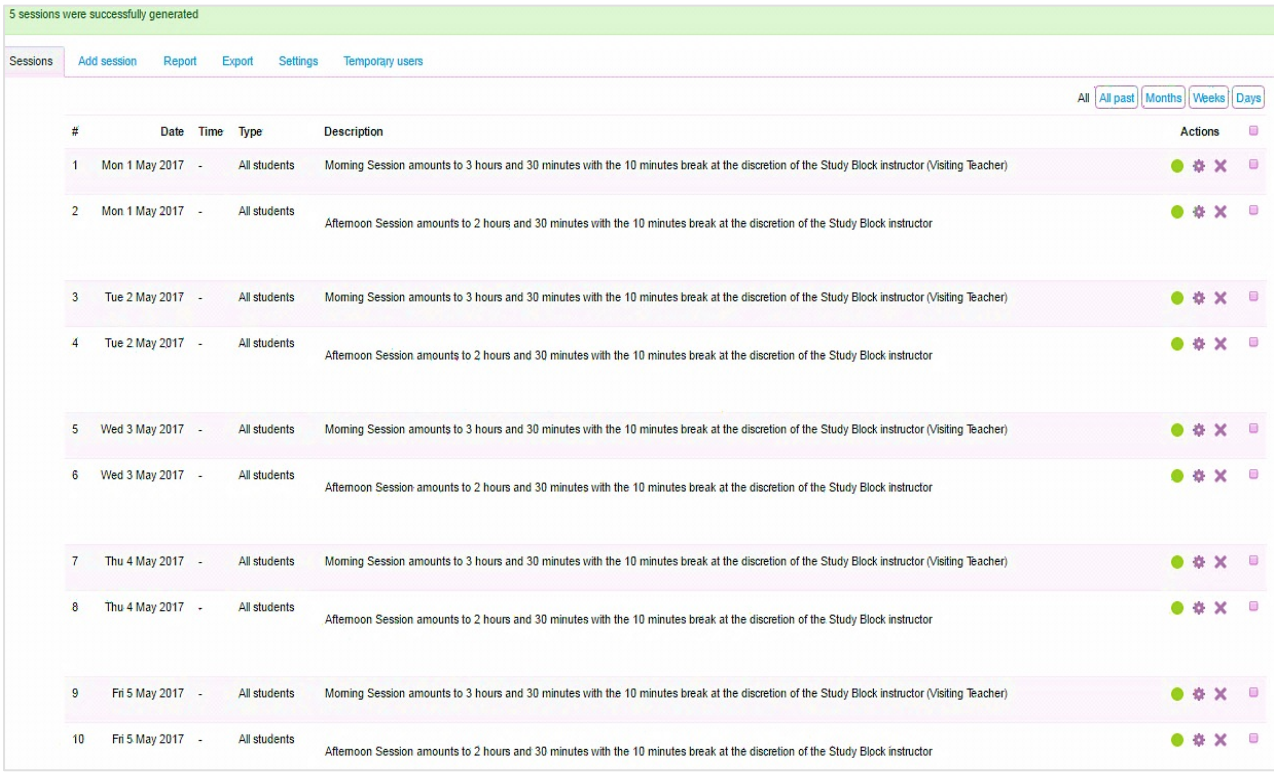

Figure 29-Complete Sessions settings for study block in Moodle. Source: author

The default options for Attendance module in Moodle are: Present, Absent, Late & Excused. For the study block case study only three options were chosen: Present, Absent and Excused.

