E-Learning Systems Requirements Elicitation:
Perspectives and Considerations

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ABSTRACT

Training and education have evolved far beyond black boards and chalk boxes. The environment of knowledge exchange requires more than simple materials and assessments. This article is an attempt of parsing through the different aspects of e-learning, understanding the real needs, and conducting the right requirements to build the appropriate e-learning system. E-learning systems, unlike the normally developed systems, have variable customers and on-going demands. It is not the easiest task to elicit unambiguous functional and non-functional requirements for such systems. However, a brief exploration of some of the e-learning characteristics may tremendously decrease the difficulty of prioritizing the most important requirements.

KEYWORDS

E-Learning, E-Learning Strategies, E-Learning Users, Middle/High School Learning or University, Requirements Elicitation, Requirements Engineering, Software Requirements

THE DEFINITION OF E-LEARNING

Figure 1 shows the average appearance of an e-learning interface to deliver a topic of mathematics. To get a hold of the right e-learning requirements, it is of value and importance to first understand what is "E-learning" and what kind of tools and facilities gives shape to that concept. E-learning, as described by Khan (Khan, 2005), is "an innovative approach for delivering well-designed, learner-centered, interactive, and facilitated learning environment to everyone, anyplace, anytime by utilizing the attributes and resources of various digital technologies along with other forms of e-learning materials suited for open, flexible, and distributed learning environment". This paper addresses e-learning systems that can be part of the education process in middle/high schools or universities. It can also be for training centers that aim to supply online training for its customers regardless of their place and time.

The majority of training and educational organizations from different types of local schools to global universities, are already accepting e-learning strategies into their educational infrastructure. Yet, there are other entities in the educational field who are still tied down to the physical and spatial limitations of the real classroom in the education and learning processes. They may still prefer the

Figure 1. Sample of algebra learning website (MathAid Algebra, 2013)
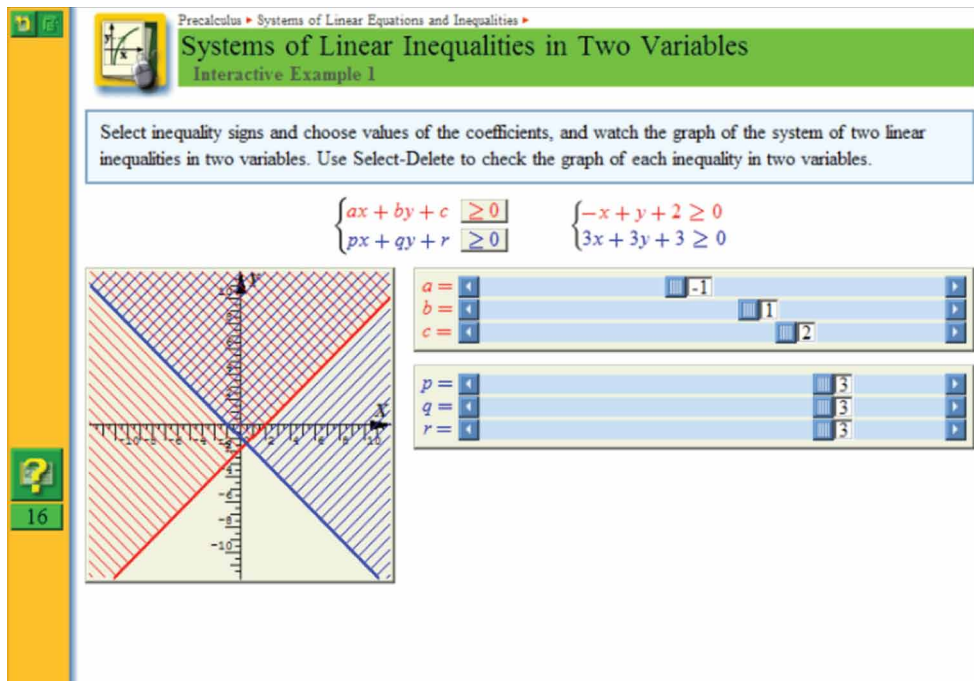
conventional ways of teaching over expanding through web platforms. Their reluctance is caused by their uncertainty that the proposed advanced e-learning tools will "fit" their needs. Moreover, they might be even concerned about the system violating their set of policies, health of their students, adaption of their staff and management crew, their annual cost and maintenance, or simply, they are just not sure that the e-learning system will be up to the right requirements for conveying educational development adequately (Hashim et al., 2014).

