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## Extracting Functional and Non-Functional Requirements for E-learning Systems

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### **Abstract:**

Extracting functional & non-functional requirements is a basic step in software development. The process of requirements engineering includes seven main activities Elicitation, Negotiation, Specification, Modeling, Verification & Validation, Management, and Traceability, this study focuses on requirements engineering in E-learning systems to be performed in all educational systems. Non-functional requirements are considered more critical than functional requirements because the non-functional requirements can affect all the systems and some of non-functional requirements may become functional requirements like security. So, hoping that this constructed study is going to help the developers of the system to understand the requirements to build E-learning systems, especially in higher educational institutions.

**Keywords:** Education Technology, E-learning Systems, Requirements Engineering, Educational Systems, Software Development.

## 1. Introduction

Considering education as a social activity. It accurately and specifically points out school education, which is a dedicated, planned, methodical influence on the following generation's social pursuit. Mostly, the education process is all the activities that can develop people's knowledge and skills and change the thinking and behavior of people [1]. Throughout the history of humanity, education is being improved and activities have been changing constantly, from beginner learning to modern education skills and activities which are dependent on a major and complex education system that is based on highly informative means of education. Modern education is not Fulfillment of educational activities to fulfill educational aims [2,3]. The education system has two meanings: the aim of the system is to achieve education activities to fulfill educational targets; the system contains a group of education elements that are oriented and related together (such as. teaching organizations, staff, teaching facilities, and so on.). Education systems are varied in several sizes. It may be huge as a universal education system, or tiny as a nursery school [1].

One of the most serious steps of software development is the (RE) Requirements Engineering. Badly executed RE processes is a big risk for the failure of projects. Requirements elicitation and definition derive and concentrate on the collection of requirements from several stakeholders. Ideal and perfect resulting artifacts that are textual requirement descriptions, use cases, and sketches of prototypical user interfaces [4]. In order to back up the activities related to requirements elicitation or deriving and definition including Re commending Stakeholders, StakeNet [5], many recommendation approaches were proposed, also recommending requirements, managing Feature Requests, [6], [7], Consistency Management [6], and Dependency Detection [9]. Yet these works have a shortage of accuracy. Lately, on the coming of

the methods of data mining, a lot of chances are now obtainable for improving the requirement-gathering process and one of them is using the recommender systems.

Software requirements demand plays an important part in the final success or failure of a software product which was documented by research through the years [10]. The Standish Group [1] made a very miserable study of the case of the software industry.

Its report shows that 31% of projects will be canceled before accomplishment and that 52.7% of the projects, its estimation will cost at least 189% of its value. In the report, one distinguishes three common factors behind these maxim numbers which are:

- The lack of user input is (13 % of the projects).
- Requirements and specifications not completed (12 % of the projects).
- Changing requirements demands and specifications are (12 % of the projects).

The report properly identifies various factors that were common to successful projects and the three important factors that were usually cited include:

- User participation (16% of the projects)
- Plain statement of requirements (14% of the projects).
- Getting support from the upper management (12% of the projects).

The remaining sections of this paper are structured as follows. Requirements engineering in the software development process are reviewed in section (2). Section (3) provides more details about standard online E-learning Models. The requirements of e-learning are presented in Section (4) which explains the difference between functional and non-functional requirements. Finally, this work will be concluded in Section (5).

## 2. RE IN THE SOFTWARE DEVELOPMENT PROCESS

RE is a major step of the software development process, in this step the errors will cause problems in the next phases like design and implementation. The domain or software RE is divided into two parts, requirements development and requirements management [11]. The requirements development is split into four major activities namely requirements elicitation, requirements analysis, requirements documentation, and requirements validation or validity. These are the core RE activities suggested by [12], [13] and include all the activities engaged with gathering, evaluating, and documenting the requirements for a software application. The activity of requirements management includes establishing and maintaining an agreement with the customer on the requirements for the software project [14].

The RE process is endless [15], On delivering a software product the users start using it, and they discover new needs and utilize it, then they want to expand. This promotes new requirements, then, goes across the same requirements process.

In spite of the assortment of the number, the names, and the types of models used in the RE process, seven main activities are used in the RE process. The seven main activities in the RE process are as follows: [16]

- Elicitation: This activity includes the identification of stakeholders, determining and tracing of business, users, and system requirements. Functional requirements and NFRs are deemed during elicitation activity.
- Analysis and Negotiation: Is the activity that dissolves high-level requirements into details, estimating feasibility, and consulting the priorities with users. Requirements can be preferred to mandatory or optional. This activity includes identifying conflicts, determining unclear, incomplete, vague, or conflicting requirements, and resolving all these matters.