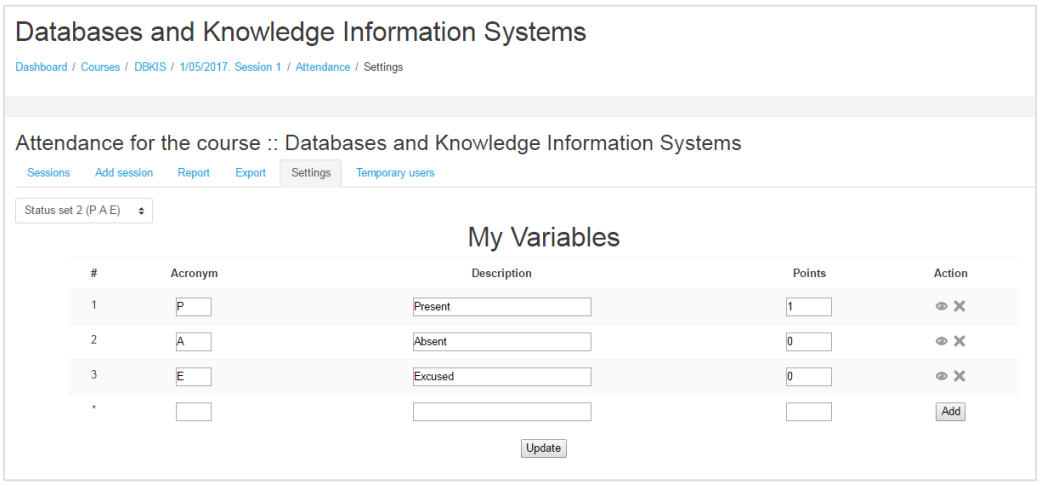

Figure 30-Attendance options settings in Moodle. Source: author

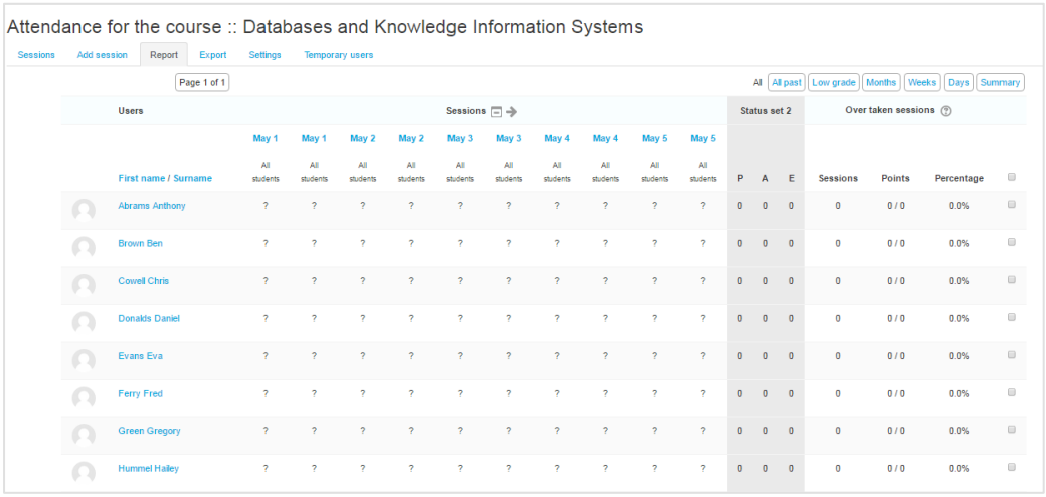

Figure 31- Example of attendance list in Moodle. Source: author

6 Results and Limitations of the Study

6.1 Results discussion

Following to the formulated partial goals of the Thesis the important results were obtained.

Through the literature study, Moodle LMS was determined as one of the most popular and advanced open source software for education. The implementation solution of the study, hence, was focused on Moodle environment using.

The overview of CULS existing information systems identified that CULS just like many other academic institutions tend to utilize various information systems in order to cover different academic and administrational needs and requirements. As a result from this section it was concluded that Moodle LMS is an important part of University information environment since it covers the substantial number of teaching and learning processes.

In order to show how workflow approach can be applied to teaching and learning processes at University, the modeling was conducted using Craft.Case modelling tool as well as workflows models for education process participants were created.

The main result of the case study implementation revealed the capabilities to improve study block education process. Particularly, the automation of study block teaching, learning and administration methods in Moodle can provide some improvements through efficient planning and supporting of important course activities. At the same time it simplifies the teaching and learning processes for both teachers and students.

