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Design & Development of Modular Learning Management Systems

Methods & Techniques: Learning From a Success Story

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Abstract

The rapid development of current information technology has brought about new aspirations in the academic world, especially in higher education organizations. Learning management systems (LMS) are software applications or Web-based technology used mainly for digital learning and studying. Even though there are many different kinds of LMS, the more advanced ones are usually highly priced and the simpler ones are limited, so the question is would an in-house built LMS be the best solution? This research focuses on the analysis of an in-house built LMS called LIBRI designed by the research team at the South-Eastern Europe University in Macedonia. The aim of this research is to describe the project of LIBRI as a success story and transform its development pattern into a standardized methodology for other future in-house LMS developments. A number of interviews were conducted and later analyzed through the research framework in an attempt to better view the step by step procedures taken by the developers. We present a detailed process view of the analysis, design, development, implementation and evaluation phases by conjoining their similarities with theories that compose the original research framework. Lastly, we were able to distinguish a clear pattern to serve as a guideline for future Modular LMS developments.

Acknowledgements

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Valdrina & Ismail

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Abbreviations

LMS	Learning Management System
MLMS	Modular Learning Management System
LIBRI	The name of the LMS developed by SEE University
ISD	Instructional Systems Design
IS	Information System
SCT	Social Construction Theory
VLE	Virtual Learning Environment
ANT	Actor-Network Theory
MD	Modular Design
VLAN	Virtual Local Area Network
ACL	Access Control List
SEEU	South-Eastern Europe University
UI	User Interface

1. Introduction

The rapid development of WEB technology has triggered new initiatives in the academic and organizational world, especially in universities and schools. One of the most significant developments in this field is the concept of digital learning and studying (Bartolomé, 2008). While virtual learning environments in some competency have existed since the 50s (Office for Standards in Education, Children's Services and Skills, 2009) Learning Management Systems (LMS), in their contemporary form, have only been available since the 1990s (Vollmer, 2003). Even so, over the past decade, LMS have become almost universal thanks to the rapidly development of technology and its use in the educational system. Whether the focus is on distance education or on campus based education, institutions around the world are using LMS to advance, update and improve learning within their institution by using its initial intent which is to enable administrators and educators to organize and manage the learning process. In essence, this trend has continued to increase when the so-called WEB 2.0 was introduced. Terms like e-Learning, Education 2.0 or Virtual Learning Environment (VLE) are the ones mostly used to identify this field. From the researcher's point of view, each of these terms represents different aspects and meanings (Strawbridge, 2010). The term of LMS can be similar to these in certain points, but in most aspects it goes beyond them, since it covers broader perspectives of e-Learning, Education 2.0 or other similar terms.

1.1. Background

Designing highly functional learning management systems can be a complex process and a challenge for many designers and system developers. The nature of LMS platforms is directly connected to the nature of learning. Academically speaking, it goes beyond our traditional perception.

> *"While there are several definitions of a learning management system (LMS), the basic description is a software application that automates the administration, tracking, and reporting of training events.*
> *However, it's not that simple." (Ellis, 2009, p.2)*

Needs and expectancies for an LMS for two distinct organizations (for instance universities) differ considerably. Thus, there is no standardized procedure or model of design and development for LMS used by designers.

Today organizations usually apply one of the following strategies to implement a LMS: (1) they purchase already built commercial LMS solutions from different vendors (Blackboard, CCNet, etc), (2) they implement already built open-source LMS solutions (aTutor, JoomlaLMS, ILIAS, Moodle, etc.), (3) they develop independent in-house LMS solutions (Biggs & Olive, 2009).

Each of these strategies has its advantages and disadvantages, but it is the organization that decides which one better suit to their needs and that may offer an acceptable solution. The decision-making process is predetermined by many factors and conditions that may arise, for instance, the need for an LMS to be integrated with other platforms (LDAP, Email Server, etc.) inside the organization, the solution should be user friendly and easily acceptable from all stakeholders, or the solution should offer a secure environment of sharing information, etc. Nor the first or second strategy will provide an optimal solution, due to the limitations we may face. The third strategy is considered to be in trend, since it gives the organizations freedom to build fully adaptable LMS platforms fulfilling their users' requirements and general goals (Holmes & Gardner, 2006).

Despite the unique nature of many organizations, there is a space for similarity between them, in context of main elements and factors. For those organizations that may operate in similar environments under certain conditions, we may apply a general strategy containing a set of previously used methods and patterns in other successful projects. Moreover, building in-house LMS solutions based on others' successful experiences (models) can be the best choice when commercial and open-source platforms fail (Karrer, 2007).

1.2. Problem Area

1.2.1. About LIBRI

In December 2007, the South-Eastern Europe University's research project software development team and representative educational employees created a better use of their network infrastructure by making learning resources available to educators and students through the LMS LIBRI.

LIBRI is an in-house built learning management system that is used by the entire SEEU's members (administration, staff and students) to participate mainly in e-learning activities and assessments, but also in other aspects such as communication, collaboration, and organization. In simpler terms, amongst many other things, LIBRI is used by SEEU's administration to document, track, report and schedule programs; SEEU's staff uses it to post, organize and evaluate course content; and the students use it as their primary learning path by receiving the contents, posting new entries, communicating with other students and teachers, etc.

1.3. Purpose and Relevance of Study

Our aim in this research study is to investigate and describe in detail the design and development process of the project of LIBRI. The project was considered very successful and finalized before the deadline. Thus this was one of the main factors that motivated us to extend the investigation of this project development.

Each phase of this research is conducted from a combination of Design Research approach (Edelson, 2002) and Development Research approach (van den Akker, 1999). Our specific interest area is the investigation of activities and the experience of designers, system developers and selected end-users as representations of participants during the project of LIBRI. We aim to identify all methods, techniques and patterns used in LIBRI project, based on the two above mentioned approaches. We intend to construct a new framework/guideline from the investigation results as a possible standard for other future in-house LMS developments based on this knowledge.

1.3. Research Question

This paper is intended to answer the following research question:

What methods, tools and techniques can be used from designers and developers for modular-based LMS in-house developments?

We expect that the answer of this research question will contribute to the field of LMS design and development with a main focus on university-based learning and collaboration platforms.

1.4. Limitations

In this thesis we focus mainly on background processes of design and development. We exclude any evaluation technique of existing frameworks or newly created ones. Also, we exclude any critical success factor assessment and quality assessment. In this context, we use both technological and social aspects of design, without going into a detailed study of technical implementation steps.

This area of investigation may cover wider fields of design and development, but our intention is to concentrate our investigation mainly on the instructional design and modular design, the strategies that were applied by the LIBRI team to support these two design fields.

Moreover, this investigative study is driven by our theoretical framework which contains a set of social-driven and technical-driven theories that are closely related to this field. Furthermore, this framework may represent another limitation, since we have excluded other theories that may support this study.

2. Literature Review

In this chapter we seek to present theories that are closely related to our research study. The chapter is divided into two parts; the first part includes social-driven theories such as Actor-Network Theory, while the second part is a combination of social-driven and design-driven theories such as Instructional Systems Design and Modular Design. These particular theories were chosen as an attempt to better describe the design and development process of LIBRI. In the end, we present our built research framework and its components.

2.1. Learning Management Systems

> *"A good educational system should...provide all who want to learn with access to available resources at any time in their lives; empower all who want to share what they know to find those who want to learn it from them...." (Illich, 1971, p.24)*

Much of the accomplishments of e-learning can be attributed to the existence of Learning Management Systems (LMS), also known as Virtual Learning Environments (VLE) (Karrer, 2007). Paulsen et al. (2002) describe a Learning Management System as an environment where developers can create, store, reuse, manage and deliver learning content from a central object repository, usually a database. In a more simple term, an LMS is a software application or a Web-based platform used for the core purpose of facilitating access to learning contents and administration. It allows an institution to offer courses electronically, to create electronic learning materials, to test and evaluate the students electronically, and to develop student databases in which student results and progress can be classified. Hall (2003) defines a LMS as *software that automates the administration of training events*. All Learning Management Systems manage the log-in of registered users, manage course catalogs, record data from learners, and provide reports to management.

There is a variety of commercial LMS, but based on an analysis on the Online Education Review, LMS such as the BlackBoard, WebCT, FirstClass, and Lotus Learning Space are among the most used LMS systems in Europe. Despite the fact that there are many commercial LMS some institutions would rather invest in in-house developed systems eliminating high costs, linguistic problems and supporting special needs for their target groups (Holmes & Gardner, 2006).

2.2. Actor-Network Theory – Identifying the Actors and Creating the Networks

The "actor-network" as a concept was developed by Michel Callon, Bruno Latour, and John Law during the course of the 1980s as an acknowledgment that actors build networks combining social and technical elements. The actor-network theory (ANT) deals with the social-technical divide by denying that purely technical or purely social relations are possible, and considers the world to be full of hybrid entities (Latour, 1993) containing both human and non-human elements. ANT implies that science is a process of heterogeneous engineering in which the social, technical, conceptual, and textual are puzzled together and transformed or better yet, translated.

It might sound a bit complex, however the idea, is fairly simple. When going about doing something as simple as riding your bike to school there are a lot of things that influence how you do it, for instance, the bike's condition, traffic regulations, and prior riding experiences. These factors are related or connected to how you act. The act you are carrying out and all of these influencing factors should be examined together. This is exactly what the term actor-network achieves. An actor-network is when the act is linked together with all of its influencing factors, which are again linked, altogether creating a network.

ANT was developed when coming face to face with troubles affiliated with attempts to handle socio-technical 'imbroglios' (Latour, 1993) like electric cars (Callon, 1986a), supersonic aircraft (Law and Callon, 1988), Kodak and the mass market for amateur photography (Latour, 1991) and a new railway system in Paris (Latour, 1996) by regarding the world as heterogeneous (Chagani 1998). An information systems researcher using an actor-network approach in an analysis would concentrate on issues of network formation, investigating the human and non-human actors and the bonds and networks they build up (Tatnall and Gilding, 1999; Tatnall, 2000). According to Monteiro (2000, p. 76) The idea of an actor-network literally instructs us to map out the set of pieces (in other words forming "the network") which influence, structure or determine action. But each of these elements is in turn part of another actor-network and so forth.

Black Boxes

An actor can be thought of as a 'black box' (Callon, 1986a), the contents of which at this point are not important. The features and actors involved in its creation are just complications we can avoid dealing with and considering this entity as just one actor, but if doing so, it needs to be acknowledged that behind that actor hide other actors that have also been in one way or another 'black-boxed' (Callon, 1987). If the time comes to open the black box and look inside, a whole network of other, in more detail alliances will be relieved. A network can similarly be 'punctualised' (Law, 1992) to look like a single point actor, and when this happens it is replaced by the action itself and the "seemingly simple author of that action" (Law, 1992, p.385).

Translation

"Translation means at once offering new interpretations of interests and channeling people in different directions. The results of such renderings are a slow movement from one place to another" (Latour, 1987). The translator spokesperson is an actor that becomes especially important as representative spokespersons as the network develops. These actors than create new OPPs. Obligatory passage point (OPP) is the situation which must occur for all the actors to achieve their interests. In other words, OPP is viewed as the solution to a problem in terms of the resources available to the actor that proposes it as the OPP. The social process of aligning an initially diverse collection of interests to "one", i.e. reaching a certain degree of alignment of interests, leads to acceptance, "truth" or stability. (Law, 1992).The solution reached is composed by an aligned actor-network. In order for this to be accomplished, one must be able to transform the interests of others to one's own. An inscription is the outcome of translating interests into material form resulting into an intermediary. An intermediary is anything passing between actors, which define the relationship between them (Callon, 1986). There are four main types of intermediaries: texts, including reports, books, articles;□ technical artifacts, including consumer goods, scientific instruments; human beings, including their skills the knowledge; and money in all its different forms.

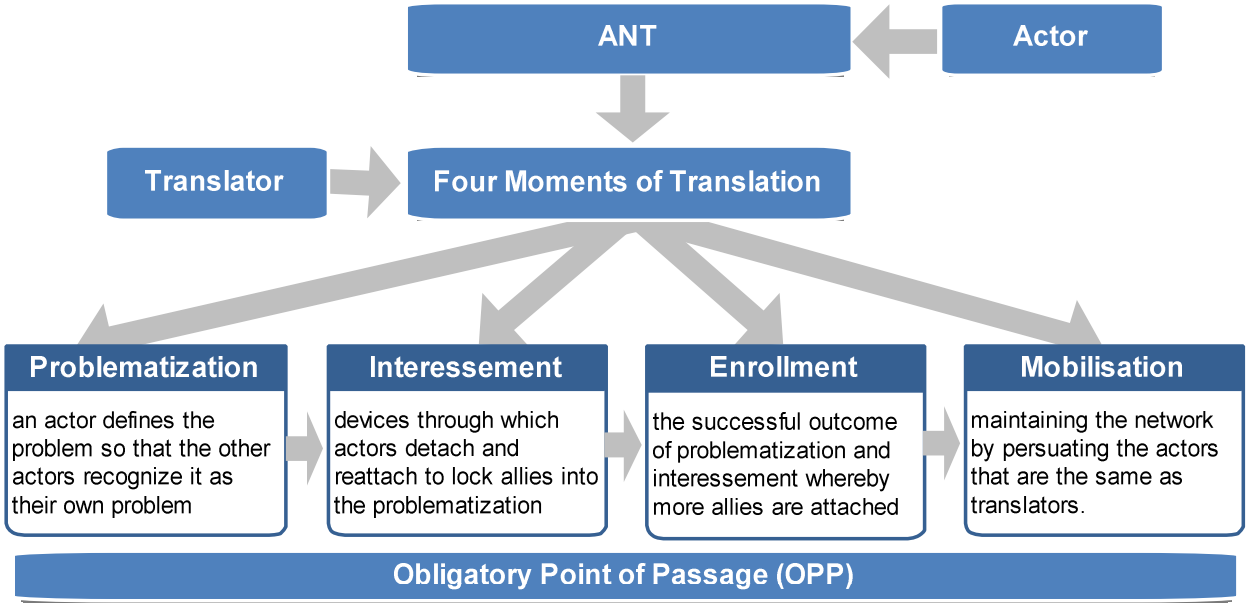


Figure 2.1. Adaption of (Hassard, Law & Lee, 1999) ANT Key Concepts

Callon (1986b) outlines the process of translation as having four 'moments' the first of which he calls problematisation, or 'how to become indispensable', in which one or more key actors attempts to define the disposition of the problem and the clearly fits in the roles of the other

actors to the solution suggested. Which lays the groundwork for Callons' (1986b) second moment, interessement, or 'how allies are locked in place'. It is a series of processes which attempt to impose the identities and roles defined in the problematisation on the other actors. It means interesting and attracting an actor by coming between it and some other actor (Law 1986).The third moment, enrolment or otherwise known as 'how to define and coordinate the roles', leading to the establishment of a stable network of alliances. The last moment , mobilization or 'are the spokespersons representative?' occurs as the proposed solution gains wider acceptance (McMaster, Vidgen et al. 1997) and an even larger network of absent entities is created (Grint & Woolgar, 1997) through some actors acting as translators for others. Irreversibility is achieved when it becomes impossible to return to a point where alternative routes exist (Monteiro & Hanseth, 1996; Walsham, 1997).

2.4. Systems Design Perspective

Design issues have been constantly categorized from design research theorists into a variety of conceptualizations, especially when Information Systems became an independent research area. The major contribution to the field of design as a distinct science has given Herbert Simon through his book "The Sciences of the Artificial". Simon (1988) argues that design should be considered as *science of the artificial*, not a part of natural sciences or social sciences. This distinction has been reflected into all forms of procedural design including Instructional Design and IS Design.

The aim of IS design science research is to develop practical knowledge for the design and realization of "IS initiatives" or to be used in the improvement of the performance of existing IS (Carlsson, 2006).
The outputs of Systems Design should not be only the artifacts, but also new gained knowledge that will contribute to future design projects. In our case, selection of design research theories was made based mainly on two factors: (1) social context of learning, respectively instructional and pedagogical approach of LMS platforms, and (2) technical context of learning, respectively structured and systemic design of LMS platforms. For the first factor we have selected Instructional Systems Design (ISD), while for the second part Modular Design (MD) is selected.

2.4.1. Instructional Systems Design

Gros et al. (1997) define the Instructional design as a strategy that have the ambition to provide a link between learning theories and the practice of building instructional systems. At its most basic level, instructional design focuses on three fundamental concerns: identifying the goals; selecting the strategy; and, evaluating success (Moore, Bates & Grundling, 2002). The theory helps both designers and instructors to create a single framework for communication and interaction during each phase of the design and development. ISD provides a road map to guide designers and instructors through analysis, design, development, implementation, and evaluation to the goal (Zimnas, Kleftouris & Valkanos, 2009).

The rapid evolution of information technology has been also reflected into the ISD development. Moreover, traditional ISD models such as ADDIE model, Rapid Prototyping Design (RPD), Morrison, Ross, and Kemp Model, or Seels and Glasgow Model have remained unaffected from these changes (Prestera, 2002). As Hannafin (1992) states, "we have re-hosted traditional ISD via computer technology, but have not reassessed the basic foundations or assumptions of our models".

Every ISD model in a large scale is considered as an extension or evolution of ADDIE model. Thus, our research applies this model as a central framework of ISD in combination with RPD which is considered as an extension of ADDIE model (Prestera, 2002).

2.4.1.1. ADDIE Model

The ADDIE model can be described as the most general and traditional representation of ISD. In essence, as Molenda (2003) outlines, it acts more like an umbrella that covers certain parts of other models. The term ADDIE derives from the initials of five traditional phases: Analysis, Design, Development, Implementation and Evaluation. Some researchers perceive it as a traditional waterfall model of software development where each phase follows a sequential order of execution. But in essence, the ADDIE model except being sequential is also an iterative process. It is the evaluation phase that makes this model iterative. Each major phase of the process is accompanied by some sort of formative evaluation to test the adequacy of the decisions made during that phase (Molenda, 2003). For instance, if evaluation shows low performances of the project or incomplete support of user requirements, then the model tracks back to the Design phase for further improvements.