- Specification: This activity concentrates on documenting the functional requirements that software provides, and the NFRs which have to be respected. All requirements must be specified in a consistent, attainable, and reviewable style.
- Modeling: Modeling activity allows for applying certain techniques to generate useful and verifiable requirements models. Models like UML contain diagrams and their notation.
- Verification and Validation: This activity applies the different tests and means of evaluation which are used in verifying and validating the requirements. Verification includes inspection that the software meets its stated functional and NFRs. Validation includes checking the requirements it defines the system that is wanted by the customer.
- Management: This activity is the monitoring of the changes and the maintenance of the requirements, to guarantee that the requirements surely reflect the product.
- Traceability: Concentrates on documenting the lifetime of a requirement, giving relationship mechanisms among different associated requirements, and chasing the changes which were made to each single requirement throughout the software development process.

### 3. STANDARD ONLINE E-LEARNING MODELS

Online e-learning is a very confronting and challenging research stage or program. The most ordinarily used standard of online e-learning models for example are (1) IEEE Learning Technology Systems Architecture (LTSC), (2) Sharable Content Object Reference Model (SCORM), (3) Blackboard, and (4) Moodle.

### (1) IEEE Learning Technology Systems Architecture (LTSC):

The IEEE Learning Technology Systems Architecture (LTSC) model basically has six components (ingredients) as appeared in Fig.1.

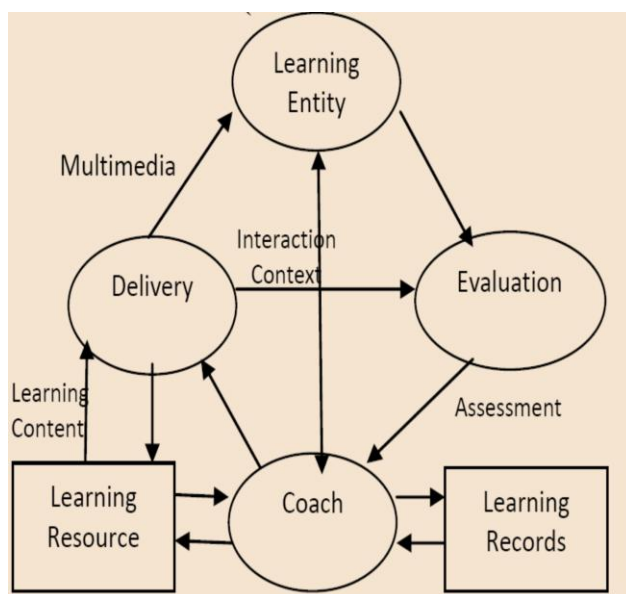


Fig 1: Learning Technology Systems Architecture.

The learner entity is GUI for the student or learner who will access the information from the online e-learning system. The coach acts as the heart of this pattern or sample [17]. It supplies the learning materials with estimating information and answers to the questions. Delivery components are for delivering the study material in a well and predefined format using any multimedia applications. The learning resources component shape has a catalog of information deciding what information was provided to a learner through the delivery section. The important component of this model is the evaluation section which constantly evaluates the behavior of a student's progress in the study by an evaluating test, assignment or any kind of

examination done by the system. The last section, which means learner records is keeping the information of the learner's profile, whether they are current or historical information, and the personal as long as academic information.

## (2) Sharable Content Object Reference Model (SCORM):

The Sharable Content Object Reference Model (SCORM) architectural model is widespread through the web-based online e-learning systems to allow Online Course Content to share information as it is shown in Fig.2 the content management systems are an extra service provided by the SCORM model [18].