6.2 Limitations of the Study

The first limitation of the work is the lack of information on previous studies of CULS information systems. This fact limited the extent of obtaining comprehensive information describing the university teaching and learning environment and its core information systems. The information of Chapter 4 is collected through university websites and study guides. The coverage of study would have expanded in case of availability of extensive documentation.

Second limitation is related to the fact the findings were entirely obtained from studying Moodle capabilities based on activities of a specific study block for particular course only. It is comprehended that courses from other departments may provide different sets of requirements for study blocks. Therefore analysis of specifics from other studying activities and courses requirements from academic programs would have afforded further contribution to the results.

The third recognized limitation arises from the fact that study block management (including studying materials uploading and students enrollment) in Moodle has to be done with a strict deadline occasionally. This limitation cannot be lifted internally because it strongly depends on visiting teacher schedule.

Nevertheless, the most of the factors that are recognized as limitations in this chapter can provide directions for further studies.

7 Conclusion

The main goals of the Diploma Thesis were to analyze the problem field, and then to model, manage and implement the information solution for the flow of activities and events in the study block educational process, with respect to workflow structure of teaching and learning processes.

Literature review was conducted to provide an overview of E-learning and LMS objectives and the background related to their adoption in the academic institutions nowadays.

Since CULS is the case study, an overview of CULS existing information systems was performed. The objective was to understand the roles of each information system in the university's virtual learning environment. It was concluded that Moodle LMS is a important part of University information environment since it covers the substantial number of teaching and learning processes.

In order to determine how e-learning solution might provide improvements in the teaching and learning with respect to workflow structure of study block education processes, a proposed implementation of study block for Databases and Knowledge IS course was set up. A Moodle module for the course was created and the corresponding resources and activities modules were tested.

Results of the implementation proposed some teaching and learning improvements through the construction of efficient workflow for teaching and learning by automation education processes executed manually (study materials providing, online knowledge testing, attendance checking, survey participation).

The final results of this work might be considered as useful to the CULS teaching board and management by means of Moodle LMS further development can bring changes to the university at managerial, academic and technical levels.

List of abbreviations

ADL	Advanced Distributed Learning
API	Application Programming Interface
BPA	Business Process Analysis
BPM	Business Process Management
CSS	Close-source software
CDN	Content distribution network
CMS	Course Management System
CULS	Czech University of Life Sciences Prague
ECTS	European Credit Transfer and Accumulation System
FEM	Faculty of Economics and Management
GNU GPL	GNU General Public License
ICT	Information and Communications Technology
ILIAS	German for Integrated Learning, Information and Work Cooperation System
IMS	Information Management System
ISO/IEC	International Organization for Standardization/International Electrotechnical Commission
HTML	HyperText Markup Language
LMS	Learning Management System
LTI	Learning Tools Interoperability
Moodle	Modular Object-Oriented Dynamic Learning Environment
OSS	Open-source software
SaaS	Software as a Service
SCO	Sharable Content Object

SCORM	Sharable Content Object Reference Model
UML	Unified Modeling Language
VLE	Virtual Learning Environment
WfMC	Workflow Management Coalition
XML	eXtensible Markup Language