ADDIE model provides a general framework for instructional-based design of learning environments, which is widely used in learning and training-based application developments. Below is shown in a visual representation the ADDIE model with some of the core elements for each phase (see figure 2.2).

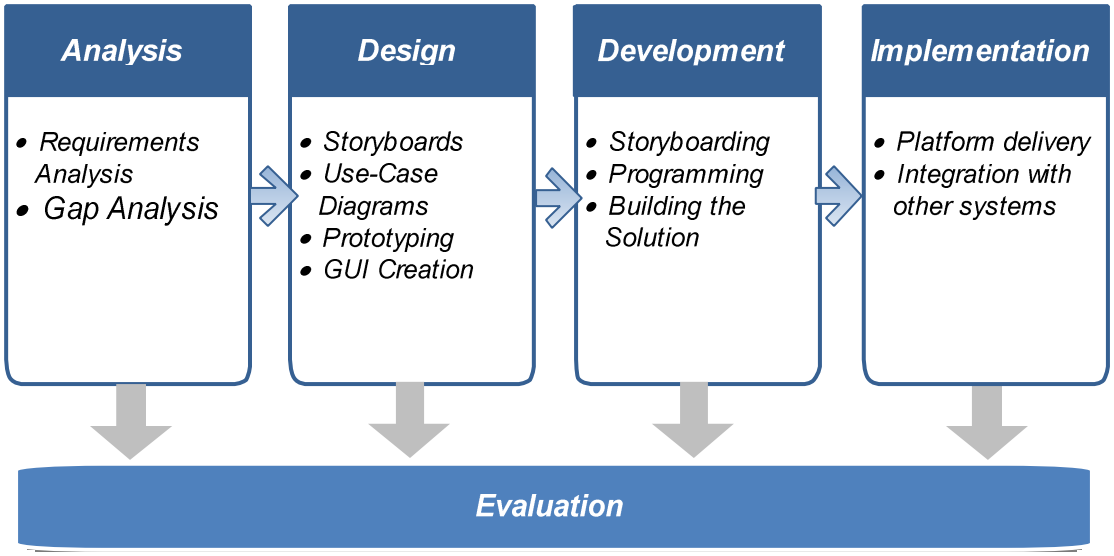


Figure 2.2. ADDIE Model

Basically, the model starts with the Analysis phase which consists of task analysis, needs analysis and job analysis. Reigeluth (1999) generalizes this phase as a process that identifies the needs continuing with the goal setting for the instructions. During this phase designers try to identify the gaps between the desired outcomes and the present situation based on their assessments and end-users' (students, teachers, course administrators) expectations. Moreover, main organizational objectives and tasks are clarified and structured in new procedures. These procedures serve as an input during the Design phase which according to Gustafson & Branch (2002) designers establish specific objectives and structure these learning objectives into sequential steps. In the Development phase designers use low-tech tools, such as storyboards, user scenarios and mockups to build the initial conceptual model of the LMS. In the Implementation phase are involved developers who integrate all identified tasks and objectives into platform functionalities. During Implementation, developers work on the finalization of the platform by implementing each module (component) into the main platform. In the end comes the Evaluation phase as an assessment strategy to test and evaluate each task and functionality of the platform. This phase is conducted in parallel by the team and instructional representatives in the role of end-users.

2.4.1.2. Rapid Prototyping Design

Another popular model of Instructional Systems Design is the so-called Rapid Prototyping Design (RPD). Jones, Li & Merrill (2006) have given a simple definition of RPD. They define it as a process that integrates main key elements of the product, which is incomplete due to the lack of functionalities and exception handling. In simple words, a prototype of an LMS can be seen as a final version, but with no functionalities added. RPD is a multi-dimensional model which usually is combined with ADDIE model in early design phases. Kruse (2009) states that RPD

should be used after the Design phase of ADDIE model. According to him, the output of RPD is an instantly created module that can be tested with the student audience early in the Development phase. While, ADDIE model is used as a general framework, RPD is considered as an extension of that model.

The advantages of RPD can have a great benefit and may influence the overall performances of the project. Jones, Li & Merrill. (2006) refer to the prototypes as a way for designers to test and evaluate their achievements before continuing with the Development phase. Designers can use the so-called low-tech tools mentioned before to build their prototypes. Practically, prototyping is an ideal strategy to reduce time and energy invested in the process. Products, in our case LMS's, are evaluated iteratively, which means that if a certain prototype doesn't fulfill identified user requirements, designers immediately are able to create another prototype with additional improvements. The process continues until the last constructed prototype fulfills the main criterions.

> *"Rapid Prototyping Design (RPD) uses a more formative model that is based on usability testing of prototypes. Results of usability tests on the prototypes are used to modify and improve the product. This model shares many attributes in common with the ISD model, and stresses the importance of iterative analysis and evaluation". (Srivastava & Kumari, 2005, p.22)*

Srivastava & Kumari (2005), Jones, Li & Merrill (2006) and Kruse (2009) in their studies identify the ADDIE model with the Instructional Systems Design (ISD) itself, due to the general understanding of ADDIE as a classical and traditional approach of ISD. Thus, we distinct these two concepts and use them separately. A common approach of both ADDIE and RPD model is the dynamic and spiral-based interaction of steps (phases), as a result of multiple evaluations in different checkpoints. Below is Tripp and Bichelmeyer's (1990) visual representation of the RPD model shown (see figure 2.3).

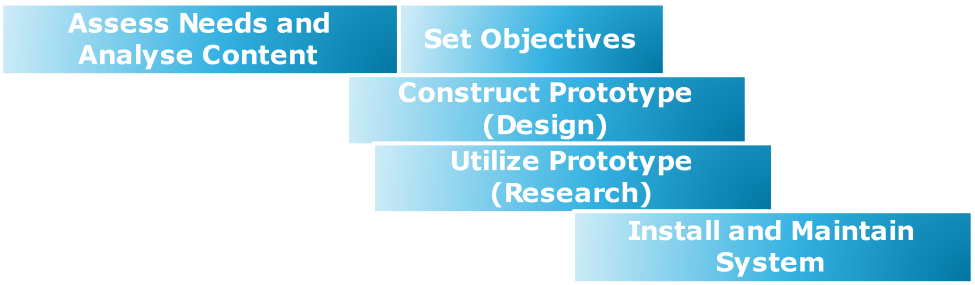


Figure 2.3. Tripp and Bichelmeyer (1990) Rapid Prototyping Model

The model above is a detailed step-by-step procedure which can be initiated as a standalone model or in combination with ADDIE. Tripp & Bichelmeyer (1990) interpret this model as a

non-linear process that involves multiple subjects, starting from requirements engineers, user interface designers, developers, instructional designers, and ending with instructional representatives (students, teachers, course administrators).

Most steps of the model are overlapping with each-other, a fact that shows its iterative approach. This model can constantly increase the interaction between each team member involved, and indirectly establish an environment where the team members can share their experiences.

2.4.1.3. Benefits of Rapid Prototyping Design

There are two main advantages of Rapid Prototyping that has transformed it into a successful ISD model: (1) its non-linear approach (each step is a part of the loop which ends when satisfactory prototype is built), and (2) use of low-cost techniques (storyboards, personas, sample coding, etc.) (Rounder, 2008).

Lu (2010) in her article *"Prototype Advantages and Rapid Prototyping Benefits"* highlights some of the most significant benefits Rapid Prototyping can offer in any field of use, including here Instructional Design and Software Development. These are:

- Reduction of project cost and risk; the overall costs can be reduced effectively. These costs cover the instructional design costs and development costs. Building prototypes requires minimal investment and time.
- Rapid prototyping increases the speed of system development; designers can detect any deficiency in the earlier stages of the model, before proceeding with other time consuming steps.
- Communication between users and designers is optimized, especially in the phase of identifying users' requirements and expectations.

2.4.2. Modular Design

The term of *modularity* has been widely used in different contexts, ranging from manufacturing to the design of electrical and mechanical products and software (Kusiak, 2002). The concept of modular design as a part of the field of modularity can be applied in all identified complex systems. When we say *systems*, we refer to LMSs as independent systemic entities. From the systems theory point of view, an LMS fulfills the criteria of as a system, since it is itself representing a set of sub-systems (modules) (Currie & Galliers, 2003). From this perspective, each module interacts with the system (LMS web platform). Practically, an LMS may be extended to a large number of components (modules), such as News Module, Messaging Module, Course Management Module, Lesson Module, etc. Every module is interconnected and provides distinct information to other modules. For instance, Course Management Module shares the information about assignments and lectures with the Lesson Module, or News Module sends information to Messaging Module, etc.

This approach of modularity was present only in industrial environments, such as in car industry, computer hardware, or electronics, but lately has started to be used in software architecture, with a special interest in web applications after the WEB 2.0 tools were introduced (Kusiak, 2002). The invention of wikis and blogs as a part of WEB 2.0 technology has triggered new changes in the LMS development field (Christensen, Johnson & Horn, 1997). New attributes and components are added to Learning web-based platforms, for example collaborative platforms (blogs and wikis) are integrated into many LMSs as a part of the learning process.

The benefits of modularity do not follow automatically from the act of subdividing a program. The way in which a program is decomposed can make an enormous difference to how easy the program can be implemented and modified (Foster, 2009).

Modular design is new to many system developers, especially to web-based system developers, therefore further explorations and investigations in this field are needed. It affects both sides of system development: design principles and software architecture principles, thus each designer and developer must feel familiar with this methodology. Modular design requires persistent and competent designers and developers and a collaborative environment between all involved parties.

2.4.2.1. Modular Learning Management Systems (Modular LMS)

One of the supporting theories for Modular LMS's is Renaux et al.'s (2005) expression of modularity based on the mapping between functionalities and components. In their paper called "*Learning Management System component-based design: a model driven approach"* we notice a similarity of model-driven approach with component-driven approach which leads to the so-called *ad-hoc components.* What makes special these components (modules) is the most significant attribute they have – they can be activated or deactivated without affecting the whole platform. In practical terms, main users of the platform (teachers and students) can add or remove extra components or elements in certain situations in accordance to their given permissions, and also can be reused when they are needed.
Any platform allowing for this concept (component-based platform) should be able to implement a core of collaboration and teaching tools, which would make it more convenient for the rooster (Renaux et al., 2005).

The component-driven approach of modular LMSs is viewed as an attempt to reach the optimal use of the platform which content is built from teachers' and students' individual and group contributions. Schneider et al. (2003) point out to the modularity as a logical separation of platform functionalities into independent components. It is a mechanism that is used to transform each dependent component into independent and reusable component, resulting with better management of modules and the platform itself.

A Modular LMS applies the model of "loosely coupled systems", often used to describe educational organizations, to a technical context. Loosely coupled systems are those whose component parts are responsive to each other, but retain their individual identity (Culatta, 2010). In this context, modular LMS's offer better learning environments than the so-called monolithic LMS's which represent the traditional model based on static implementation of functionalities. In comparison to monolithic LMS's, modular LMS's embed the social collaboration component and the ability to be customized or transformed to real-time end-users' requirements and expectancies.

2.5. Research Framework

The following research framework (see Figure 2.4) was built to support our research from the theoretical perspective. It is based on main components of our chosen theories described in this chapter. We have identified three significant components: ISD Component, Modular Design Component, and ANT Component. In the central part of the framework we have positioned the ADDIE model which represents in general the Instructional Systems Design. The model is visualized as a collection of its five phases. Three other components are connected to one or more ADDIE phases. Gray arrows are used to show the relationship between secondary components and the central component. Blue (dark) arrows show the iterative nature of the model.

RPD model is not presented in this framework due to the close relation with ADDIE model which are both parts of the Instructional Systems Design. In essence, RPD is an incorporation of ADDIE, for this reason we assumed that adding the model to this framework will only make it more complex to understand. At the same time, we are aware of this issue as a potential bias of our framework. Nevertheless, in the Results chapter we include the RPD model as a part of the framework.

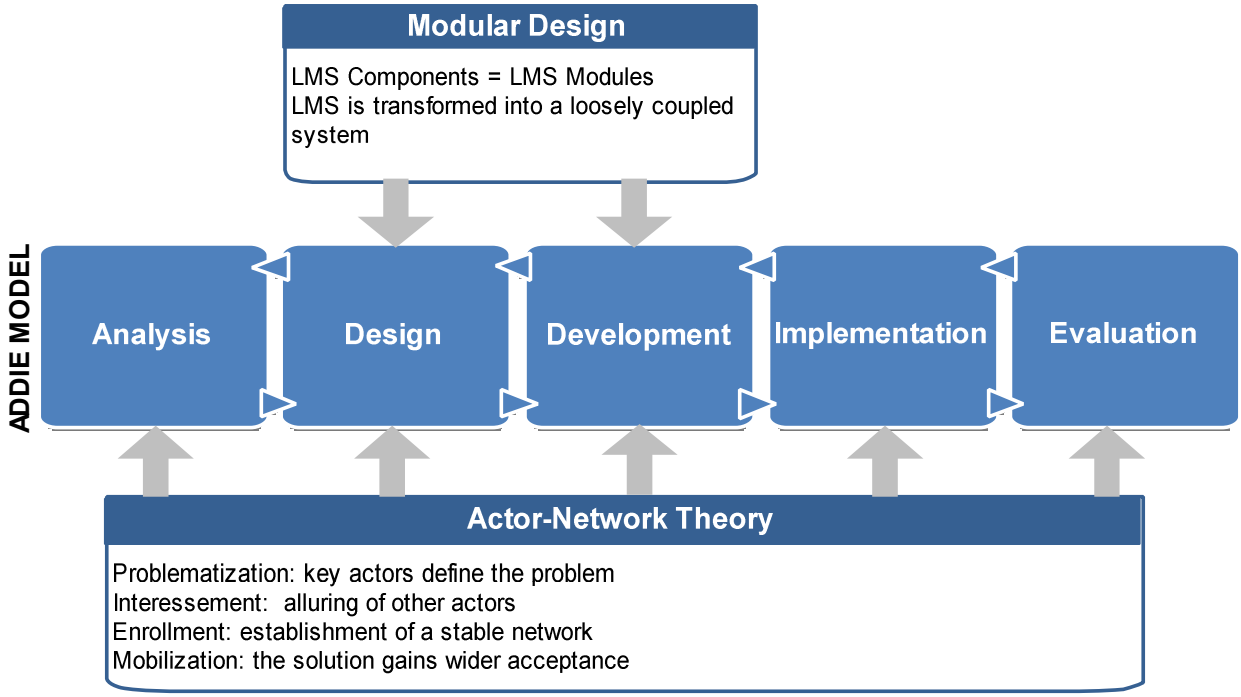


Figure 2.4. Our Theoretical Framework

2.5.1. Framework Components

In this subchapter are shown general conceptions of each framework component and the relations that occur within the framework.

2.5.1.1. ADDIE Model

Since the ADDIE instructional design model forms a roadmap for the entire project we think that this should be the core component of the research framework. As a representative part of ISD together with RPD, it provides a well-structured step-by-step procedure of activities. In many ways all of the other components in one phase or the other fit into the ADDIE model. One commonly advantage of this model is that almost everyone uses it to attempt to catch design flaws while they are still easy to fix.

2.5.1.2. Modular Design

This component is directly connected to Design and Development phases of our central component. From the modular point of view, we consider LMS platforms as a set of independent modules that are built separately from each-other, thus we intend through this framework to identify situations (when the modular design was used), methods (how modular design was applied) and subjects that can initiate the modular design during the design and development process. Basically, each designed LMS component is viewed as a potential LMS module that can be further developed.

2.5.1.4. Actor-Network Factors

As mentioned earlier in the chapter, ANT consists of four moments: Problematization, Interresement, Enrolment and Mobilization. Therefore, the moments of ANT will be applied into ADDIE to fulfill the arguments of this research. By using the combination of ADDIE and ANT, this research can include the ANT which focuses the interaction and participation on actor and their relation. Though ADDIE model consists of five phases, we will not mention the Design and Development Phases since they are not included in this methodology since in this part of the framework mostly focuses on how the ANT relates to the ADDIE model.

Problematization

The Analysis Phase clearly defines the analysis and distinction of the problem background. Problem background is an important step in determining the problem statement in a specific research. Problematization which is the first moment in ANT fits in perfectly into this phase since the tasks of problematization moment are to identify the actors, define their roles and building the actor-network. These tasks help identify and understand the current situation of the problem.

Interresement

The development and design phase investigate the needs or requirements of end users based on their assessments and end-users' expectations. Interresement is the second moment in ANT and also another moment that fits into almost all the models' phases starting off with the development and design. The main activities in Interessement are identifying each actor's interest on the system and come out with the requirements expected. According to the ANT if those interests align with the interest of other it would be enough to form a network.

Enrollment

The Implementation Phase involves establishing already approved applications into production environments. Enrolment moment will consist of activities and elements that can be used to achieve the focal interest. For it to be a success, it will require more than just one group of actors showing of the systems advantages or imposing their will on others, it will also require them to give up their old methods of transferring knowledge and so forth.

Mobilization

Of course in the final phase we use Evaluations as a process to better identify and validate the requirements. This is linked in closely to the fourth moment of translation, mobilization, which maintains commitment to the problematized cause of action. The most important part in this step is establishing the legitimacy of the translator.

3. Research Method

After the literature review and framework construction, we continue with our research method relevant to this study. Initially, we present our research strategy, our reflection for qualitative research and the data collection procedure. In addition, we present the main data collection instrument – the semi-structured interviews, interview guide, and the interviewing process. In the end of this chapter we describe the validity, reliability and the ethical side of this study.

3.1. Research Strategy

According to Yin (2003) it is nearly impossible to quantify questions starting with *how* and *why*. Thus, choosing a quantitative approach for this study would be a wrong strategy. Therefore, we have chosen the qualitative research, since it is the only appropriate method for this study that helps us to construct answers of our main research question. It is also the subjective orientation of qualitative methods that has influenced in our choice. In comparison to quantitative methods which drive the research process into a generalization of study, qualitative methods bring us nearer to subjects and help us focus on one specific field (phenomenon). In simple terms, our strategy is to use semi-structured interviews to collect qualitative information in order to describe the development process of LIBRI. We intend to have individual interviews with the complete development team that has built LIBRI platform. In total, there will be six open-ended interviews, with the possibility to extend the number of interviews when other persons involved on the project are identified.