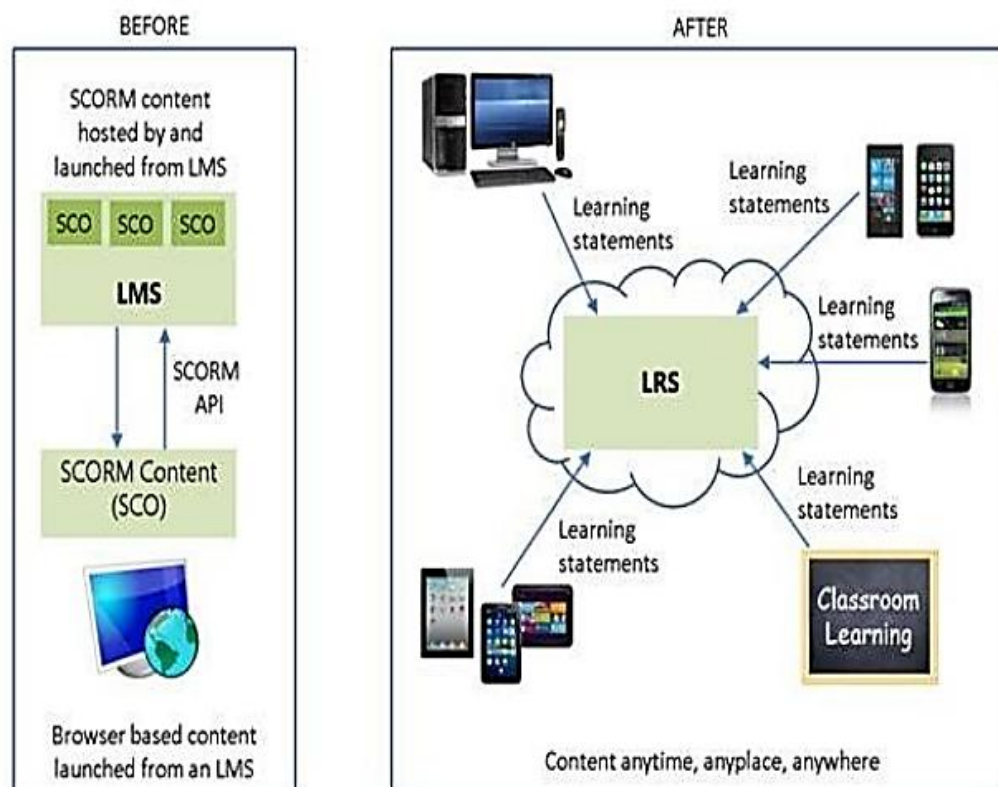


Fig2: Sharable Content Object Reference Model.

The system provider has an elasticity to make the content of learning material available according to the user, furthermore, has an API adapter that helps to supply an application-level interface that is independent of programming languages. Therefore, it provides information only through a web browser.

### (3) The blackboard:

The Blackboard [19] is an application-based online e-learning system to manage the teaching and learning processes. It was designed for helping and supporting teachers and students to interact with the electronic classes using the electronic materials online as a sort of combination for the activities and material which were given face to face in these classes. The blackboard gives teachers the ability to introduce the content of the course, making conferences, chatting, making discussions with students, and giving assignments online via the Internet. Using the concept of an Agent is one of the characteristics of this system. Despite its Agent concept is not so efficient. Adding an intelligent concept by using agent technology is a new approach and worth appreciating. It has a client-server architecture for information sharing as it is shown in Fig.3.

It gives elasticity to the instructor to upload all the required information about the subject using any multimedia style. This architecture is divided and split into two parts. The first is the identity server that performs as the authentication and authorization or license of the login user. After that, the authorized user is redirected to the blackboard learning system, which supplies all e-learning material for studying a particular subject.

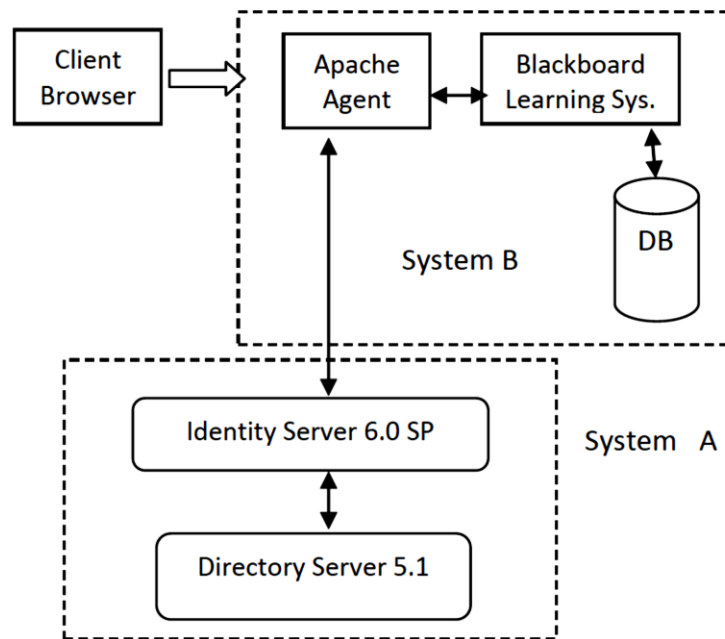


Fig 3: The Blackboard Architecture.