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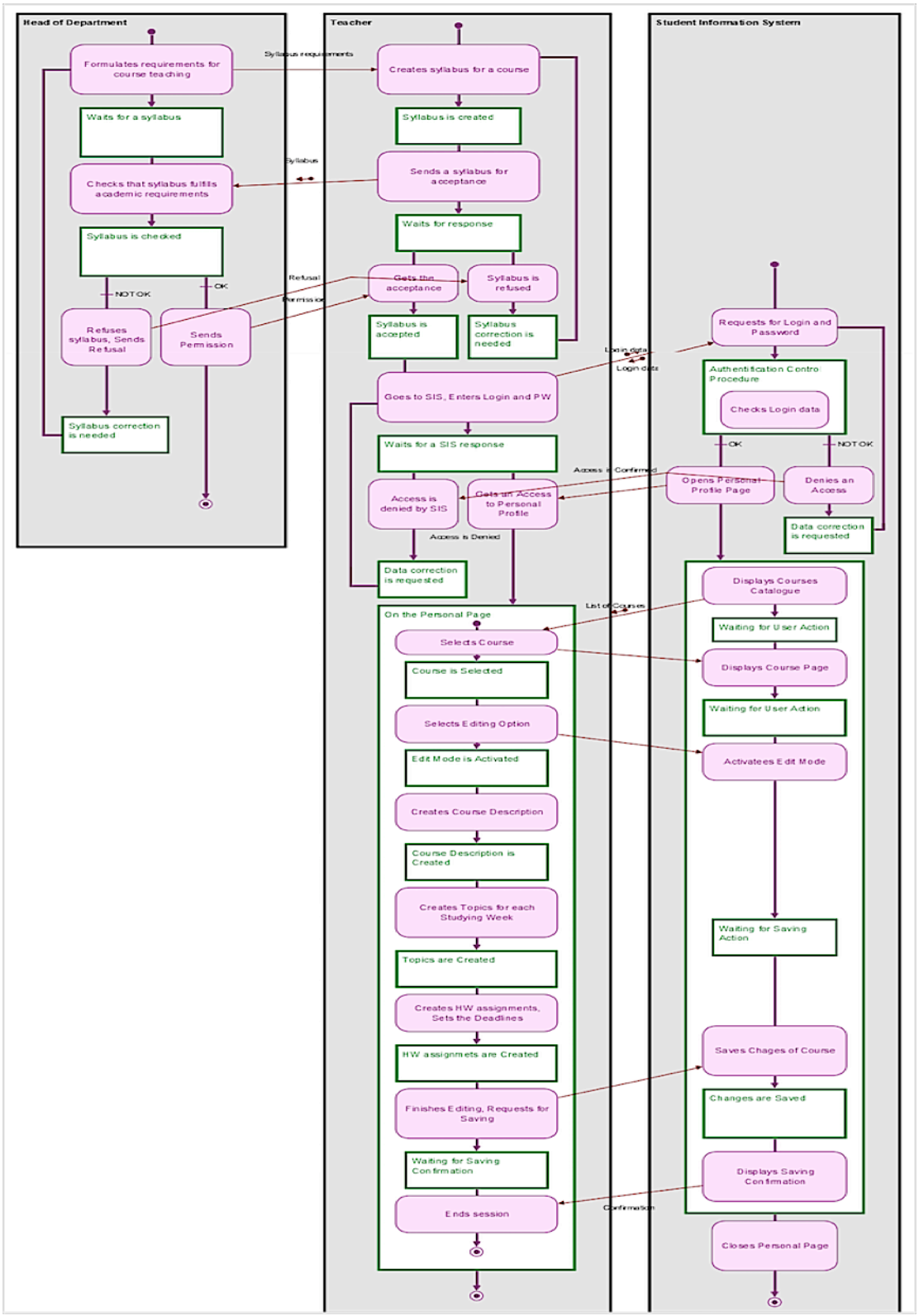
APPENDIX 1. Course Management Process in UIS



APPENDIX 2. Scenarios for Pre-Studying and Post-Studying Processes at CULS

	Description
Name	Student Registration
Initiation	Student fulfilled entrance requirements.
Action	Program Coordinator gets the Students List of the particular Program from Study Department. Program Coordinator provides instructions to IT Department to subscribe the students of particular Program and year of studies to Program Courses .
Result	Students of the Program get the access to personal page with the list of courses in the System.

	Description
Name	Teacher Registration
Initiation	Teacher is accepted to teach (is officially hired by the University) at the University by the Academic Senate, by the Head of Department.
Action	Program Coordinator gets the Teachers List from Study Department. Program Coordinator gives instructions to IT Department to provide Teachers registration in University Information System.
Result	Students of the Program get the access to personal page in the University Information System.