In our case, we want to obtain a sequential and procedural flow of LIBRI's development team activities, starting from the initial phase of requirements analysis until the final phase of evaluation of the LMS.

3.2. Data Collection

3.2.1. The Semi-Structured Interview

Comparing to structured interviews, semi-structured interviews are more flexible. They give the interviewers the freedom to interfere to the predefined questions with additional questions during the interview session. Kvale & Brinkmann (2009) argue that such flexibility must be applied during the whole interview session. Basically, we are allowed to change the interview flow at each moment when circumstances are changed. In this way, we have left the interviewees to freely express their opinion and speak for a certain theme in their own words. Our secondary questions that were arisen during the sessions were stated in order to go deeper into the context

of the theme being discussed. As a result, we have managed to extend our expectations of answers and to gain more detailed answers and explanations from the interviewees.

Our main intention was to identify and describe participants' experience gained during their project activities, such as tools, techniques, and methods they have used or practiced. At this point we have used semi-structured interviews as the most appropriate data collection instrument.

> *"This kind of interview seeks to obtain descriptions of the interviewees' lived world with respect to interpretation of the meaning of the described phenomena." (Kvale & Brinkmann, 2009, p. 27)*

3.2.2. Interview Guide

Initial categorization of interview questions is considered as an important step towards well structured interviews. Results of the interview analysis are proportionally related to the level of categorization of interview questions. Such a categorization of questions is predeterminant for the success of empirical analysis (Bryman & Bell, 2007). Thus, in order to reach this categorization we have created a set of interview themes containing five main themes: Analysis Issues, Design Issues, Development Issues, Implementation Issues, and Evaluation Issues. Each theme is extended to more specific categories.

These themes represent the main areas of our investigation. The use of themes and categories have provided us three important advantages: (1) the interview sessions were carried systematically and the context of study was preserved, (2) such a systematization of questions have made easier the empirical analysis and investigation process, and (3) selected theories were embedded easily.

We have applied Bryman & Bell's (2007) framework to build our general interview guide as a support for our interviewing sessions. The first step of this framework (General research area) incorporates the overall investigation area, which is the design and development process of LIBRI. In the second step (Specific research questions) we have placed the research question described in the first chapter. Third step (Interview topics) represents the categorization of the questions, respectively the interview themes. In the next step (Formulate interview questions) we have formulated our interview questions based on selected themes. An important step of this framework is the possibility to review and revise the interview questions in cases when they are not fully synchronized with the interview themes (topics) or are outside the context of study.

Figure 3.1. Bryman & Bell's (2007) Interview Guide Framework

The table below represents created themes relevant to the research question, with the most basic interview questions.

Table 3.1. Thematization & Categorization of Interviews

Interview Themes	*Interview Topics/Categories*	*Interview Questions*
Analysis Issues	*- User Requirements* *- Investigation of Previous LMSs* *- Project Timeline* *-Main Objectives*	1. *What are the main objectives (functionalities) of this project?* 2. *What was the main reason for developing a new Learning management System (LMS)?* 3. *How many persons were involved in LIBRI?* 4. *When did the project start and when was it finished?* 5. *How does LIBRI differ from other previous LMSs (ANGEL)?* 6. *Who are the end-users of LIBRI?* 7. *How was communication between team members conducted?* 8. *What were the major challenges you have faced during this time?*
Design Issues	*- Design Models and Patterns* *- Prototyping* *- End-users Involvement* *- Design Technology*	1. *Can you describe the user requirements?* 2. *Have you used any prototype, persona, or user scenario as a part of your initial phase of design?* 3. *Which models have you used for designing the User Interface (UI) of LIBRI?* 4. *What technology was used for the design process?* 5. *How are end-users involved in the design process?* 6. *What were the major challenges you have faced during the design process?*
Development Issues	*- Modular Development Approach* *- Development Technology*	1. *Can you describe in details the software architecture you have used?* 2. *What models (software-oriented) have you used?* 3. *What technology was used for the development process?* 4. *What were the major challenges you have faced during the development phase?* 5. *What are your plans for future improvements (updates) of LIBRI?* 6. *How were security issues managed in LIBRI?*
Implementation Issues	*- Integration of LIBRI with other IS*	1. *Can you describe step by step the implementation procedure of LIBRI?* 2. *What were the major challenges you have faced during this phase?* 3. *How did you resolve them?*

Evaluation Issues	*- Internal Evaluation* *- External Evaluation*	*1. How was LIBRI evaluated?* *2. How are end-users involved in evaluation?* *3. In what extent there are involved?*

3.2.3. Selection of Interviewees

First, we had to identify all involved stakeholders (actors) of the project, respectively all respondents. In addition, we have identified most significant subjects that have given their contribution through their knowledge and skills. As a result, we have created an intersection of these two groups, with the intention to choose only those subjects who have participated in the project and who also have a strong professional background and knowledge. Our initial selection criterion was to involve only respondents (those who are involved in the phenomena/project) and excluding any informant (those who are not involved in the phenomena but have knowledge about the field). This was done due to the closeness of the project and the team involved. Another criterion was to select for each theme at least one representative.

3.2.4. Interview Sessions – Conducting the interviews

Since all selected interviewees were located in Macedonia, we were unable to conduct face-to-face interviews. Therefore, we have chosen another approach of interviewing – online video interviewing. We have used the latest version of Skype and additional add-in software which enables real-time video communications and the possibility to record the conversations. A total of six interviews were conducted in different frames of time, starting from April 15, 2010 and ending at May 12, 2010. The average interview length was approximately 37 minutes. During sessions, we used transitional sentences to connect topics and reopen certain topics when we had secondary questions. Note-taking technique wasn't applied since we wanted to give our full attention to the interaction with the interviewees, in an attempt to encourage participants for more detailed responses.

3.2.5. Transcription

Qualitative researchers nearly always tape-record and then transcribe their interviews. This procedure is important for detailed analysis required in qualitative research and to ensure that the interviewees' answers are captured in their own terms (Bryman & Bell, 2007).
Heritage (1984) points out the importance of this procedure and the advantages it offers. According to him recording and transcription procedures (1) allow a detailed examination of interviewees' answers, (2) allow repeated examinations of interviewees' answers, or (3) enable other researchers to access the answers for a secondary analysis. Literally, transcription represents a formal documentation of our data collection material, which can be used by others in further studies or by critical and analytical researchers who may want to use it.
On the other hand, the transcription process in most cases is very time-consuming, thus we had to take into consideration all factors that may affect this process, such as the environment, the

technology used, etc. Therefore, our interviews were recorded in a digital video format (WMV) where its use was very easy and fast. Practically, we could rewind, pause, or forward videos easily without having any difficulty. This represented one of the advantages we had against time loss and also reached an improvement of the quality of transcripts.

3.3. Data Analysis

> *"Analysis is a breaking up, separating, or disassembling of research materials into pieces, parts, elements, or units. With facts broken down into manageable pieces, the researcher sorts and sifts them, searching for types, classes, sequences, processes, patterns or wholes. The aim of this process is to assemble or reconstruct the data in a meaningful or comprehensible fashion." (Jorgensen, 1989, p. 107)*

There are different qualitative data analysis methods that can be used from researchers. But, most of them follow in a large scale the Creswell's (2007) data analysis spiral. It is called *spiral*, due to the interrelation between most basic stages of qualitative research, such as data collection, data analysis, and empirical findings. We have chosen this model, because it covers most important steps of qualitative analysis (see Figure 3.2.).

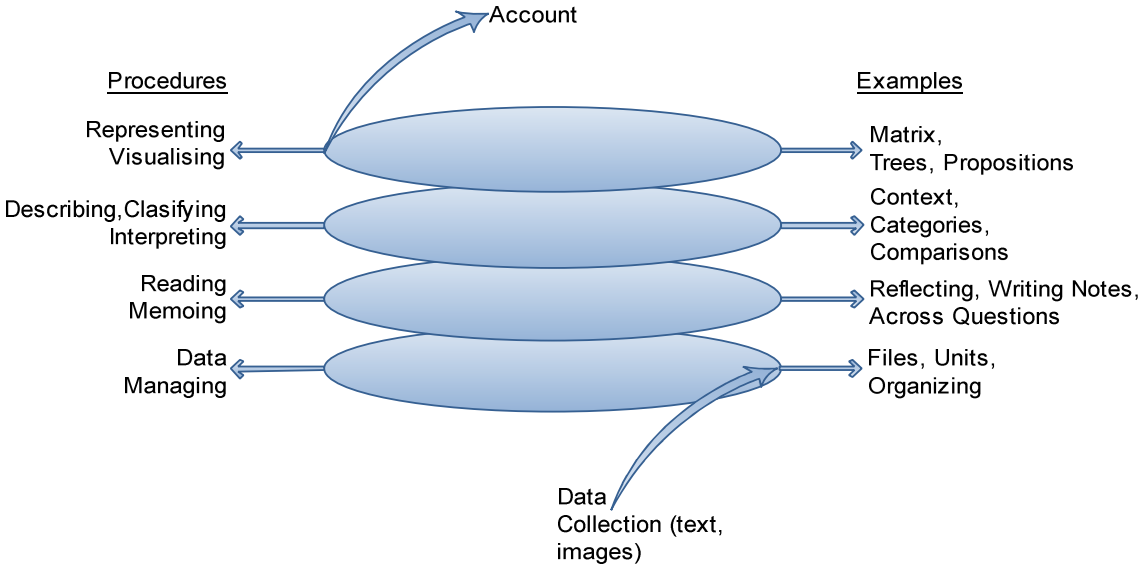


Figure 3.2. Creswell's (2007) Data Analysis Spiral

The first step was to manage the data, respectively breaking it down into units of analysis. In this manner, we have used sentences, tables and figures as main units of analysis. The second step was to read the material until we completely understood it. After we have created the general meaning of the data we have started the memo process. In addition, we have used descriptive coding techniques in the whole transcription text. This approach is known as open coding and

according to Seidel (1998) it helps us to break down the data into discrete parts. We have formatted the material using double spacing, in order to have enough space to put our coding ideas and coding labels. We have also reviewed the transcripts several times, as each time we have identified new important passages of text that were of high relevance. A sample of coded transcript with highlighted and labeled text is shown below:

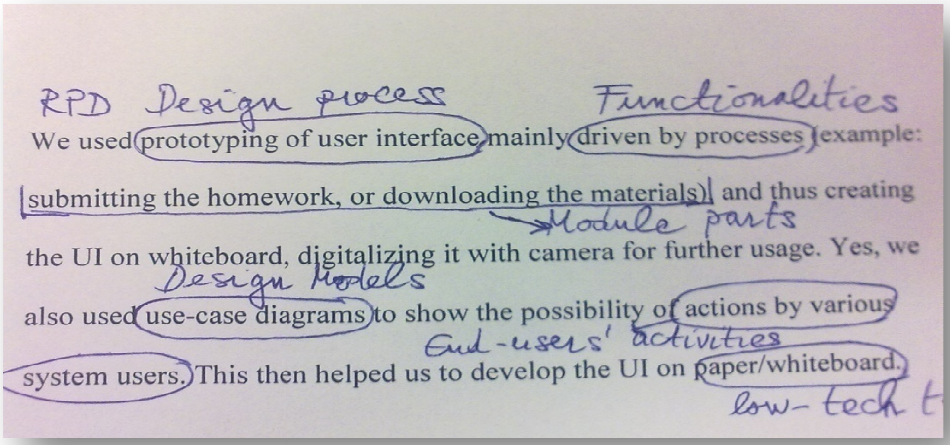

RPD Design process Functionalities
We used prototyping of user interface mainly driven by processes example:
submitting the homework, or downloading the materials and thus creating
Module parts
the UI on whiteboard, digitalizing it with camera for further usage. Yes, we
Design Models
also used use-case diagrams to show the possibility of actions by various
End-users' activities
system users. This then helped us to develop the UI on paper/whiteboard.
low-tech t

Figure 3.3. Coded Transcript Sample

Creswell (2003) reminds us that we need to extend our open coding techniques with the so-called axial coding. According to him, axial coding represents the integration process of categories with our theoretical models. This was a necessary step to achieve better investigation of LIBRI's team activities as viewed from subjects' perspective and our theoretical framework. We have embedded each category to theories and models presented in Chapter 2.

The second step of the spiral was to synthesize each identified code into specific category. These categories were then classified into bigger categories. Once we have organized sub-categories and categories, we have continued with the interpretation of data which is the third step of the spiral. As Randolph (2008) cites the interpretation means *to makes sense of the data*. For this he specifies different techniques of interpretation, such as matrices of data, casual illustrations, social network maps, or figures. We have chosen a combination of two above mentioned techniques: matrices of data and figures, since they were the most appropriate ways to interpret the data.

Finally, we could shift our investigative views from raw data into identifiable methods, models, and patterns used in project, since they were presented into procedural ways through tables, figures and categorical guide sentences.

3.4. Validity

An important aspect of this study is its investigative and descriptive nature. Our aim was to conduct an objective description of activities and processes used in LIBRI development. Kvale & Brinkmann (2009) highlight that the relationship between validity and objectivity in conducting interview-based research studies is an important issue and should be treated carefully from researchers. According to them, objectivity means no-bias and errors environments and a totally reliable and controlled knowledge used in studies. We as researchers have avoided our personal assumptions and judgments, especially in the data analysis and results interpretation. Self-criticism (self-assessment of the research) and commitment (accept the truth and fair procedures) are two of approaches we have used in this study. According to Hammersley & Gomm (1997), both self-criticism and commitment can be used to reduce potential errors and bias, and proportionally increase the overall validity of the research. Basically, in the end of each phase we have reviewed our work and assessed if any personal involvement of ours is noticed.

3.5. Reliability

Most authors divide reliability into internal and external reliability. While internal reliability compares the constructs (methods) used in the study, external reliability compares the goal (results and conclusion). Thus, researchers are more interested in external reliability as the final quality assurance and control of the research studies rather than in internal reliability. But, Seale (1999) argues that we should give more attention to the internal reliability since it predefines the whole process and the results itself. He proposes some techniques for researchers who want to increase the internal reliability of their studies. These are: low-inference descriptors (quotations) in and transcriptions, systematic coding schemes, multiple researchers' involvement and peer auditing. From these, we have applied in general, transcriptions and systematic coding schemes. We believe that these two techniques will ensure our research to remain highly reliable. On the other hand, we have tried as a team of researchers to create a common understanding of data analysis and a general moral agreement for our transparency during each phase of this study.

3.6. Ethical Issues

Our main concern about ethics was to establish stable relationships with interview participants that will lead to a bilateral trust between us and them. In order to achieve this, we had to follow certain ethical protocols. Israel & Hay (2006) and Kvale & Brinkmann (2009) share almost the same definitions and guidelines about ethical issues; therefore we have adapted the guidelines of Israel & Hay (2006) as our main protocol. The first rule of this guideline was to receive informed consents from each interviewee before the interview sessions were conducted.

Singer & Vinson (2002) argue that there is no standardized form of informed consents, but at least some of the following elements should be covered: disclosure, comprehension and competence, voluntariness, the actual consent or decision, and the right to withdraw from the experiment. We think that disclosure, voluntariness and the right to withdraw from the experiment (interview) are most important elements that our consents must contain.

In the inability to collect informed consents on hard copy, we had to create electronic PDF versions (Appendix B) and send to the participants by email the same day sessions were arranged. In order to receive documented (recorded) consents, we have asked each participant in the beginning of interview sessions whether they have read the document and if they agreed with the information presented in the document. In this way, we have received their consents in video documented files.

The second rule of the guideline is the confidentiality. According to Nuremberg codes, it is the person (participant) who decides about the confidentiality level and what information should be published or shared. A part of our agreement was to ask participants which part of the information should be published and used. Moreover, after the interviews were conducted, we have sent them the transcript of interviews for a final approval.

The third and final rule of the guideline is known as *avoiding harm and doing good*. Basically, this rule is a combination of two previous rules and an extended attention of researchers (us) to protect the most sensitive issues, such as privacy, confidentiality and objectivity of the information collected.

4. Empirical Findings

In this chapter we present our interviews outcomes. These outcomes are organized into five main stages of our central component of the research model shown in Chapter 2: Analysis, Design, Development, Implementation and Evaluation. In addition, we have created sub-categories for each stage, in order to better organize our empirical findings which will serve as refined inputs for the next chapter.

Note: References for interview transcriptions are used in this chapter. The reference format is [X:X], where the first character identifies the appendix, while the second character identifies the sequential reference number of transcript lines.

4.1. Research Setting

In the year 2000, the OSCE High Commissioner for National Minorities triggered discussions about constituting a new university in the Republic of Macedonia; this soon led to the opening of the South-Eastern Europe University (SEEU) in the city of Tetovo, in October 2001 making it the first private university in Macedonia. Since then, SEEU has succeeded in establishing itself as a quality-led, financially sustainable university now regarded as a model for multi-ethnic, multi-lingual higher education in South East Europe (SEEU's webpage).

According to its webpage SEEU (www.seeu.edu.mk) is now in its eighth year of operation with more than 7000 students and 3000 graduates. It is a unitary University with five faculties, including undergraduate and postgraduate programs embodying Business and Public Administration, Law, Contemporary Sciences and Technologies, Communication Sciences and Pedagogical Methodology Training. While reading about the SEEU we came across their mission statement which basically states that their core attempt is to cultivate excellence in teaching and research, regardless of ethnicity to maintain equality on the basis of merit and to co-operate with other local or international universities. The statement continues to say "...Our main aims are to contribute to higher education in the Albanian language, to promote inter-ethnic understanding, to ensure a multilingual and multicultural approach to teaching and research, and to develop our teaching program in a broad international and European perspective." (SEEUs' Strategic Plan 2009 – 2012).