#### (4) The Moodle:

Moodle is one of the most commonly used open-source online e-learning applications [20]. That enables the establishment of a course website, ensuring their access only to registered students. It is a three-tier or rows architecture which is shown in Fig.4.

The first is a presentation layer that provides a GUI for the user through a web browser. The second is the domain-based layer which depends on the particular domain on which the organization wants to develop an online e-learning system. The third and most important layer is the data management layer which stores all informational data in MySQL database. Furthermore, it has a connector layer used for adding external applications for providing learners with effective delivery of teaching materials. Moodle architecture includes six groups of modules:

Communication modules, Productivity modules, Student involvement modules, Administration modules, Course delivery modules, and Curriculum design modules [21].

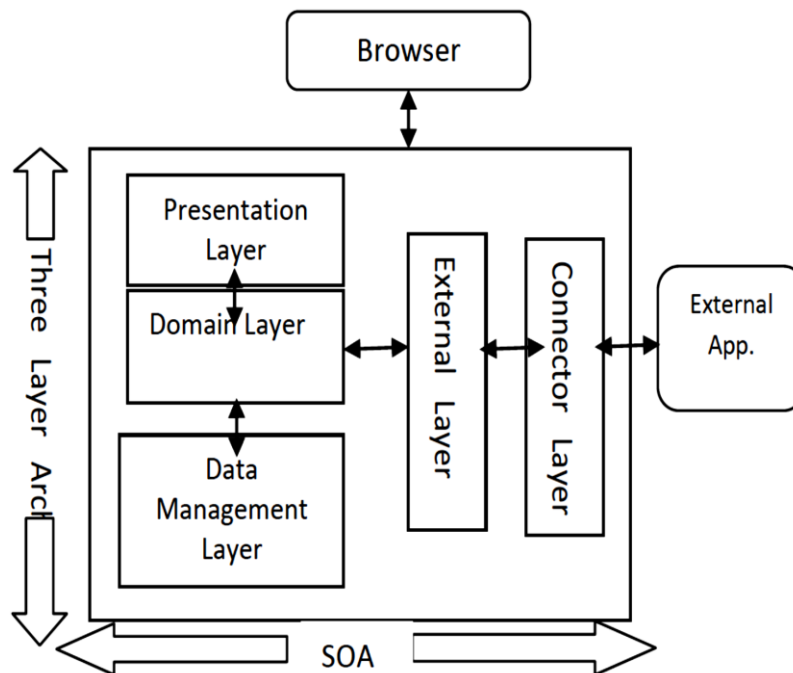


Fig 4: The Moodle Architecture.

#### 4. Requirements of E-Learning

Viable e-learning must supply its users with a real-life-like learning climate to fulfill its objectives. This system should have functional and non-functional requirements.

##### 1) Functional Requirements

The main first functional requirements related to Interface requirements include a user account form that accepts the data in a validated format and also it disables navigation and additional features when the user is not logged in. The objectives of e-learning are to create and offer courses, enroll students in offered courses, provide

a platform to present and discuss materials related to a specific course, store course materials online to be easily accessible, and provide the tools which are necessary for student evaluation and feedback.

The second major functional requirements of e-learning concerning business requirements include user data which will be displayed when the user has logged into his account, to test data: it appears only when the user takes a test online, and check if every login is valid and proper and the new accounts are validated.

The third major requirements related to Security requirements, Examinations, and assignments are important components and play a critical role in authorizing the instructor to keep track of his students' progress. He/she may set up online or take-home examinations and assignments. Taking-home examinations and assignments must be uploaded to a secure folder accessible and attainable only by the instructor and the concerned student who owns of the files. The student must be allowed to complete any online exam or assignment.