	Description
Name	Schedule Management
Initiation	Program Coordinator gets the lists of registered students of the particular Studying Program. Program Coordinator gets the lists of Registered Teachers of the Program Courses.
Action	Program Coordinator requests for the list of Available Faculty Rooms and Timetable from the Study Department. Program Coordinator organizes Study Groups with required number of students in each group. Program Coordinator gets the information from Study Department and assigns Room and Time for each Course and Study Group and Teacher in the University Information System.
Result	The Schedule is Available for Students and Teachers in the University Information System.

	Description
Name	Programme Management
Initiation	Study Program is accepted by the Head of University and the Head of the Department. Acceptance means higher education accreditation as an education quality assurance process.
Action	Program Coordinator provides the Regular Courses and Study Blocks organization. Program Coordinator provides instruction to IT Department to assign the List of Courses to the Studying Program in University Information System.
Result	Studying Program description with the List of Courses is available in University Information System.

	Description
Name	Course Management
Initiation	Course is accepted to be a part of Program by the Head of Department according to the Higher Education Accreditation Decision. Teacher is accepted to teach the Course by the Head of Department and is Registered in the University Information System.
Action	Teacher creates the Course Syllabus according to the time and Program requirements. After acceptance by the Head od Department, Course Syllabus could be uploaded to the University Information System by the Teacher. Teacher can request to the IT Department to upload the Course information to the System provided the instructions and the Course Syllabus previously.
Result	Course Syllabus is available in the University Information System.

	Description
Name	Credits Recognition Process
Initiation	Study Department gets the information about ECTS credits received credits.
Action	Study Department checks and collects the information of credits receiving in SIS
Result	Academic credits are recognized in SIS

	Description
Name	Transfering for furher year of study
Initiation	Student has necessary and sufficient number of credits for the particular studying year and fulfills other studying requirements.
Action	For the registration, students should bring a print-out of their grades from SIS. Study Department performs the final inspection and registers Student in SIS for the further studying year
Result	Student is registered for further year of study formally and in Student Information System.

	Description
Name	Interruption of Studies Process
Initiation	Official interruption of studies is initiated by a student by delivering a formal written request to Study Department.
Action	Student prepares a written request to interrupt the studying with explanation of the reasons. The Study Department officer checks and accepts all the documents. The Head of Department resolves to accept/reject the application.
Result	Studies may be interrupted either for a semester or the whole academic year and students may ask for interruption of studies more than once.

	Description
Name	Termination of Studies Process
Initiation	Student did not fulfill the requirements for further studying, such as the student has not achieved required number of credits or the student failed to pass a mandatory class twice.
Action	The Disciplinary Committee or Study Department Officer terminates studies of a student. Student gets formal written notification from Study Department.
Result	The studies are terminated. Student loses the legal status of a student.

APPENDIX 3. List of students enrolled to the Course

username	password	firstname	lastname	email	
anthony0y17_	976295	Abrams	Anthony	anthony0y17_@some.email	EX
ben1y17_	678941	Brown	Ben	ben1y17_@some.email	EX
chris2y17_	840101	Cowell	Chris	chris2y17_@some.email	EX
daniel3y17_	898513	Donalds	Daniel	daniel3y17_@some.email	EX
eva4y17_	672903	Evans	Eva	eva4y17_@some.email	EX
fred5y17_	164768	Ferry	Fred	fred5y17_@some.email	EX
gregory6y17_	749311	Green	Gregory	gregory6y17_@some.email	EX
hailey7y17_	921125	Hummel	Hailey	hailey7y17_@some.email	EX
isla8y17_	191333	Iris	Isla	isla8y17_@some.email	EX
jack9y17_	674279	Johns	Jack	jack9y17_@some.email	EX
kayla10y17_	241574	Kazek	Kayla	kayla10y17_@some.email	EX
liam11y17_	727304	Lively	Liam	liam11y17_@some.email	EX
martin12y17_	275413	Murray	Martin	martin12y17_@some.email	EX
nancy13y17_	523227	Nolan	Nancy	nancy13y17_@some.email	EX
olly14y17_	737086	Oldman	Olly	olly14y17_@some.email	EX
peter15y17_	962262	Pitt	Peter	peter15y17_@some.email	EX
russel16y17_	128420	Roberts	Russel	russel16y17_@some.email	EX
susan17y17_	416863	Stone	Susan	susan17y17_@some.email	EX
tom18y17_	888667	Taylor	Tom	tom18y17_@some.email	EX