As other universities, SEEU also has objectives, some of them being to engage all its students with a distinctive, high-quality learning experience. The university's policies are committed to maintaining a diverse student population whom they want to graduate from SEEU with the capacity for thinking and reasoning, which can equip them for decision-making, problem-solving, responsibility, leadership and service throughout their lives.

4.2. Interviewees Background

Zamir Dika, Computer Sciences - Phd. Zamir Dika is the Pro-Rector for Academic Issues at SEEU. Besides working as a professor in the Faculty of Computer Sciences, he also represented it as the Dean in the academic year 1998 -2000. From 2001 to 2003, he served as Director of Computer Centre at SEEU. Professor Dika is author of several scientific publications and teaching materials. He has managed several university development projects for SEEU including the in-house LMS LIBRI. Professor Dika was the core initiator and coordinator of project LIBRI.

Adrian Besimi, MSc. Computer Sciences – Adrian Besimi is a teaching assistant in the Computer Sciences Department, Faculty of Contemporary Sciences and Technologies at the South-Eastern Europe University. In addition to being an educator, he is also a web developer at SEEU and part of its research project software development team. Earning his M.A. in computer sciences at the Indiana University Purdue University Indianapolis – IUP, USA , MSc Adrian Besimis' research interests concern: new systems development based on .NET framework, learning management systems, e-Commerce and e-Business. Currently he is working on the projects: Development of a new LMS for SEEU and research on B2B frameworks. His prior experiences include working as a web developer at Testing Center @ IUPU.

Visar Shehu, MSc computer Sciences - MSc Visar Shehu is also a teaching assistant in the Computer Science Department, Faculty of Contemporary Sciences and Technologies at the South-Eastern Europe University and part of SEEUs' research project software development team. Besides that, he is also a co-founder at Spartans. MSc Visar Shehu is another Indiana University Purdue University Indianapolis – IUP, USA, graduate in the area of computer sciences. His Current research projects include Web Knowledge Mining and Visualization, and Learning management Systems, but his researcher interests extend from computer graphics, scientific visualization, data mining and web mining to content management systems.

Lejla Abazi - Bexheti, Prof. D-r Computer Sciences - Prof. D-r Lejla Abazi is the Director of the Computer Center at the SEEU. Furthermore she also works at the SEEU as an assistant lecturer. Her doctorates thesis included the paper "Development of a Learning Content Management Systems"

Mehmedali Shaqiri, *Computer Sciences* - Mehmedali Shaqiri is the current Chief Executive Officer and Co-Founder at Spartans<T>. He's present job also involves being a Software Developer at SEE University Website. He specializes in Model Driven Design and Development, Software Design and Architecture and Design Patterns & Pattern Oriented Design.

Visar Selimi, student, Computer Sciences – Visar Selimi is a third year student in the Faculty of Contemporary Sciences and Technologies at the SEEU. It is his second year using LIBRI.

4.3. Results of Interviews

The structure of the interview results is based on our defined topics and categories. In the end, we have included another additional category that discusses other issues outside our defined categories which can be important for further analysis of the results.

4.3.1. Analysis Issues

The main responsible person of this phase was the LIBRI coordinator, Mr. Zamir Dika. From the interview with Mr. Dika, it appears that the whole team was advised to act in a systemic manner, considering the project as a procedural work divided into five stages.
As Mr. Dika states, the analysis was conducted form three viewpoints: teachers' , students' and administration perspective [E:4].

4.3.1.1. Investigation of Previous LMSs

When identifying end-user requirements and expectations, it is necessary to find all possible useful resources. Before LIBRI, the university has used another LMS called ANGEL. It was a commercial platform offered by Indiana University.

> *The university was using Angel Learning, a commercial LMS that was very popular among staff members. Although the system was used widely, the annual cost was too high. This is why we decided to build a new in-house LMS [C:6].*

According to Mr. Adrian Besimi, the university wasn't able to cover all annual costs of ANGEL, since each year the number of students was increasing rapidly. It was the cost as a disadvantage of commercial LMS platforms that led to the need of finding another low-cost solution for the university. On the other side, ANGEL was in use for many years, and the platform had the possibility to track and log each activity of students, course administrators, and teachers. Requirement analysts have seen this as an advantage. By analyzing logs they could identify most useful components used by end-users, their activities and functions that were mostly applied [C:22].
In addition, analysts have used ANGEL's log to identify critical points and incompatibilities of the platform that has been shown during its use. The results were used on two next phases (design and development) as a strategy to avoid any of these errors in the new LMS.

4.3.1.2. Identification of User Requirements

When we asked Mr. Dika about the strategy they have followed to identify user requirements and their objectives, he replied:

> *From the analysis point of view, the user requirements was designed, in terms of the **Approach**: In-house development; in terms of **Methodology**: modularity – in order to shape the product which will be tailored with the usage scenarios; **Scalability** – need to integrate it with existing IS at the university; the **Usability Requirements** defined; **Training** needs and possibilities for **Personalization** for the teaching staff; also, the need for **Multilingual** support was stressed…*[E:4]

This is a response that reflects the systemic perspective of the project they have used.
From the coordinator's and developers' interviews we can notice that the team was using a dual strategy to identify and collect end-user requirements, needs and expectations. The first strategy was to employ a certain number of educational representatives consisting of teachers and students [E:4]. These representatives were chosen rationally. This means, the team has selected only the most experienced users of the previous LMS, who were highly active users of the platform. In addition, surveys were created in order to collect their opinions and expectations. The results of the surveys represented the main resource of this phase.
The second strategy as mentioned above was to use ANGEL logs as a secondary resource [C:30].

4.3.1.3. Project Timeline

Except requirements analysis, the analysis phase requires to calculate the exact timeline of the project. In the case of LIBRI, the timeline was strict and defined by the pro-rector of SEE University who was at the same time the project coordinator of LIBRI. The development team had to deliver the solution on a fixed deadline, due to expiration of licenses of ANGEL [C:8]. Knowing the timeline of the project is very important for all stakeholders and especially for the development team since they need to manage accurately the time for each phase. As Mr. Besimi states, the project has started December, 2007 and one year later they were able to deploy the first Beta version. The project was still ongoing until January, 2009 when the final version was released.

4.3.2. Design Issues

4.3.2.1. Prototyping

Based on the answer of the question: "*Have you used any prototype, persona, or user scenario as a part of your initial phase of design?,* both Mr. Dika and Mr. Besimi agree that their main strategy to conceptualize the design process was prototyping. They also showed that the team has used prototyping only for User Interface design, and was mainly driven by processes, such as homework and assignment submission, material download, etc. [E:6, C:26]. Although, the user interface layout didn't offer complete functionality, it helped both User Interface (UI) designers and educational representatives (in this case they had the role of instructional designers) to design easily acceptable prototypes with the possibility for evaluation and further improvement.

According to Mr. Besimi, the team used low-tech tools for prototype design. He stated that all prototypes were drawn on paper and whiteboard, due to the simplicity of the process that requires minimal resources (only pen and paper, and whiteboard). After the prototype was evaluated and discussed, the team photographed it with a digital camera for further usage. Both UI designers and instructional designers could view the whole layout in one picture during the whole development phase. In general, they developed 10 – 15 prototypes [C:28]; some of them were modified few times by adding new changes and features and the rest was judged as unusable [C:28]. The process continued until they had designed the exact prototype, which was evaluated positively as the best layout of LIBRI by instructional representatives.

4.3.2.2. Design Models and Patterns

This is an overview of findings based on design models and possible patterns that were used in the design process of LIBRI. Mr. Dika points out that the team has drawn use case diagrams (which refer to Use Case Modeling) each time when a prototype was designed. According to Mr. Besimi, Use Case Models were used to design the functionalities involving all three groups of stakeholders: teachers, students, administration. [E:8]

In addition to Use Case Modeling, the team has applied the activity diagrams used to describe the workflow which represents the logical model. According to Mr. Dika, the design pattern they have used throughout LIBRI was the Provider Model Design Pattern. The provider model is used throughout ASP.NET 2.0.
Designers also highlight one of the challenges they had in this phase, the mapping between logical and physical design. As they state:

> *…it was very important to transform the logical design into physical design.* [E:12]

4.3.2.3. Design Technology

According to our interviewees, the technology they used during the design phase consisted of low-tech and high-tech tools and applications. Prototyping design was based mainly on low-tech tools, such as paper and whiteboard.

> *…for use-case scenarios VISIO was used as well. Otherwise pen-and-paper worked fine.* [C:34]

For the user interface layout of the final prototype they used Microsoft based design applications and HTML and CSS based editors.

4.3.3. Development Issues

4.3.3.1. Modular Development Approach

Our research shows that from the beginning of LIBRI project, the team has decided to use a new approach of design and development. This was the Modular approach, where the platform is built as a set of modules, not as one general platform. The team conceptualizes LIBRI as a core integration platform that brings in one place all standalone modules. From developers' interviews we have noticed that their main intention was to provide a platform where modules can be plugged or unplugged without affecting other active modules. According to developers' statements (Mr. Besimi, Mr. Shehu and Mr. Shaqiri), each module is an entity containing different functions. Their idea was to support the rapid development to save time and resources. A part of their strategy was to make LIBRI open for other future modules, without redesigning or redeveloping existing modules [C:42]. Another target to reach was to have a rational job division among team members. According to Mr. Besimi:

> *One developer was coding one module.* [C:42]

Mr. Dika states that applying the modular approach remains one of the biggest challenges during the project. According to him, it was difficult to spread each function into only one module. As a consequence, he considers the synchronization between functionalities and modules as a critical factor for the fulfillment of identified user requirements and objectives.

> *The main challenges were to define modules and the functionalities related in achieving the user requirements.* [E:12]

4.3.3.2. Development Technology

The development team started to program (code) all identified functionalities during the design phase into software-based functions that will be further integrated into modules. This process was done by using different technologies, such as .NET Technologies (Visual Studio 2.0) incorporated into Team Foundation Server which enables multitask programming and common working environment for all developers, and MySQL for the database layer of the platform.

4.3.4. Implementation Issues

4.3.4.1. Integrating LIBRI with other Information Systems

One important request from the University Administration was to create a learning platform that will be able to integrate other university in-house information systems. This was described from Mr. Dika when he was asked about main user requirements of LIBRI [E:4]. He described this requirement in terms of platform scalability and its integrability with other university in-house information systems. Both, Mr. Besimi and Mr. Shehu, confirm that it was extremely important that the new LMS will support other systems in different ways. For instance, one way was to

interconnect these independent systems directly into the User Interface (UI) through links or incorporate them inside the UI by opening the content as a part of the LIBRI framework. Mr. Shehu explains that at the time when the development phase was initiated there were three main information systems that needed to be integrated. All these systems were in-house solutions developed by university development teams as web-based platforms with an internal authenticated access. The first one was a system called *eService*; it is used mainly by students who can access administrative information, such as personal payment information, current statements, exam schedules, exam information, and course schedules. The second integrated system was *eGrading*; a system used both by the university administration and students. The administration staff enters into the system all reported grade lists for finished courses which are approved by professors. In addition, students can access this information through intranet or internet. The third system was e*Schedule,* designed mainly for administration purposes. At the beginning of each semester, the administration staff manages schedules for the upcoming courses. These schedules are then distributed to each teacher and assistant. We could notice that the access from LIBRI to this system is restricted only to administration and teachers. Once the user is logged into LIBRI, he/she can access other systems without logging into them. Practically, user information is shared with other platforms through central university Active Directory. According to Mr. Shehu, the integration process took place during the implementation phase, after the evaluation of development phase has resulted as successful.

4.3.5. Evaluation Issues

Due to the iterative nature of ADDIE model, designers/developers have evaluated each phase after its finalization. This technique was applied for Analysis, Design, Development and Implementation phase. Thus, evaluation phase is viewed from two perspectives. We have found that evaluation phase was used in parallel for each module being developed. When the project was finished the team has initiated two sequential evaluations for the whole solution. These are presented below:

4.3.5.1. Internal Evaluation

From the interviews, we have found that team members have tested the platform right after its pilot version deployment. Their intention was to measure in general the usability level, platform quality and critical bugs by testing each module separately. Mr. Dika has initiated the so-called Nielsen's Heuristic Evaluation – a methodology that tests and checks most critical and important issues of the LIBRI layout and its functionalities. These issues in a large extent are based on the user interface (layout) design of the platform and functionalities attached to it. According to Mr. Dika:

> *The Heuristic Evaluation (combined with the pilot phase and UserVoice feedback system) was conducted in defining the visibility, user control, consistency, error prevention, flexibility and efficiency of use, aesthetic aspects, help and*

> *documentation etc. The system improvements were conducted after this phase of feedback, which gave us good opportunity to qualitatively design the "Final" product.* [E:10]

4.3.5.2. External Evaluation

Those instructional representatives (teachers and students) who were active in the Analysis and Design phase were also involved in the general evaluation of LIBRI. As Mr. Besimi states, end-users who with no previous training of use of LIBRI were encouraged to use the platform based on their previous experience with ANGEL and their individual instincts. According to him, they could test all functionalities of the platform, starting from a course registration, assignment/homework submission, discussion board, and ending with folder exploration. The results contained different requests and notices, which the instructors have risen. Both students and teachers were used to the previous platform's structure and had expected the same structure in LIBRI. According to the team, this was considered as a lack of instant trainings and as low-critical issue. In addition, they have required private notes in the calendar module in form of reminders. Another request was to offer them dedicated storage on their account where they could store and reuse their personal data independently from central storages. Our findings show that the team is trying constantly to increase the level of feedback in order to improve the platform.

4.3.6. Other Issues

4.3.6.1. Collaboration and Communication between Team Members

Interviews findings show that the whole platform was constructed collectively by the development team. This means, during each phase, team members have collaborated with each-other and shared their opinions and solutions through discussions. Each phase was divided into different checkpoints (weekly meetings). Approximately, at the end of each week one checkpoint was conducted. During these checkpoints, team members were discussing the progress made for that given time, the problems or critical situations they have faced and possible solutions to overcome these problems. According to Mr. Besimi, in parallel to weekly checkpoints, they have used *ActiveCollab,* a project management tool that helped them to have instant discussions before having the next checkpoint. Basically, all ideas, design decisions, and other decisions were decided as a team [D:18].

> *We used ActiveCollab project management tool, but that still was not that efficient, and we had to conduct more meetings on daily/weekly basis.* [C:44]

4.3.6.2. Security of LIBRI

When asked about security issues of LIBRI we have been advised by Mr. Besimi to use the published paper *"Managing Security in a New Learning Management System (LMS)"* (Besimi et

al., 2009). Authors of this paper are a part of the design and development team of LIBRI. For this reason, we have used it as our main source for security issues. The paper serves as a manual for other in-house LMSs based on successful implementation of security in LIBRI and the university network where LIBRI is installed. Thus, we have identified the step-by-step strategy that was used for the platform. The first step was the university *network security*. This was accomplished by separating the network into different Virtual LANs, applying Access Control Lists (ACL) on each VLAN positioned in routers and switches where access is restricted and authorized only for university users. The second step includes *software security*, respectively LIBRI security. The security was increased by integrating the university Active Directory into the platform, so personal account data is shared internally. In addition, the communication through web browsers and server was secured through Secure Socket Layer (SSL). Also, each platform folder was secured and restricted. In the last step, were taken measures again *software engineering* attacks, respectively against the so-called bots.

5. Results & Discussion

This chapter is based on our analysis of interviews. Through this chapter we present our final results of this study in form of a general guideline that can be used for future in-house developments of Modular LMSs. These findings are based on our combination of ANT, Modular Design and Instructional Systems Design. The guideline is a combination of empirical findings, our theoretical framework and our own reflections presented in procedural steps.

Results are based on our theoretical framework which consists of both social and technical theories. The five phases of ADDIE model are the main component, where each phase (issue) is related to other components, such as modular design component and Actor-network Theory. The whole development procedure is seen as one general network consisting of other hybrid and simple networks made of multiple elements (actors). The ADDIE model is described as the main network divided into five other sub-networks, respectively its five phases: analysis, design, development, implementation and evaluation. Due to different complex elements which are embedded into each phase, some actors are also seen as simplified networks (Law, 1992), punctualised but still with the possibility to become black-boxes (dependent on more than one network) due to the interrelated dependence between elements.

The ANT helps to better describe and explain the interaction between human and non-human elements, respectively between personal, social activities and technology-based activities, which occur in almost each phase of ADDIE model.

The findings in this case study showed that the existing LMS, ANGEL, was found to be too expensive, since the annual cost was too high therefore stating the problem. The forming of Libri on its own, could in ANT terms be seen a phase of *problematization*. We will start by identifying the different actors in Libri and their interests, and then show how their roles vary and unite in the course of the project. At the same time we will analyze the translation process in each of the ADDIE model phases.

Table 5.1. Actor-Network: Actors and Interests

Primary Human Actors	**Interests**
SEEU's Development and Design team	Create a LMS with the right functions that will cover the needs of SEEU
Administrators	Manage, schedule appointments, run daily tasks ..
Educators	Provide new material, supervise, evaluate..
Students	Receive learning material, communicate enlist.
Instructional representatives	Admin. Edu. and Stud. Expectations and potential requirements
Internal and External Evaluators	Making sure that the project works smoothly

Primary Non-Human Actors	**Interests**
ANGEL	Resource of Information
ADDIE model	Provide a step-by step procedure of activities
Rapid Prototyping	Test and evaluate achievements
Use Case Modeling	Visualization of user scenarios and functionalities
Activity Modeling	Visualization of user scenarios and functionalities
Independent Modules	Together make the learning platform
eService	The access of administrative info.
eGrading	Report grades
eSchedule	Manage schedules

The initial primary actors were *SEEU's development and design team* since their main interest was to create an LMS that would provide the rest of the actors. *Administrators, educators and students* have an interest in the project as consumers, and are therefore important for all other actors to relate to. Not all of them where actors in the project, but the *instructional representatives* took the role of the embodied actors and represented their interests and requirements for the project. The Actor Network Theory indicates that in order to create a network all actors must be aligned with each other in terms of "interests". This implies that actors' interests must be recognized and accepted by other actors, or attuned for a better fit.