## 2) Non -Functional Requirements (NFR)

NFRs are requirements that basically cannot be described in the normal functional description. They are qualitative and specific requirements that participate in the ripeness of the system: performance of response speed, reusability, reliability, or availability of the system. Functions are always designed for realizing requirements since system developments are famous to be as successful only when functional requirements are obviously defined. However, when the aims and background of the system development are not written and shared among stakeholders, not all the functions will be used in delivery. Moreover, if some attributes of the functions are not obviously defined, the system will not achieve the expected levels of performance or usability and that functional design would have to be reappraised. In the first design phase, the defining of NFRs meets many problems in the next phases. Industries have developed a body of knowledge about NFRs, but academia has been

trying to establish a model for explaining the value of NFRs and the effect or action of NFRs [22].

NFR Standardization: It is a criterion among stakeholders. Classifications have been specified fundamentally in software development. IEEE std 830-1998 was established to specify NFRs for software products to prevent observation [23]. Their NFRs are performance, safety, security, and other quality attributes. ISO9126 also defines components for measuring the quality of software [24]. The formation of these items is quality attributes and their detailed elements. The quality attributes are functionality, accuracy, usability, efficiency, maintainability, and transitivity or crossing.

Reliability is the ownership of a system that commands that it must remain in operation under passive situations. When the service is not available when needed the most, then the purpose of the service fails. A reliable or responsible system must include mechanisms or techniques (e.g., fault forgiveness) to ensure the continuity of service. Security is an important requirement for the system. The security requirement is defined as a control, safeguard, protection, defense, or countermeasure to avoid or remove vulnerabilities and sensitiveness which may be exploited to violate or assault the confidentiality - privacy, integrity, or availability of the data. These constraints or chains must be part of the development through all phases 7, 8, 9, 10, and 11. The classroom materials should be protected in a way that unauthorized people cannot make changes (integrity). The materials must be available when they are required.

Since performance is an important requirement for the virtual classroom so we will discuss some of the important reliability, security, and performance requirements.

#### 4.1 Reliability Requirements

When a user is disconnected during an online E-learning session (without the user explicitly logging out), then the connection will be restored as soon as possible without asking for credentials. If the connection cannot be re-established, then the time when the user was disconnected will be postponed for future reference, the current state of the user's work will be saved, and the user will be logged off.

- If the connection between the user and the system is broken before, the system will make the user able to save the current state and continue again from that state when the connection is restored.
- The system should backup user data at regular intervals for avoiding loss.
- The system shall try to restore a lost session due to communication interruption to the point where it was interrupted.

#### 4.2 Security Requirements

- All the users must be authenticated or certified before granting access to the E-learning system.
- All the users must have access according to their respective privileges of the authorization.
- A student should be registered in a course before he accesses its materials and tries its function, duty, and exams.
- The instructor is only allowed to mark those who are absent or present in the E-learning system.
- A student can be marked inactive if he/she is present but does not reply to the instructor or has not performed an action during a certain time.
- Missions should be uploaded before being graded or assorted.
- Exam must be attempted before grading.
- The instructor can only start a class that is scheduled before at least 1 day.

- All internet communications that involve any personal information should be encrypted.
- Instructors should only be able to access the records of students who are registered on their course. And these records should be limited and fixed to the course which is taught by the instructor.

#### 4.3 Portability Requirements

- The design of the E-learning system should permit the application to continue on all vastly used browsers.
- The design of the E-learning system should serve different screen sizes such as (desktop, laptop, tablet, and smartphones).
- The design of the system of E-learning must be able to run on various operating systems.

#### 4.4 Performance Requirements

- The system should be able to entertain and host at least 50 users (approximate strength of a class) together in video conferencing mode. This requirement will ensure that at least one class can proceed during any time opening. This requirement can be enriched when adding more resources to the system.
- All Web pages created by the system shall be able to be downloaded in about 10 seconds over a 40 Kbps modem connection.

### 5. Conclusion

This study provided a model to be helpful in gaining the E-learning education systems available at anytime and anywhere. E-learning is the perfect and complete gateway to education. Students should register themselves into the course they wish by filling in the formal procedure online. The schedule of every class should be announced to the students who were enrolled. This study can be used by those who require education, so it points out to the public. This study would raise the rate of literacy and introduce a completely new approach that would be favorable and

suitable in many ways for different people. Moreover, the study concentrates on non-functional requirements of reliability, security, and performance. These non-functional requirements are necessary for any application or implementation. In this paper, several non-functional requirements are proposed to improve and develop the reliability, security, and performance of all virtual learning systems.

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