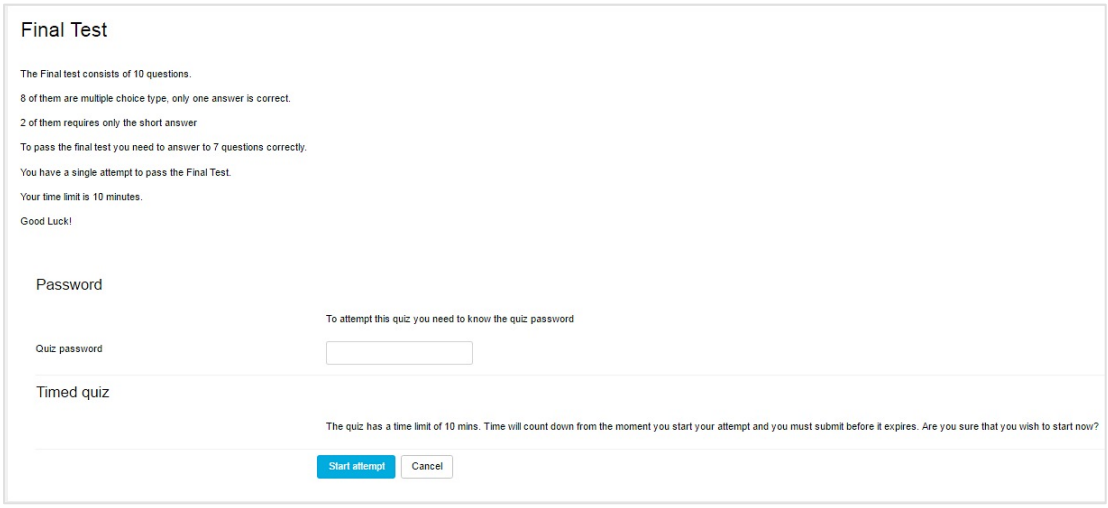
APPENDIX 4. Course Profile for Study Block in Moodle

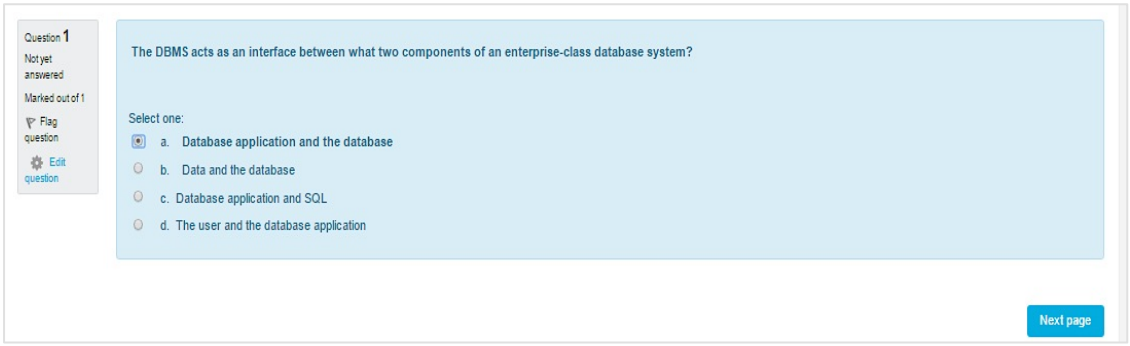
Databases and Knowledge Information Systems