SEEUs' development and design team had a strong interest to create and manage an in-house build LMS, therefore establishing Libri as the *Obligatory Passage Point* and becoming the translators. They *inscribe* this interest by starting off with the analysis phase of the ADDIE model were they are assigned to make a requirements and a gasp analysis. To do so, this interest

must be *aligned* with that of the instructional representatives and the previous LMS ANGEL. Since their interests are to act as the role of information providers both party's interests *align* and an *intermediary* is created. In this case different types of surveys were used as intermediaries to point out the instructional representatives' requirements and ANGELs log files were used to pin point its functions and gaps, giving the actors enough alignment to create a network and move on to the next phase. Callon et al. (1983) propose that translation involves all the strategies through which an actor identifies other actors and arranges them in relation to each other. On the second phase of the ADDIE model (design) the designers *inscribed* their interests with Rapid Prototyping design which was tightly *aligned* with the interests of the Use Case Modeling and the Activity Modeling, by testing and evaluating finished phases of the design. Here, different prototypes were used as the *intermediaries*. In this phase as in many others the team *enrolled* the instructional representatives and used their interests as arguments to *align* the other actors. During the development phase new actors and other networks are *enrolled* such as the independent modules that together form the learning platform and the translation processes keeps going. According to our studies the implementation phase was the phase in which the three actors eService, eGrading, and eSchedule while keeping in mind their interests were *aligned* together to draw the other actors into its plan of actions and accepting them as the main path for action and identity. By creating technical (or other) artifacts and inscribe interests in them, the actor tries to ensure that its interests are protected (Latour, 1992). And finally on the evaluation phase the developers *inscribed* the interests of the internal and external evaluators with all of the other actors *aligning* them and in a way creating the fourth moment of translation, *mobilization*. Here the crucial question is to ensure that the representatives of other actors are accepted as representatives of those actors and since we don't see and conflicting interest from any of the previous actors we concluded that the translator, meaning SEEUs' development and design team may speak on behalf of all actors in the network. At this point we concluded that Libri became SEEUs' primary learning and assessment tool and that it was impossible to return to a point where alternative routes would be used achieving *irreversibility.*

5.1. Analysis Issues

In general, when a software project is initiated, the first necessary task is to identify the present situation, requirements and the environment that may affect the project. The same approach was used in LIBRI development, but in a more organized way. The phase was conducted in two structural analysis tasks: requirements analysis, and gap analysis. According to our empirical findings, the requirements analysis seems to cover a wider area than gap analysis.

Our findings also show that it is important to identify all possible resources of information that can be used for requirements analysis. The first resource was a carefully selected group of experienced instructional representatives (teachers and students) who have given their opinions and expectations through surveys and discussions and who have also participated in other development phases. From the ANT perspective, both resources represent a set of networks and

actors. Teachers and students are considered as human actors that are a part of different hybrid networks based partially on social activities and technical activities. Social activities such as collaborations and discussions are carried through technical activities such as online surveys and digitally recorded interviews of teachers and students. These activities are embedded into networks where main actors are teachers and students.

Our empirical findings show that Maddux's (1997) concept of collaboration is carried mainly through discussions and surveys. The team was aware of the importance of end-users' opinions, thus they have included them during the first phase of analysis.
In addition, the second resource of information was the previous LMS (ANGEL). Our findings show that the team has used ANGEL's log files to identify all functions and activities used by students and teachers. Also, they used it to identify gaps between the platform and end-users. In this way, the team has constructed a gap analysis output used for further improvements of LIBRI.

Below are presented main user requirements and LIBRI's objectives identified through requirements and gap analysis:

- *resource publishing/sharing,*
- *online classrooms,*
- *assignments and homework support,*
- *messaging,*
- *publishing of announcements,*
- *discussion forums,*
- *access of roster, and*
- *Plagiarism control.*

When it comes to the systemic and systematic approach of the development process, it can be noticed that the whole project is assessed from different points of view. When speaking about the in-house nature of this project, the team sees this as an approach towards their objectives: creating a platform that will successfully replace ANGEL and preserve all its functionalities, and improving university's education and student's learning quality. The modular nature is seen as a methodology to create a learning platform based on independent modules (Renaux et al., 2005). While the opportunity of the platform to be integrated with other university information systems is seen in terms of scalability and integration.

The framework presented in this study indicates that the analysis phase of the ADDIE model is also tightly connected to the problematisation and the interessement moments of translation of the ANT. The findings in this case study showed that the existing LMS, ANGEL, was found to be too expensive, since the annual cost was too high therefore stating the problematisation. Next, SEEUs' research development team, in this case the translators, decided to take matters into their

own hands and build an in-house LMS making the translation from the problematisation into the interessement moment.

5.2. Design Issues

System and UI designers were asked about models that have driven the prototyping process and the final design of LIBRI. Concerning this issue, we have found that the whole prototyping design process was based on Rapid Prototyping (RPD). Furthermore, RPD approach was used to test and evaluate the achievements made when the design phase was considered as finished (Jones, Li & Merrill, 2006). The results of the evaluation were used for further improvements of the prototype. This process has been repeated 10 – 15 times, until the constructed prototype has fulfilled all defined user requirements and objectives, and gained instructional representatives' approvals (Tripp & Bichelmeyer, 1990). An important finding at this point was the combination of RPD and ADDIE model inside the framework of instructional-driven design and development. In addition, we present this combination of both models into an integrated framework used during the project:

Table 5.2. Combined Framework of RPD and ADDIE Model

RPD Model	ADDIE Model
Assess Needs and Analyze	Analysis
Set Objectives	Design
Build prototype	Development
User evaluation	Evaluation
Concept refinement	Development
Implementation of refined requirements	Evaluation
Concept refinement	Development
Implementation of refined requirements	Evaluation
Install and Maintain Prototype	Implementation

Our empirical findings have shown that the end-users' involvement compared to other phases, was the highest in the design phase. This was due to their participation in prototype testing and evaluation during Rapid Prototyping Design. It is very important to involve actively instructional representatives during this phase in all possible ways. The collaboration between them and the team is a critical factor of the usability and acceptability of LIBRI from other end-users (Jones, Li & Merrill, 2006).

From the modeling perspective, designers have systematically used the combination of Use Case Modeling and Activity Modeling during each prototyping design. In essence, a visualization of user scenarios and functionalities through use case diagrams and activities through activity diagrams corresponds to the nature of design phase as a part of ADDIE model.

The whole design phase is perceived as a set of networks as a concept of ANT. Designers are considered as actors of the Prototyping network, where they use different tools and techniques

described above to build the LMS prototypes. For instance, Use Case Modeling is a technique used from designers to interpret different use cases and activities. This technique itself represents another network which remains more conceptual than real, but that leads to other potential actors and networks that may be involved during the design process.

5.3. Development Issues

The main finding of this research is the modularity approach of LIBRI's team used in Development phase. Results show that the team's mission was to create a unique learning platform based on independent modules, where each module can be activated or deactivated without affecting the whole platform (Culatta, 2010). Also, an important aspect of modular development was the workflow of the project and rational job division between each developer. All modules were developed at the same time, in parallel to each-other. As a result, time factor was not so critical for the success of LIBRI. The meaning of *"One developer - one module"* can be also interpreted as *"one developer – one responsibility"*. The whole idea was to engage each developer in a responsible manner. When responsibility is increased and treated seriously, the quality of each module will be also improved, and as a result the platform itself will preserve its quality too.

The output of the Design phase serves as input for the Development phase. In essence, each functionality is mapped into its respective component Schneider (2003). This research shows that the same hierarchy of transformation of core elements was used in LIBRI platform.
Below is shown the initial conceptual model of LIBRI's core components:

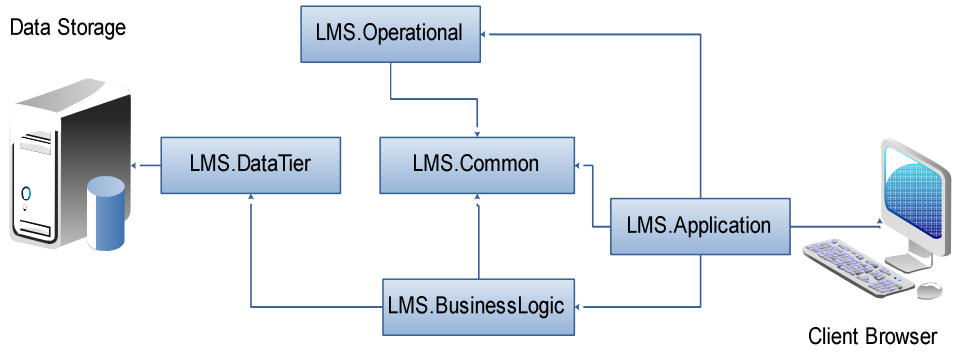


Figure 5.1. Conceptual Design adapted from Behxheti (2008)

This model represents the architectural component connection and interaction. All modules are spread into distinct components. For instance, *LMS.Operational* component includes Messaging and News Module, or *LMS.Common* includes Course, Assignment, Roles, Calendar and Blog Module, etc.

Our empirical findings show that modules were organized into two groups: User Management Modules and Course Management Modules. The first group includes all modules that provide user-based functionalities, while the second group includes all course-based and content-based modules. Below are shown both groups and descriptions about each module:

Table 5.3. LIBRI's Primary and Secondary Modules

User Management Module	***Course Management Module***
Enrollment Module	*News Module*
Roles Module	*Calendar Module*
	Quiz Module
	Resource Module
	Blog Module
	Lesson Module
	Assignment Module
	Messaging Module

Enrollment Module – The enrollment procedure is initiated from another information system which operates as a background platform of the administration to enroll students in their selected courses. In parallel to this procedure, teachers and course administrators can move, delete or add students from one to another course.

Roles Module – Both teachers and course administrators can assign new roles to course participants based on different levels of accessibility. Also, they can create participant-based or content-based specific privileges. For instance, a student is allowed to access only assignments and material documents (participant-based), or a certain document, an article or e-book can be accessed only by teachers (content-based) not by students.

Assignment Module – An assignment can be created by a teacher or course administrator. They can also give different attributes to assignments, such as maximum grade or points, or possible due date for reply. In addition, students who are involved in a specific course are allowed to upload their individual or group assignment replies in different file formats (doc, docx, pdf, etc.).

News Module – Information and news are published from faculty departments in one single RSS. The RSS information is distributed through announcements, messaging (internal emailing) and news panel on the main page of LIBRI layout.

Messaging Module – The content of messages can vary from simple information to course content. LIBRI's users can send to each other internal messages; also teachers can send mass-messages to one or more student groups.

Calendar Module – Calendars are used to handle events and other notices. This module interacts with messaging module, when a certain end-user wants to send events and reminders to other

users. Practically, this module is designed to support events sharing and reminders for individuals or groups.

Lesson Module – Lessons are organized into files and folders and displayed in structured multi tree-views. Administrators can apply different security and accessibility levels on each lesson. Files and folders can be secured by password protection. Passwords are then shared only to competent persons of the lesson. Teachers are supported through advanced HTML editing tools such as WYSIWYG that makes easier to handle text and image formatting.

Quiz Module – Quizzes and surveys can be used to support course learning from students. The module allows creating multi-choice questions combined with textual/image and true/false questions. A quiz can be limited in time during the session and after the time passes they become unavailable. Randomization of questions can be used to create smart quizzes against cheating when they are used in groups.

BLOG Module – Blogs take the central place of social networking in LIBRI. All end-users are able to contribute through blogs with their opinions and criticisms. The module also extends the possibility to use Wikis as well in form of community knowledge-base.

5.4. Implementation Issues

Findings in this study explore that LIBRI is an integration of three main information systems eService, eSchedule, and eGrading, into one and that at the beginning of each semester the administration staff manages schedules for the upcoming courses. Later on the educators and students post learning contents and finally the educators evaluate students by enlisting their grades. By using the research framework and combining the ADDIE model phases with the moments of translation in the ANT, we use the enrollment moment as a tool to fully understand the implementation phase of LIBRI. Enrollment is the process of translation that can be described as “enticing and engaging” (Callon, 1986) actors in the assemblage, and the creation of a key role in LIBRI, which acts as the “obligatory passage point”. SEEUs’ project development team (translator) translated LIBRI into an online learning space for 7000 students, with that; they matched their conceptions of “efficiently and effectively achieve learning and professional development goals”. LIBRI made possible an approach to assessment in which students, educators and the administrative of SEEU can share their resources amongst each other. Mr. Shehu defined assessment in LIBRI as an open ended, visible and transparent task. As a result, learning is translated into LIBRI and activities and assessments are located in LIBRI.

5.5. Evaluation Issues

As we arrive at the final phase of the ADDIE model, the evaluation, the research framework suggests that we can connect it with the fourth moment of translation in the ANT, mobilization. This stage indicates the extent of support leading to stabilization and extension or mobilization of

a network. The question here is, do the delegate actors in the network adequately represent the masses? If so, enrollment becomes active support. The prospect of over 7000 students using LIBRI as their main learning resource provider linked the innovative pedagogy of LIBRI to a potent institutional actor, the "evaluation". As class size increased, so did the diversity of students' responses and their orientation to learning. The evaluation was present in two forms: from an internal and an external point of view. In the internal evaluation the actors consisted of the team members and in the external evaluation the actors where the end-users. The evaluation howed highly positive results concluding that the majority of many glitches and imperfections where corrected, making the ties between LIBRI and the SEEU more tenuous. As a result of all this, LIBRI becomes SEEUs' primary learning and assessment space.

5.6. Security Issues

After the implementation of LIBRI, the team has faced another challenge. It is the security of the platform inside the university network and outside the network (internet). The team has initiated a three tier security for the platform. The first tier relies on network security through VLANS (Figure 5.2.); VLAN switches secure the access through access control lists. The second tier consists of internal security of the platform, respectively the software security. A step towards this security was the integration of Active Directory with the User Management Module of LIBRI combined with SSL Client-Server communication. And last, the third tier is considered as more internal security of LIBRI. It is based on software engineering protection strategies against agents (bots) and phishing from outside.

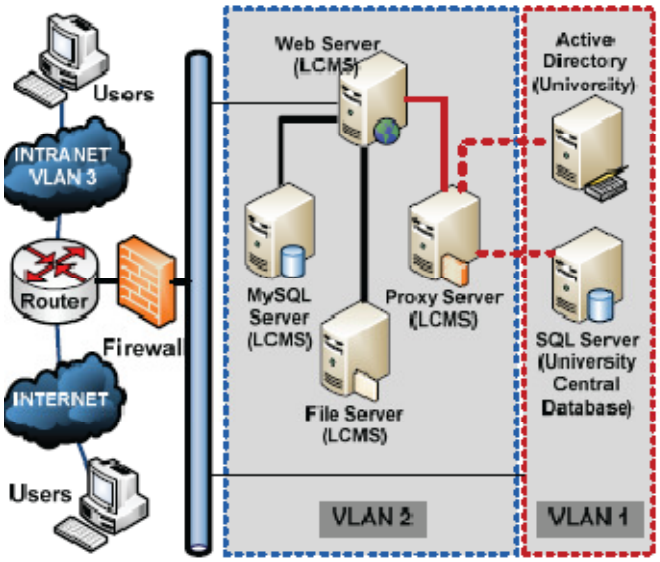


Figure 5.2. Besimi et. al (2009) Simplified University network schema and infrastructure architecture for a LMS solution

5.7. The Guideline

Finally, we summarize our findings into a sequential step-by-step guideline (Figure 5.3.) based on most significant methods, techniques, and strategies used for design and development of LIBRI. Security issues presented in this chapter are not included in the guideline, but it was described above as an additional source for LMS security which stands outside of our design and development framework.

We strongly believe that a standardized and unique framework which is based on previous designers' and developers' successful experiences can be used from others as a part of their strategies to build LMS in a rational and well structured environment. Therefore, this systematic approach will be of a great benefit for many schools and universities by reducing two main factors: time and costs, and also increasing the quality and effectiveness of end-users' activities.

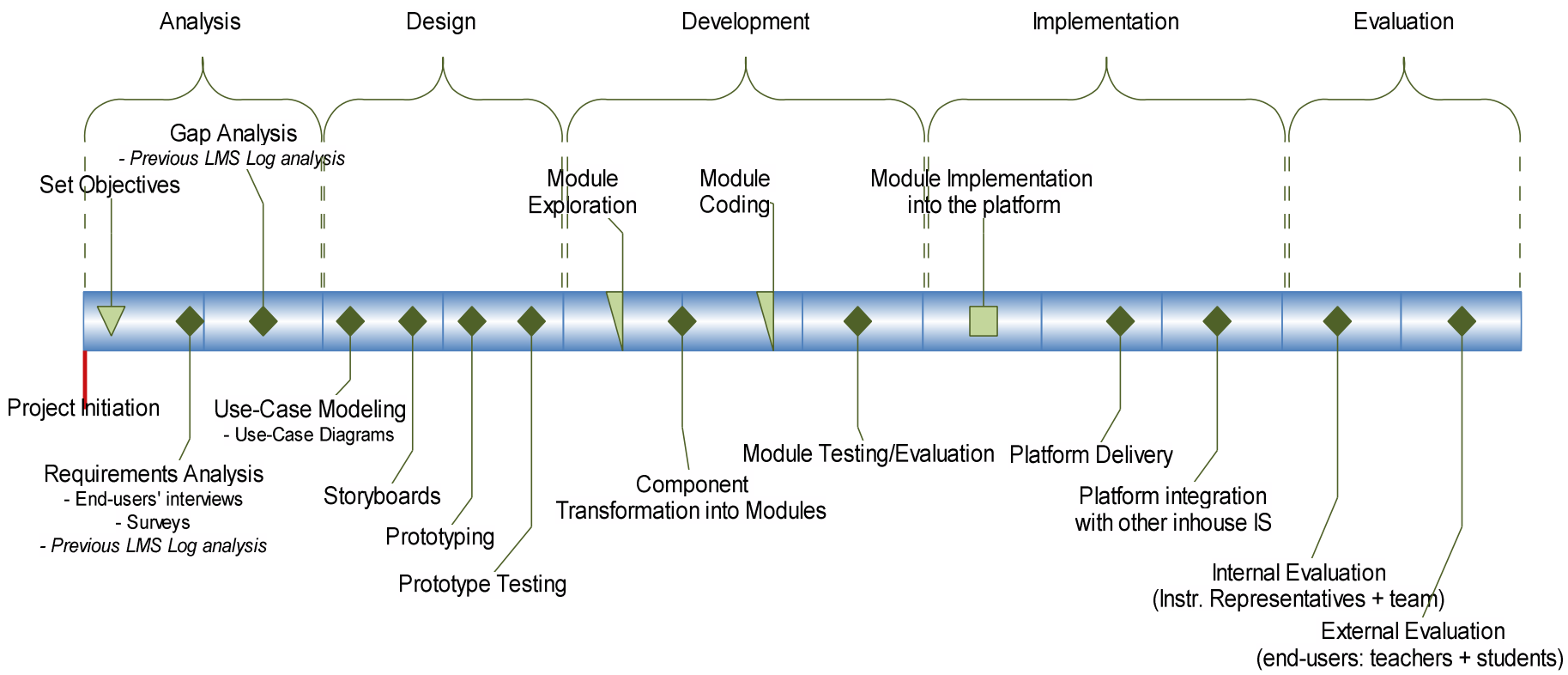


Figure 5.3. ADDIE-based Guideline for building in-house Modular Learning Management Systems

6. Conclusion

Finally, we present a summary of our findings. In general, we present our overall research results in terms of aggregation of our theoretical framework, empirical findings and our reflections. Additionally, we highlight further studies that can expand this field of study or may support the guideline for designers and developers.

This study's intention was to investigate in details the design and development process of a learning management system called LIBRI, developed by a team of designers and developers from the South Eastern European University in Macedonia. In doing so, we were able to formulate our core purpose, to create a new framework and guideline to serve as a standard procedure for other future in-house LMS developments. This particular framework was a combination of the ISD Component, the Modular Design Component, and the ANT Component. Common characteristic of these components led us to the use of the ADDIE model as our core component correlating all of them into one distinguished framework.

This framework seemed captivating in our attempt to explain the selected LIBRI case for two main reasons. First, it is specifically developed to help follow the step by step procedures from the designers and developers perspective. Second, it played a major role in helping explain the already in-house built LMS LIBRI by combining each phase of its establishment with the theories presented in chapter two.

To get an accurate answer for our given research question, we started off by identifying the purposes and advantages of LMS, more specifically in-house Modular LMSs used on university-based learning and collaboration. We then chose a few theories that mostly related to our research study including social-driven theories such as Social Construction Theory and Actor-Network Theory and design-driven theories such as Instructional Systems Design and Modular Design. Our reflection for qualitative research and the data collection procedure included six interviews with the research project software development team and representative educational employees who were the creators of LIBRI. With the help of these interviews we are able to describe in detail the outcomes and findings of each of the individual steps.

6.1. Further Studies

Extending this investigative study to other in-house LMS successful developments from other academic institutions will be of a great benefit for this field. We have limited our investigation only to one institution due to its specific nature (most of the team members were involved in academic activities by lecturing or assisting different courses). Nevertheless, design and development technology and methodology is evolving continuously. New methods and techniques are created and old ones are being replaced or removed. Thus, similar studies must be continued in the future and must be extended into other factors reflecting the area.

The findings of this study can be used in other organizations that operate with their in-house MLMSs for deeper studies. Further investigations of different MLMSs can lead us to more detailed and procedural-based guidelines enriched by new methods and techniques. This area is very wide, thus new findings from different studies may fill the gap of knowledge that designers and developers may face.

Appendices

Appendix A - Interview Guide

Analysis Issues:

- *User Requirements*
- *Investigation of Previous LMSs*
- *Project Timeline*
- *Main Objectives*

1. What are the main objectives (functionalities) of this project?
2. What was the main reason for developing a new Learning Management System (LMS)?
3. How many persons were involved in LIBRI?
4. When did the project start and when was it finished?
5. How does LIBRI differ from other previous LMSs (ANGEL)?
6. Who are the end-users of LIBRI?
7. How was communication between team members conducted?
8. What were the major challenges you have faced during this time?

Design Issues:

- *Design Models and Patterns*
- *Prototyping*
- *End-users Involvement*
- *Design Technology*

1. Can you describe the user requirements?
2. Have you used any prototype, persona, or user scenario as a part of your initial phase of design?
3. Which models have you used for designing the User Interface (UI) of LIBRI?
4. What technology was used for the design process?
5. How are end-users involved in the design process?
6. What were the major challenges you have faced during the design process?

Development Issues:

- *Modular Development Approach*
- *Development Technology*

1. Can you describe in details the software architecture you have used?
2. What models (software-oriented architectures) have you used?
3. What technology was used for the development process?
4. What were the major challenges you have faced during the development phase?
5. What are your plans for future improvements (updates) of LIBRI?
6. How were security issues managed in LIBRI?

Implementation Issues:

- Integration of LIBRI with other IS

1. Can you describe step by step the implementation procedure of LIBRI?
2. What were the major challenges you have faced during this phase?
3. How did you resolve them?

Evaluation Issues:

- Internal Evaluation
- External Evaluation

1. How was LIBRI evaluated?
2. How are end-users involved in evaluation?
3. In what extent there are involved?

Appendix B

Interview Agreement

This interview will serve to explore and investigate interviewees' experience they had during the LIBRI development. This research study remains investigative and is based on interviewees' interpretations of activities, such as models and techniques used in each phase and collaboration process with other team members.

I as an interviewee have the right to choose the level of anonymity and the information I allow to be published.

I also agree that my participation remains completely voluntary and I am aware that this interview will be video recorded and transcribed and saved for further researches.

I reserve the right to withdraw this consent during the research by informing the interviewers at least one day before the withdrawal.

Interviewee's Full Name: _____

Interviewee's Signature _____

Date: _____

Appendix C – Interview 1

#REF = Sequential Reference number of conversational lines
SUB = Subject
IN = Interviewer
AB = Participant

Interviewee full name = Adrian Besimi
Position = Lecturer at Communication Sciences and Technologies of SEE University and System qDeveloper of LIBRI
Interview Date = April 15, 2010
Interview Time = 09:21 PM
Interview Duration = 42 min.

#REF.	***SUB.***	***Question/Answer***
1	IN	*Hello. May we continue with our first question?*
2	AB	Yes.
3	IN	*What are the main objectives (functionalities) of this project?*
4	AB	The main objective, first of all was to create a new LMS for the needs of SEE University, that will have the major functionalities that are required for the purpose of disseminating learning materials and collaborate on the teacher-student level.
5	IN	*We will continue with our 3rd question since we see that it is more important* *How many persons were involved in LIBRI?*
6	AB	OK. LIBRI is a creation of 5-6 people. They were involved in various stages, including design, development, implementation and graphical user interface design, one of our members was the coordinator, prof. Zamir Dika, one was Researcher and analyst, 3 were system designers & developers and one was graphics designer.
7	IN	*Basically you have followed the classical software waterfall model, right?*
8	AB	Actually not. We had strict deadlines, and we followed agile development techniques, non-standard ones, due to the fact that the developers were experienced and thus, everything on paper was quickly turned into code.
9	IN	*When did the project start and when was it finished?*
10	AB	The project started in 2007, December, and Beta version was ready one year later. The final released version was available in September 2008.
11	IN	*We have been informed that previously the university has used another LMS called ANGEL.* *How does LIBRI differ from the previous LMS ANGEL?*
12	AB	Yes, ANGEL was a very good, commercial LMS used by our University. The main reason to stop using ANGEL was the price per license per year

		which was too high. LIBRI is not different in the main functionalities, but it lacks some of the advance features of ANGEL. But, therefore it is IN-HOUSE product and it can be developed in the future and it costs less...
13	IN	*Can you describe briefly these advantages, except being In-house project and low cost, if there are any?*
14	AB	No, price was the most important, next the features of LIBRI are similar to ANGELs mostly used features, plus we offer in-house support.
15	IN	*Who are the end-users of LIBRI?*
16	AB	Mainly teacher and students. Teachers provide the content and students usually read the content.
17	IN	*How was communication between team members conducted?*
18	AB	WE had regular meetings in our development office and usually the coding was done there. Plus we used mailing as a regular communication tool. No other specific software was used.
19	IN	*What were the major challenges you have faced during this time?*
20	AB	The major decision was to be done during this time. Actually we had to decide wether we are going to use Open Source projects, such as SAKAI or MOODLE and try to support our position. This is where the research helped us a lot, and finally a decision came that we need to continue to develop our own project.
21	IN	*Can you describe the main user requirements?*
22	AB	Even though someone else was dealing with user requirements, I might give you some info. We had the user log from ANGEL, and we processed that log to gather the info on the main functions used by students/teachers. This is where we gathered the user requirements; basically they need whatever they are currently using. The results were that students use LMS for downloading materials, sending homeworks, discussion and announcements. Teachers were using LMS for uploading content, organizing content, opening discussion forums, checking roster, adding announcements, grading homeworks and similar.
23	IN	*We would like to know if you have participated in the UI design phase?*
24	AB	Yes.
25	IN	*Great. Have you used any prototype, persona, or user scenario as a part of your initial phase of design?*
26	AB	We used prototyping of user interface mainly driven by processes (example: submitting the homework, or downloading the materials), and thus creating the UI on whiteboard, digitalizing it with camera for further usage. Yes, we also used use-case diagrams to show the possibility of actions by various system users. This then helped us to develop the UI on paper/whiteboard.

27	IN	*Around how many prototypes were built before continuing the finalization process?*
28	AB	If I remember, I think we built prototypes UI for majority of complex processes, such as downloading materials or listing materials or submitting the assignment. Maybe around 10-15, majority of them were modified few times, adding new changes/features.
29	IN	*And during this time were any end-users involved?*
30	AB	Just few targeted end-users, some teachers that were active users of ANGEL and some students, but not too many. We just gathered surveys from the majority of them, but not actively involve them.
31	IN	*So, surveys are used to collect end-users opinions.*
32	AB	Yes, but before the design phase, not during the design phase.
33	IN	*OK. What technology was used for the design process?*
34	AB	No specific technology was used, except for the Database design where we used VISIO and for use-case scenarios were VISIO was used as well. Otherwise pen-and-paper worked fine.
35	IN	*When you mention database, have you used the ER model or another model?*
36	AB	E-R model.
37	IN	*OK. Can you describe in details the software architecture have you used? We go with the final part of questions.*
38	AB	Yes. We have divided our software in three tiers, mainly: Business Logics, Data Tier and Presentation layer. This way we could manage processes inside the business logic and thus define core libraries. Next, we separated the Data Tier and made it independent, because we thought that Data should not be dependent on the presentation.
39	IN	*What models (software-oriented) models have you used?*
40	AB	There were no specific models, except for the rapid application development techniques used.
41	IN	*According to some materials, you have used the so-called Modular Design* *Basically, you have organized each component into modules, right?*
42	AB	Yes, that material is published by another author, our team member. Yes, I forgot to mention, our idea was to divide it in chunks or modules. This was easier to manage, as well as delegate the job to some developer Additionally, this helped us in the future to release specific modules, without having to change anything in the design. One developer was coding one module.
43	IN	*OK. Have you used the collaboration theory, respectively collaborative tools such as web 2.0 wikis and blogs?*
44	AB	No, we used ActiveCollab project management tool, but that still was not that efficient, and we had to conduct more meetings on daily/weekly basis.
45	IN	*What technology was used for the development process?*

46	AB	The technology used is the Microsoft VISUAL STUDIO and MySQL server for the database server. Also for deployment we used Microsoft Server 2003 with IIS 7.0 and .NET framework support. Also, we used some third party frameworks such as jQuery.
47	IN	*OK. What were the major challenges you have faced during the development phase?*
48	AB	Database optimization, or query optimization was major challenge. Initially before testing everything seemed fine, but when we ran the pilot project, we realized that some queries run slow and they needed to be optimized again.
49	IN	*And now we have two last questions.* *What are your plans for future improvements (updates) of LIBRI?*
50	AB	LIBRI is being improved all the time. We get feedback from users and we add new features or modify existing feature all the time. WE also plan to develop new modules in the near future that will increase the level of usage of LIBRI, such as Social media integration (Facebook) or Video Tools (YouTube or similar).
51	IN	*And how were security issues managed in LIBRI?*
52	AB	The security is important. I have a paper published on Security in LMS specifically. I can send you the paper and you will get all the answers there.
53	IN	*It would be great.*
54	AB	OK, I will mail it to you.
55	IN	*Thank you! And that is all for this interview.*
56	AB	You're welcomed.
57	IN	*We thank you very much for your time you have dedicated.*
58	AB	Thank you, too. Good luck with your paper!
59	IN	*Thank you!*

Appendix D – Interview 2

#REF = Sequential Reference number of conversational lines
SUB = Subject
IN = Interviewer
VS = Participant

Interviewee full name = Visar Shehu
Position = Adviser and Developer of LIBRI
Interview Date = April 17, 2010
Interview Time = 01:35 PM
Interview Duration = 25 min.

#REF	*SUB*	*Question/Answer*
1	IN	*Hi there. First we start with general questions.*
2	VS	OK.
3	IN	What are the main objectives (functionalities) of this project?
4	VS	Our idea was to create a LMS that would offer the basic functionality for the SEEU users. This LMS was designed to fulfill the requirements of our staff (after a requirement gathering process we conducted). These requirements varied from: resource publishing / sharing, online classrooms, messaging, announcement publishing tool, discussion forums etc.
5	IN	What was the main reason for developing a new Learning Management System (LMS)?
6	VS	The university was using Angel Learning, a commercial LMS that was very popular among staff members. Although the system was used widely, the annual cost was too high. This is why we decided to build a new in-house LMS.
7	IN	How many persons were involved in LIBRI?
8	VS	Six people in the beginning: Dr. Zamir Dika – Project Coordinator Dr. Lejla Abazi – Research and System Designer MSc. Adrian Besimi – Adviser and Developer MSc. Visar Shehu – Adviser and Developer BSc. Mehmetali Shaqiri – Developer
9	IN	When did the project start and when was it finished?
10	VS	The project started in 2007 and is still under development. In January 2009 we released version 2.0 of the system.
13	IN	How does LIBRI differ from other previous LMSs (ANGEL)?
14	VS	Libri is designed to support modular development approach. At first we implemented only the most used features from Angel. Later upon staff

		request, we implemented other features and we are actively working on introducing new options (such as one current project dealing with plagiarism detection). The system is open, students and staff members can use publicly available web-services to enhance the system and build additional modules. Also the system is integrated seamlessly with other SEEU systems (eGrading, Schedule, eService…).
15	IN	Who are the end-users of LIBRI?
16	VS	Students and instructors.
17	IN	How was communication between team members conducted?
18	VS	We developed the system as a team, with weekly meetings to discuss progress issues. All ideas, design decisions etc. were decided as a team.
19	IN	What were the major challenges you have faced during this time?
20	VS	The main problems we faced was managing strict time constraints and especially fulfilling all the requirements from the management. One of the problems was also the decision from the management to directly publish the new system and not to use a parallel adoption phase of migrating from one to the other system.
21	IN	Can you describe in details the software architecture have you used?
22	VS	The system was developed in the .NET framework. We used C# as a programming language and MySql as a database management system. The system was however developed to support other DBMS-es as well. Client side programming utilized AJAX technologies with the support of JQuery and similar frameworks.
23	IN	What models (software-oriented) models have you used?
24	VS	We implemented the system to support modular development. We strictly followed the provider model design pattern during development.
25	IN	What technology was used for the development process?
26	VS	.NET Technologies developed with Visual Studio .NET IDE, communication and versioning was made using the Team Foundation Server.
27	IN	What are your plans for future improvements (updates) of LIBRI?
28	VS	We have a roadmap of developing many other features for the system. Currently we are working in plagiarism detection, and we plan to offer video conferencing capabilities to the system for the next academic year (since the university is planning to deliver distance learning courses starting from october). We are also in the process of integrating with MIT OCW (Open CourseWare) which will be available soon in Libri.
29	IN	What were the major challenges you have faced during this phase?
30	VS	Scaling was one of the first and major problems with the system. After the initial launch, we experienced a scalability issues, since the system started to be used by few thousand of users. Immediately we started to face performance issues, which at times brought the system down few times. As mentioned previously, we did not have the time to do a parallel deployment scenario that would enable us to rollback to Angel if things

		went bad.
31	IN	How did you resolve them?
32	VS	We scaled into multiple servers, allocated disc space and based on database usability, we optimized the system to manage the load.

Appendix E – Interview 3

#REF = Sequential Reference number of conversational lines
SUB = Subject
IN = Interviewer
ZD = Participant

Interviewee full name = Zamir Dika
Position = Pro-rector for academic issues at SEE University and LIBRI's project coordinator
Interview Date = April 20, 2010
Interview Time = 06:35 PM
Interview Duration = 39 min.