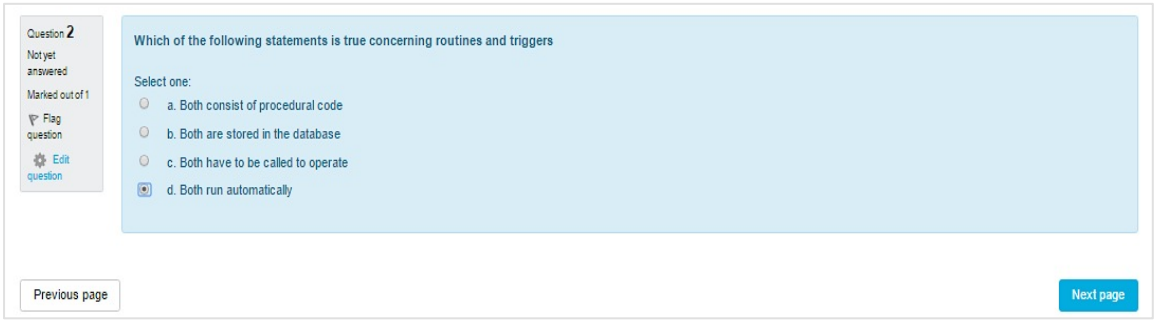
View | Edit | Enrolled users | Delete | Hide | Backup | Restore

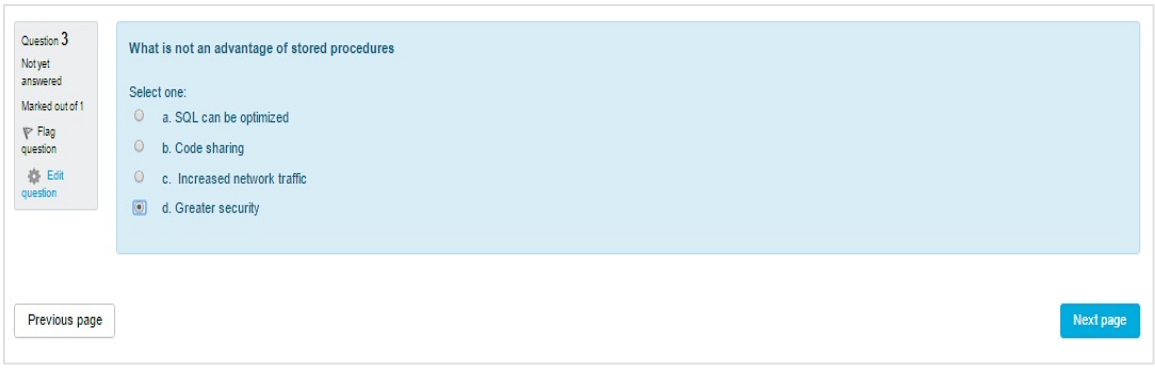
Full name	Databases and Knowledge Information Systems
Short name	DBKIS
ID number	DB01
Category	Разное
Groupings	0
Groups	0
Role assignments	Teacher: 1 Non-editing teacher: 1 Student: 20
Enrolment methods	Manual enrolments
Format	Topics format
Sections	General 1/05/2017. Session 1 2/05/2017. Session 2 3/05/2017. Session 3 4/05/2017. Session 4 5/05/2017. Session 5 Additional Academic Duties
Modules used	Attendance File Forum Questionnaire Quiz

APPENDIX 5. Final Test realization in Moodle









Question 4
Not yet answered
Marked out of 1
Flag question
Edit question

The following are components of a database except _____.

Select one:
- a. indexes
- b. user data
- c. reports
- d. metadata

Previous page | Next page

Question 5
Not yet answered
Marked out of 1
Flag question
Edit question

SQL views can be used to hide:

Select one:
- a. None of the above is correct.
- b. columns and rows only.
- c. both of the above can be hidden by an SQL view.
- d. complicated SQL syntax only

Previous page | Next page

Question 6
Not yet answered
Marked out of 1
Flag question
Edit question

The SQL ALTER statement can be used to

Select one:
- a. Add rows to the table
- b. Change the table structure
- c. Change the table data
- d. Delete rows from the table

Previous page | Next page

Question 7
Not yet answered
Marked out of 1
Flag question
Edit question

What type of join is needed when you wish to include rows that do not have matching values?