#REF.	***SUB.***	***Question/Answer***
1	IN	*Hello. Now we start with our questions.*
2	ZD	OK.
3	IN	*Can you describe the user requirements?*
4	ZD	Since *Libri* had a predecessor in Learning Management Suite *Angel*, there was a good opportunity to design user requirements for the new product. Data from 3 year experience of *Angel* usage was analyzed in order to define the user requirement. The analysis was conducted form the three viewpoints: teachers, student and administration perspective. Form the analysis, the user requirements was designed, in terms of the *Approach*: In-house development; in terms of *Methodology*: modularity – in order to shape the product which will be tailored with the usage scenarios; *Scalability* – need to integrate it with existing IS at the university; the *Usability Requirements* defined; *Training* needs and possibilities for *Personalization* for the teaching staff; also, the need for *Multilingual* support was stressed…
5	IN	*Have you used any prototype, persona, or user scenario as a part of your initial phase of design?*
6	ZD	The *Prototype* was designed and implemented in a pilot project, involving several Courses to gather the feedback of Teachers and students. The teachers and students who was using it, was asked to provide feedback electronically (with a feedback system – "UserVoice").
7	IN	*What technology was used for the design process?*
8	ZD	A Use Case Model was used to design the functionalities involving all three groups of stakeholders: teachers, students, administration. The activity diagram was used to describe the workflow (logical model). The design pattern we've used throughout *Libri* is The Provider Model Design Pattern. The provider model is used throughout ASP.NET 2.0.
9	IN	*How are end-users involved in the design process?*

10	ZD	The Heuristic Evaluation (combined with the pilot phase and UserVoice feedback system) was conducted in defining the visibility, user control, consistency, error prevention, flexibility and efficiency of use, aesthetic aspects, help and documentation etc. The system improvements were conducted after this phase of feedback, which gave us good opportunity to qualitatively design the "Final" product.
11	IN	*What were the major challenges you have faced during the design process?*
12	ZD	The main challenges were to define modules and the functionalities related in achieving the user requirements. This was very important because as a person in charge for the realization of this Research Project in the University Level the priorities were set as: the enhancement of the learning and teaching experience and in the same time the cost reduction for the in-house development and maintenance-operation to be realized. Also, it was very important in transforming the logical design into physical design. The challenge was to be maintained desirable user requirements within the existing technology and IT framework at the university. Another challenge was to ensure the integrability of the system with other IS at the university level, which will give an added value to the new product vis-à-vis the commercial one that was used until then.
13	IN	*Can you describe in details the software architecture have you used?*
14	ZD	We have decided to use three-tier client/server model. ***The presentation layer*** was developed using Web 2.0 technologies. It combined AJAX (Asynchronous JavaScript and XML) technologies, XHTML, and CSS thus offering a very rich interactive environment. The server side was coded using ASP .NET. ***The business layer*** This layer implements all the classes, interfaces and functions required by the application. This layer was developed with scalability in mind, offering various means to extend the system via modules. At the same time this layer communicates with the outside world using web services. This way the system could be extended by third party applications and modules. One could create software in any platform (desktop applications, mobile applications etc) enabling users alternate means to access the system. ***The data layer*** The primary database choice was MySql Server due to its open source license model.
15	IN	*What are your plans for future improvements (updates) of LIBRI?*
16	ZD	*Google Analytics* is used to collect usage data, and the improvements are being made in real time. We are using the historical data to design the training programs for all type of users, and also to prepare developmental plans for integrating other modules to increase the quality of use of the LMS.
17	IN	*Thank you! And that is all for this interview.*
18	ZD	You're welcomed.
19	IN	*We thank you very much for your time you have dedicated.*

20	ZD	You're welcome and Good luck!
21	IN	*Thank you!*

Appendix F – Interview 4

#REF = Sequential Reference number of conversational lines
SUB = Subject
IN = Interviewer
MS = Participant

Interviewee full name = Mehmetali Shaqiri
Position = Software Developer (System Developer of LIBRI)
Interview Date = April 29, 2010
Interview Time = 07:43 PM
Interview Duration = 40 min.

#REF.	*SUB.*	*Question/Answer*
1	IN	*Hello.*
2	MS	Hello.
3	IN	*May we continue with the interview questions?*
4	MS	Yes.
5	IN	*Can you describe the user requirements?*
6	MS	Building a new Learning Management System faces a lot of challenges, especially when this system is a successor of a previous successful LMS (a commercial system - Angel Learning, used for more than 3 years on campus). The most extensive process was gathering requirements and design phase. We used different methodologies such as experience based on the previous system, surveys and expert interviews. The benefits of studying a previous system is that we analyzed its features and for the alfa version we decided to implement only the most commonly used features.
7	IN	*Have you used any prototype, persona, or user scenario as a part of your initial phase of design?*
8	MS	Yes, we've used our experience based on the previous system, surveys and expert interviews.
9	IN	*What technology was used for the design process?*
10	MS	In this phase we've defined the system's overall structure and its nuances. In terms of the client/server technology, the number of tiers need for the architecture, the database design, the data structure design etc. Thus we created a software development model. Analysis and design played a very crucial role in the whole development life cycle. We have used UML (Unified Modeling Language) to design the model of the system.
11	IN	*How are end-users involved in the design process ?*
12	MS	Using the experience from the previous system to gather requirements was the first approach. Those requirements were a starting point. Another requirement gathering method was to convey a university wide survey

		resulting with new feature proposals. Then we interviewed a group of users familiar with LMS systems. This group of users was consisted from IT professionals such as network administrators, LMS developers/maintainers and instructors. We've also integrated s feedback system using UserVoice (http://libri.uservoice.com) helped participants to communicate with the development team, report concerns, bugs or even request new features.
13	IN	*What were the major challenges you have faced during the design process ?*
14	MS	The main objective was to identify and solve problems with the existing systems such as integration with other university systems, scalability as well as compliance with SEEU business models. Priority was given to create a system that would integrate with other e-Services such as enrollment services, scheduling and e-grading systems.
15	IN	*Can you describe in details the software architecture have you used?*
16	MS	Once we decided that we'll design a new LMS from scratch we had to determine which features were needed, there were the following remaining technical considerations: architecture, integration and security. To enable scalability, the system was designed using a modular and service oriented architecture. The design pattern we've used throughout Libri LMS is The Provider Model Design Pattern. The provider model is used throughout Libri. It is a means of writing each of the technologies used so that new versions can easily be created and plugged in. For example, if you need to access a different database or authentication server, you can create a provider for it. The theory of the provider is that it allows us to define a well-documented, easy-to-understand API, but at the same time give developers complete control over the internals of what occurs when those APIs are called. Therefore, if the university in future decides to change the type of the data source for any kind of reasons, for example to switch from using MySql to SQL Server etc. the system administrator will have to change only the connection string and the type of the provider used for a particular entity.
17	IN	*What models (software-oriented) models have you used and how?*
18	MS	Throughout development of Libri we've used Waterfall Development Model in combination with agile development techniques.
19	IN	*What technology was used for the development process?*
20	MS	The Libri Platform is as follows: - ASP.NET 3.5 (C#) - MySQL - jQuery (the UI of first version of Libri was developed using Coolite Toolkit but we had major performance issues and that's why we switched to using pure CSS and jQuery)
21	IN	*What were the major challenges you have faced during the development phase?*
22	MS	The major challenges during development phase were: • Scalability – so the technical infrastructure can grow in audience size

		and sophistication; add to the system without compromising its performance – or having to switch to a new one. • Extensibility – easily add new functions and features as they become available;
23	IN	*What are your plans for future improvements (updates) of LIBRI?*
24	MS	Since January 2009, when Libri was first launched, we immediately started planning on enhancing existing modules. After the launch of Libri, we've created a feedback forum where we collected remarks, ideas, comments and bugs reported from users. Based on user's feedback, we sat down and started brainstorming. We reviewed every single feedback and accepted those we thought were needed most. You can find the Libri Roadmap here : http://blogs.seeu.edu.mk/Articles/Details/f0a2d384-28c1-4723-9811-62efbbce7076 The future development plans are to implement the following modules: - Plagiarism Detection Module - this module has to do with analyzing assignments/projects/capstones delivered by students. It will try to detect plagiarism and generate reports. - Quiz Module - Private Storage - display content of user's reserved space on account: on Libri and allow users to manipulate with the drive's content. - Surveys & Polls - Personal Notes (with reminders)
25	IN	*Can you describe step by step the implementation procedure of LIBRI?*
26	MS	We first started using Waterfall model. The reason why we choose this model is because developers have to follow these phases in order: requirements specification, design, implementation, integration, testing, deployment and maintenance. It's always wise to define everything in requirements specification and analyze and verify it deeply, because it is easier to change before it has started the implementation process. Otherwise you'll end up throwing away a lot of good code, your costs will increase and it will have a major impact on the time of delivery. Then later on, after we released the alfa version, we switched to using agile, because the user feedback was very crucial.
27	IN	*What were the major challenges you have faced during this phase?*
28	MS	The major challenge here was data integration.
29	IN	*How did you resolve them?*
30	MS	In order to reach the maximum effectiveness, the system is well integrated into the existing university's network infrastructure and existing applications and data. University's unique business needs required the system to be customized to support specific requirements – and these were addressed prior to deployment. The key to a successful platform is the ability to get information in and out. The system uses web services to pull the existing university data like: student roster, teachers, staff members, courses and schedules. In this way we eliminated data duplication. So when a new student is registered in the university, a staff member is added or a new course is registered, they will automatically be

		available in the system.

Appendix G – Interview 5

#REF = Sequential Reference number of conversational lines
SUB = Subject
IN = Interviewer
VS = Participant

Interviewee full name = Visar Selimi
Position = Student at CST Department of SEE University. User of LIBRI.
Interview Date = May 07, 2010
Interview Time = 08:05 PM
Interview Duration = 25 min.

#REF.	*SUB.*	*Question/Answer*
1	IN	*Hi there.*
2	VS	Hi. How are you?
3	IN	*We are fine. Thank you. May we continue with our interview?*
4	VS	Yes, sure.
5	IN	What can you say about the organization of information presented by LIBRI?
6	VS	It is very useful to have this kind of information at one place and it does save a lot of time. The information if organized in a very logical way and it is easy to find the thing you are looking for.
7	IN	Does LIBRI have all the functions and capabilities that that you expected?
8	VS	Yes, Libri does offer the functions and capabilities that I expected, having a list of the courses, email service and a calendar it is perfectly capable of fulfilling ones needs.
9	IN	What additional functionalities might you suggest?
10	VS	The forum and announcements are also very useful. My only suggestion might be to update the announcements more often.
11	IN	Overall, how would you describe the usability of LIBRI?
12	VS	Well, overall is it very comforting to know that all the necessary information is available at one place; there is no need to search and look for things. Libri is very easy to use so finding the information you need takes little time.
13	IN	Does the program require lots of training or is it fairly intuitive to use?
14	VS	Libri is very user-friendly it only takes a few minutes for someone to learn the way around the program, no training or intensive computer knowledge is necessary. The clearly labeled sections are easily identified and there are no complicated procedures to find what you're looking for.
15	IN	What level of expertise is required?
16	VS	The required expertise to use Libri are minimum, one only needs to know basic computer knowledge, the program is laid out in a way that even people who aren't computer savvy can easily use and benefit from Libri.

17	IN	What are your expected benefits and outcomes from LIBRI?
18	VS	One of the biggest benefits I see from Libri is the peace of mind you get when you realize that everything is in one place, there is no need to go out and look for the materials and information you need one by one. This saves time and effort, giving students such as myself more time to concentrate on studying the material instead of trying to find it.
19	IN	What are the challenges and pitfalls of LIBRI?
20	VS	The biggest challenge I think for Libri is to get the older professors to constantly be active in the forums and to update the information as much as they can, but this is challenge for all new technologies not just for Libri.
21	IN	Which tools do you use the most?
22	VS	The tool I use the most from Libri is the course page where I can register for the current courses I have and receive all the slides and other materials after every lecture. This means I don't have to take notes while in class because I know that they will be available in Libri the same day.
23	IN	How does LIBRI contribute to and enhance the teaching and learning process?
24	VS	The contribution and enhancements Libri provides to the learning process are great, as mentioned earlier it is a very effective that one does not have to concentrate on taking notes while in lectures. Instead students can concentrate on what the professor is explaining, it also must be very useful for professors to spread the necessary material to all students. The email capabilities are also very useful for questions regarding the courses, as well as the forums wich are perfect for group questions.
25	IN	Are you satisfied with private and secure?
26	VS	Yes I am completely satisfied and have never had any problems with the privacy and security.
27	IN	How so ?
28	VS	Well, the password encryption seem to be strong enough so that others can't log in to my personal account.
29	IN	What are the top three features of LIBRI that you favor?
30	VS	My top three features are first of all the course page which gives the ability to share course materials that are crucial for passing the course, the second is the forum which is very useful as many frequently asked questions are answered. And the third is the calendar which is great because is gives an overall prospective on what the week or month looks like.
	IN	What are your suggestions for making this system more effective?
31	VS	My suggestions for making the system more affective is to get more people involved as active users which update and post things often, other than that I think the system if very effective and useful.
		What is the overall impression of LIBRIs' interface?
32		Libri's interface is very easy to use and I have never had any problem using it, I find it very useful and I am glad I have such a program to make

		my student life a little easier.
33		OK, and this was the last question. We thank you so much for your contribution.
34		You're welcome.
35		Good Night.
36		Good Night.

Appendix H – Interview 6

#REF = Sequential Reference number of conversational lines
SUB = Subject
IN = Interviewer
LA = Participant

Interviewee full name = Lejla Abazi Bexheti
Position = Assistant Professor at CST Department and Research and system designer of LIBRI
Interview Date = May 12, 2010
Interview Time = 09:35 AM
Interview Duration = 48 min.

#REF.	*SUB.*	*Question/Answer*
1	IN	*Hello.*
2	LA	Hi.
3	IN	*We continue with Design questions.*
4	LA	OK.
5	IN	*Can you describe the user requirements?*
6	LA	SEEU had a three year experience in using commercial LMS Angel. Based on this experience and the data that were generated from the system itself as well as a lot of survey questioners and analysis of these data we defined the mostly used tools in a LMS are and what their main preferences are.
7	IN	*Have you used any prototype, persona, or user scenario as a part of your initial phase of design?*
8	LA	The experience based on the previous system, surveys, data analysis and expert interviews.
9	IN	*What technology was used for the design process?*
10	LA	UML. In this part was specified who will use the application and set system boundaries. The main dimensions of an LMS functionality are students (student's role), academic (teacher's role) and institutional (administrator's role). We used the Use Case Model to illustrate the planned functionality of the new system.
11	IN	*How are end-users involved in the design process?*
12	LA	Based on their experience, the data that we gathered were further on studied using statistical tool STATA where we have gained knowledge regarding the tools that mostly impact the student access on the LMS. These tools were the starting initial tools of the system.
13	IN	*What were the major challenges you have faced during the design process?*
14	LA	One of the requirements before building this system was to easily bundled/integrated with other SEEU systems. A full integration with

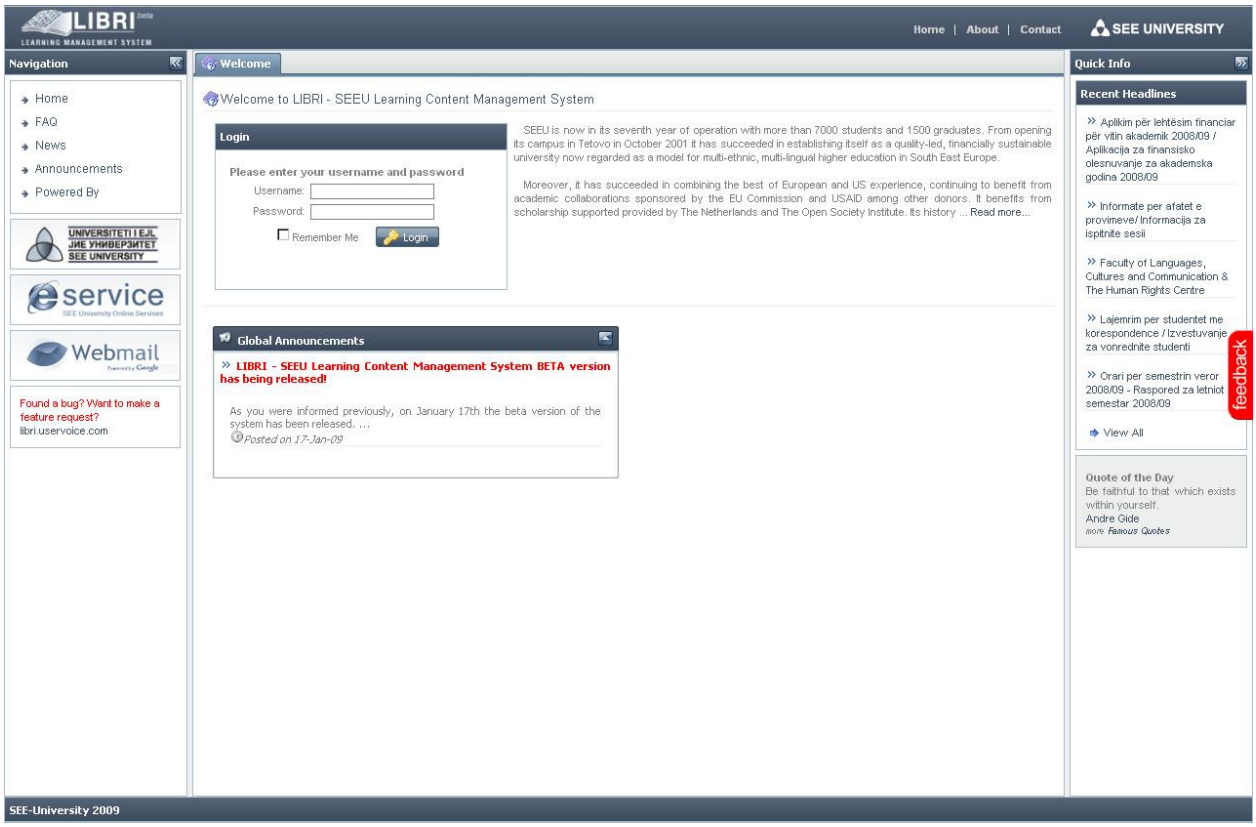
		other electronic services on campus (enrollment services, grading schedule etc.), would be the main advantage of this LMS, something that was impossible or very hard to be achieved with other third party systems. This is why from the start the system (Libri[1]) was designed to be open communication wise with other systems and platforms. Thus, Libri was designed to support service oriented architecture, with XML based Web services used to transfer data from and into the system. However, due to security reasons the system would not have full access to other databases or even knowledge about the database structure and designs. One of the pitfalls of this architecture is the variety of data types, which must be handled appropriately. Moreover the DBMS is also unknown, our system was designed to work using MySql (with support for other DBMS as well) and other systems that would transfer data to Libri were designed under SQL Server, MySql and Oracle. Libri was designed not to keep any personal information about students and staff members. All data, starting from user information (first name, last name, affiliation...) to personal private data such as passwords, will be centralized on other SEEU systems and databases. Our system would just verify user credentials using secure Web services, and obtain the affiliation of those users (whether the user is a student or staff member). Upon successful authentication Libri will keep only the username and affiliation of the user as a session variable. There is storage of personal settings for each user, which would only be used by Libri, and would enable personalization of the system.
15	IN	*Can you describe in details the software architecture have you used?*
16	LA	We used three-tier client/server model. This approach clearly divides the presentation layer from content and data storage. This kind of system decomposition enables us develop large-scale software systems and reduce overall development time. The design pattern we've used throughout Libri is The Provider Model Design Pattern. The provider model is used throughout ASP.NET 2.0. It is a means of writing each of the technologies used so that new versions can easily be created and plugged in. For example, if you need to access a different database or authentication server, you can create a provider for it. ASP.NET 2.0 will then work with that provider just as it works with the existing features. This makes ASP.NET 2.0 much more flexible, expandable, and customizable than ever was before. The theory of the provider is that it allows us to define a well-documented, easy-to-understand API, but at the same time give developers complete control over the internals of what occurs when those APIs are called. The pattern itself is exceedingly simple and is given the name