Select one:
- a. Equi-join
- b. Outer join
- c. All of the above
- d. Natural join

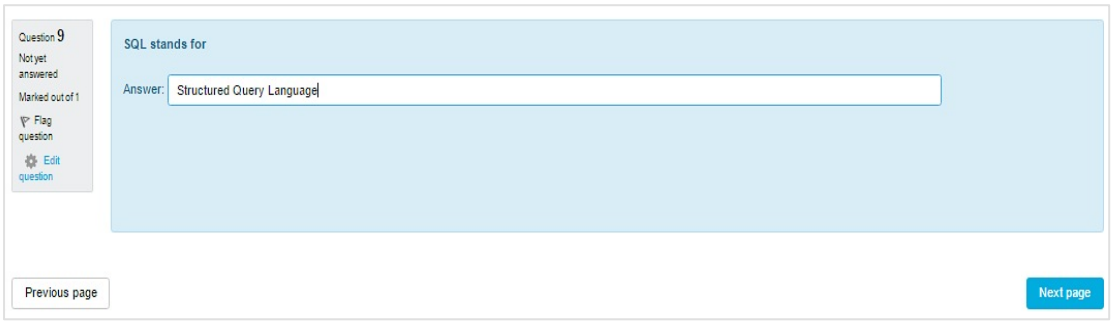
Previous page | Next page

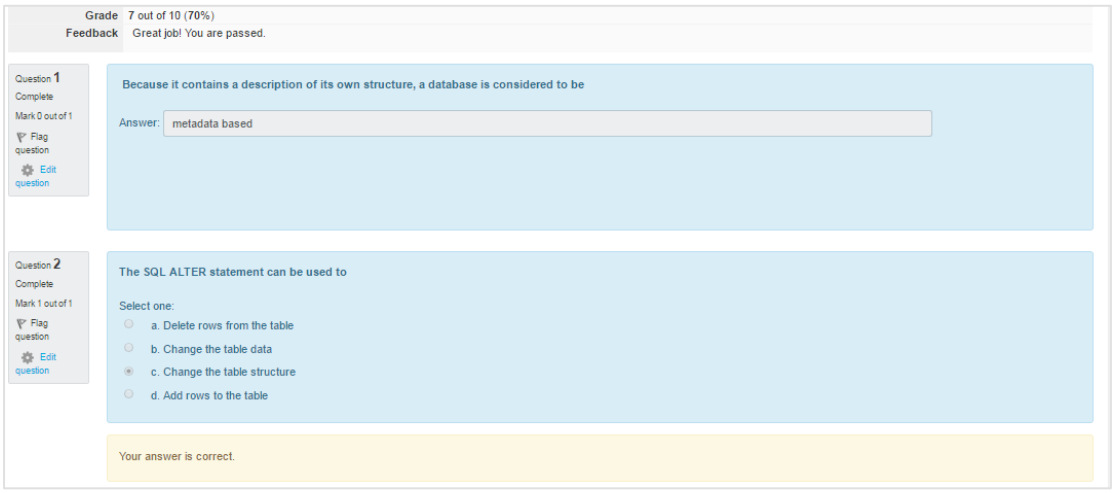
Question 8
Not yet answered
Marked out of 1
Flag question
Edit question

Because it contains a description of its own structure, a database is considered to be

Answer: metadata-compatible

Previous page | Next page


Question 9
Not yet answered
Marked out of 1
Flag question
Edit question
SQL stands for
Answer: Structured Query Language
Previous page
Next page


Grade 7 out of 10 (70%)
Feedback Great job! You are passed.
Question 1
Complete
Mark 0 out of 1
Flag question
Edit question
Because it contains a description of its own structure, a database is considered to be
Answer: metadata based
Question 2
Complete
Mark 1 out of 1
Flag question
Edit question
The SQL ALTER statement can be used to
Select one:
a. Delete rows from the table
b. Change the table data
c. Change the table structure
d. Add rows to the table
Your answer is correct.