		"provider" since it provides the functionality for an API. Defined, a provider is simply a contract between an API and the Business Logic/Data Abstraction Layer. The provider is the implementation of the API separate from the API itself. Therefore, if the university in future decides to change the type of the data source for any kind of reasons, for example to switch from using MySql to SQL Server etc. the system administrator will have to change only the connection string and the type of the provider used for a particular entity.
17	IN	*What models (software-oriented) models have you used and how?*
18	LA	Waterfall Development Model in combination with agile development techniques.
19	IN	*What technology was used for the development process?*
20	LA	The Libri Platform is as follows: - ASP.NET 3.5 (C#) - MySQL - jQuery
21	IN	*What were the major challenges you have faced during the development phase?*
22	LA	**Scalability**- so the technical infrastructure can grow in audience size and sophistication; add to the system without compromising its performance – or having to switch to a new one. We have accomplished this by using The Provider Model Design Pattern which was introduced in .NET Framework 2.0. It is a means of writing each of the technologies used so that new versions can easily be created and plugged in. **Extensibility –** easily add new functions and features as they become available; When designing Libri LMS, we always were planning about future developments. We also kept in mind that maybe in near future, the community may want to join the team and help us developing a better user experience. Therefore, keeping in mind that this might happen, the design patterns we've used throughout Libri enable us to easily develop and integrate the modules into the system.
23	IN	*What are your plans for future improvements (updates) of LIBRI?*
24	LA	Adding new modules such as: - Plagiarism Detection Module - Quiz Module
25	IN	*Can you describe step by step the implementation procedure of LIBRI?*
26	LA	Initially we had a six month pilot stage when the system was used only by selected courses. Based on the user feedback we enhanced the solution according to their needs. Another important moment in this stage was also the migration of the content from the old LMS to the new one.
27	IN	*What were the major challenges you have faced during this phase?*
28	LA	Data integration.
29	IN	*How did you resolve them?*

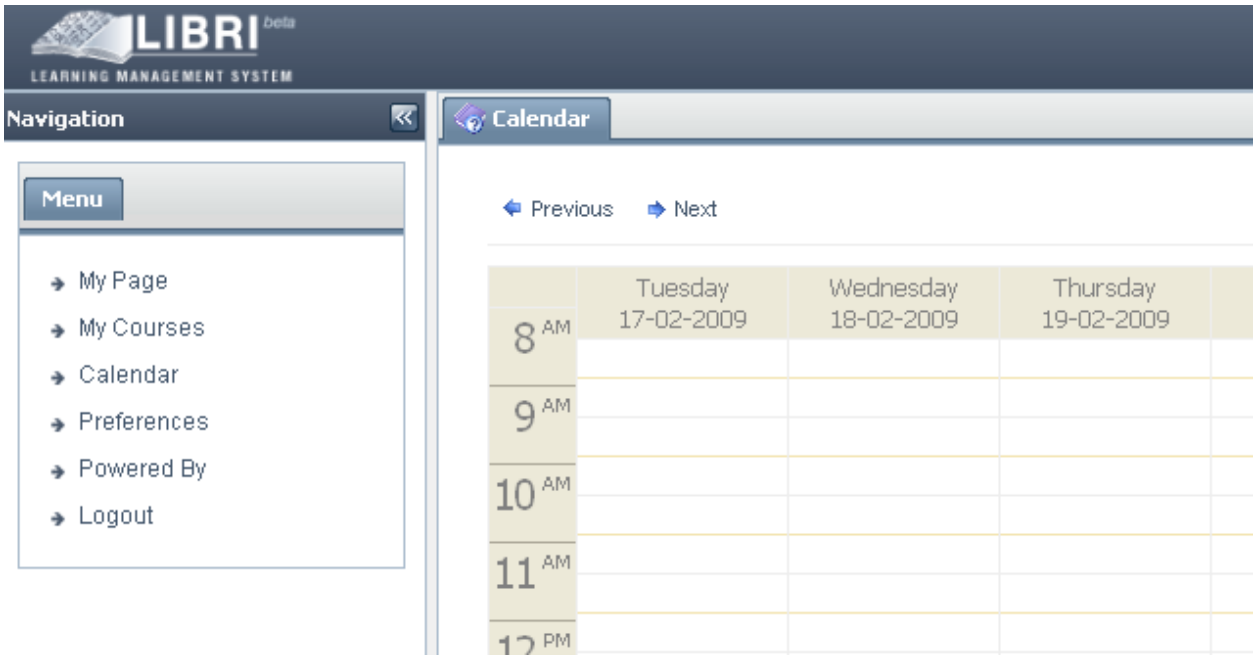
30	LA	The system uses Web services to pull the existing university data like: student roster, teachers, staff members, courses and schedules. In this way we eliminated data duplication. So when a new student is registered in the university, a staff member is added or a new course is registered, they will automatically be available in the system. More precisely, the LMS database contains only the foreign keys that refer to the other databases primary keys that are managed by the organization. The IT Office provides Web Services for internal use. These Web services are developed and hosted by IT Office on their own Servers and the only access is through the proxy server who has direct access to the University central database. The Web Services provide methods to query this database without having access to the same database. These methods range from querying Staff members data, Student Data, Scheduling Data, Study Programs and similar. Every request is authenticated on the proxy server, and then the response is being generated in XML format. LMS uses this response to generate the data for internal use. When original data is required a proxy server queries the other databases within the organization and returns the result to the LMS server. To make the new LMS work perfectly a full integration with the existing data from these two databases is implemented, through the proxy server. The proxy server runs Web services that execute queries and return results as data objects to the LMS. This way, no student data are stored on the LMS database server, neither teacher data nor course data. Only references to University Central Database are saved and through the Web services served by the proxy every data can be retrieved without the need of duplication.
	IN	*We thank you so much for your participation.*
31	LA	You're welcome. Good luck!

Appendix I – LIBRI's WEB Platform Screenshots

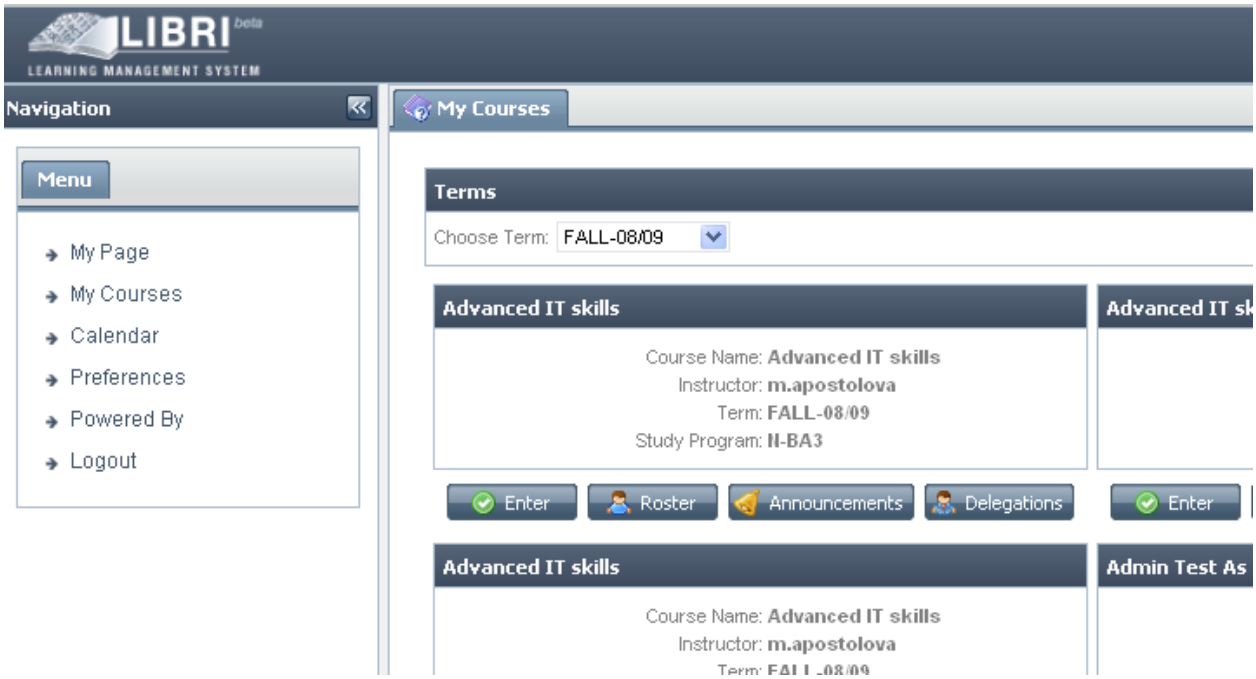
1. Main Page



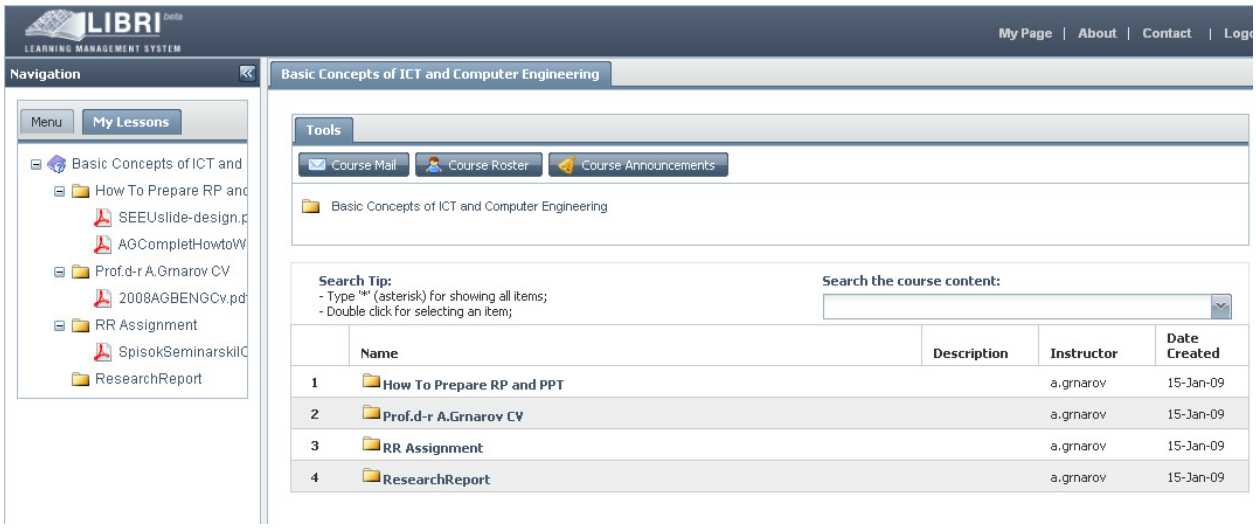
2. Calendar



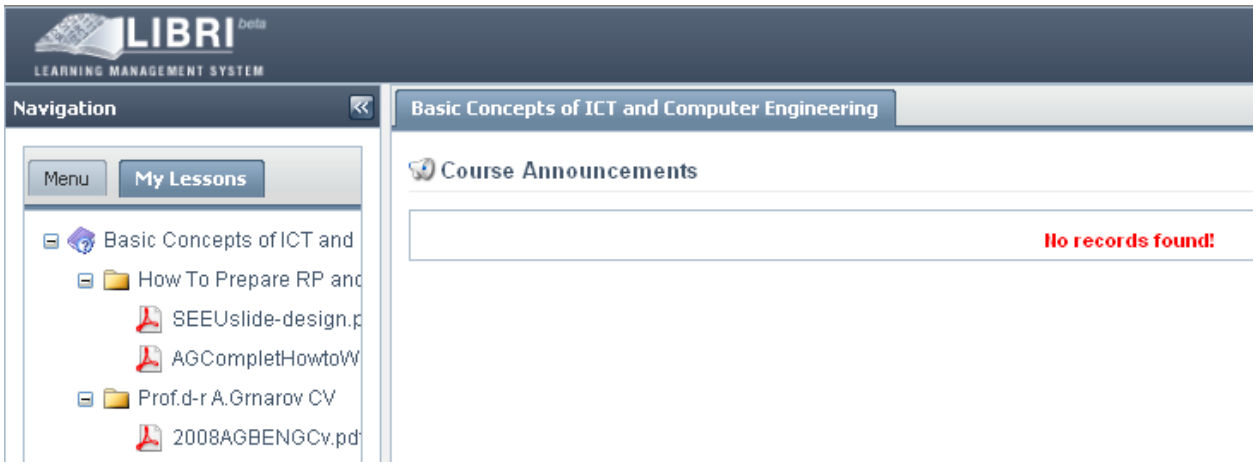
3. My Courses



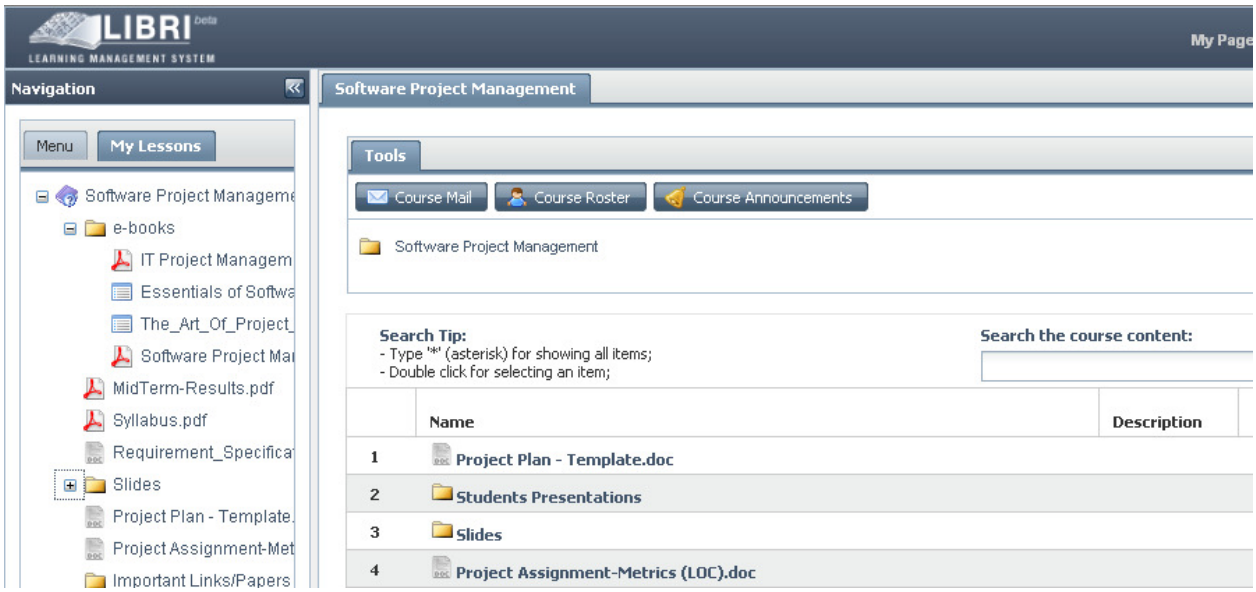
4. Course Management Tools



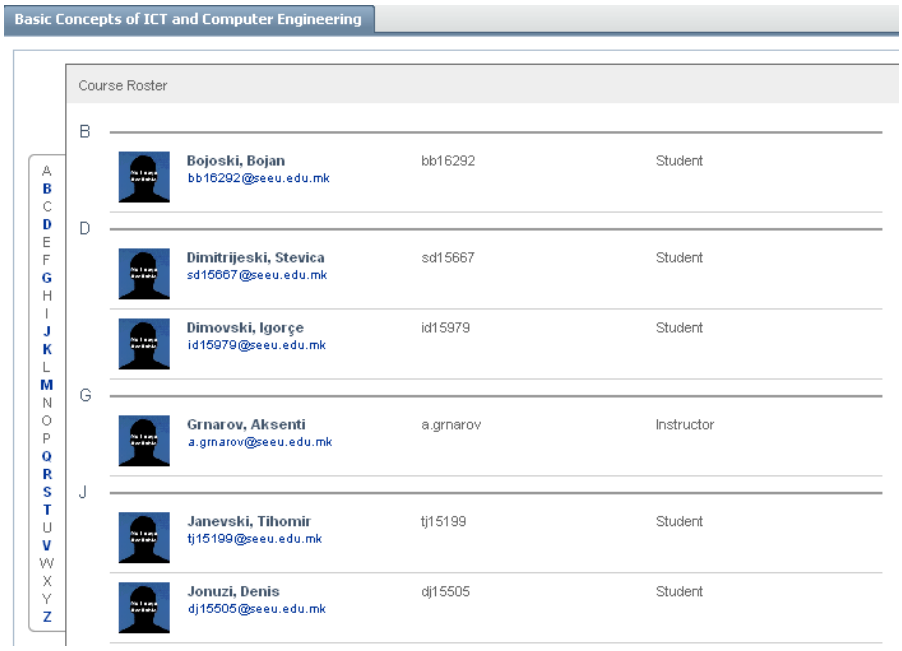
5. Course Announcements



6. Course Page



7. Course Roster



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