This is when eliciting requirements for e-learning systems gains higher importance and plays an undeniable role in constructing the e-learning system that the customer was looking forward to. The health of students mentioned here as a concern is due to considering exposing eye-sight to screen for extended time periods rather than dealing with conventional printed text, and it also includes neck or back posture preserve whilst using tablets or desktops during learning hours. There are too many of e-learning requirements affecting factors to cover in one paper of research, so four of them will be focused on in this paper; such as:

- E-learning best user interface (UI) design requirements;
- E-learning teaching methods requirements;
- E-leaning social communication requirements;
- The requirements for creating the most suitable e-learning environments.

These points of interests were chosen as pivots of discussion due to the value they hold for designers, stakeholders, and users. They are easily affected by the origin of users, their age and

interests, laws and regulations of the country, religion and beliefs, and available resources. For each of these considerations, a moderate analysis will be presented to show practices of requirements understanding and elicitation.

This paper's contribution is summarized through:

- Emphasizing the importance of eliciting valid requirements for e-learning systems;
- Discussing common factors that affect eliciting requirements for e-learning systems' users;
- A brief overview of two e-learning systems used in academic environments;
- Suggesting an approach for eliciting e-learning systems requirements.

E-LEARNING USER INTERFACE (UI) REQUIREMENTS ELICITATION

So, who is the user of an e-learning system? what is the environment of application? Typically, the process of developing any system involves identification of the customer needs. In e-learning systems development, however, the customer can be an entire academic institution, a training center, or an open resource that offers knowledge to online users.

The interface of e-learning systems is the first thing that the user's eyes meet. It explicitly serves the requirement of readability, ease of use, and accessibility. The learning course materials should be presented properly in a layout that is easy for the user to read and navigate through. The font of wording should be comfortable for the average reader, not too tiny, neither too large forcing the user to do more navigation than actually reading. Animations can be used in the material presentation, but not in a context that would distract the user's attention from the core subject, yet, interactive design can create a better user experience on e-learning systems (Ning, 2014). Leaving some white space on the screen can go a long way in showing the clarity of information presentation. Some UI designers see that investing all of the space of the screen with pictures or animations and colors is the best way to deliver the best e-learning experience, but this case does not always hold true (Brusilovsky et al., 2007). Keeping a fixed theme through the online classrooms shows consistency, such as maintaining the font and master layout, therefore, the user can concentrate more on the information passed to his comprehension than getting used to the appearance of the screen. As a good practice of "usability analysis" Instructional Design Expert (IDE) suggests that the following primary points should be validated (IDE, 2009):

- Embedded Uniform Source Locators (URL) links should work properly;
- Functions should work as they are supposed to;
- Grammar and spelling check;
- Visibility of graphics;
- If integrated with other assets, system should work seamlessly;
- Asserting that e-learning objectives are being fulfilled with what is presented through the system.

The fulfillment of these requirements can present a better e-learning system. They can also save time and effort that could have been spent on the hassle of recovering from missing crucial points in the stages of development.

Interaction with UI Components

The proposed system of e-learning should be supported with the appropriate tools and kits that help deliver the required content smoothly. Table 1 is a statistical view of how users interact with pages in terms of spending time on a page and reading its content of text. For pages with almost a hundred word, users tend to read approximately half of that word number. Minimal content encourages users to interact with most of that content. For instance, if your e-learning system offers an algebra course,

Table 1. Attention span statistics

Internet Browsing Statistics (Taken from 59,573 Page Views)	
Percent of page views that last less than 4 seconds	17%
Percent of page views that lasted more than 10 minutes	4%
Percent of words read on web pages with 111 words or less	49%
Percent of words read on an average (539 words) web page	28%

then it should support the specified web technology that allows the student to interact with an axis of a graph or to easily insert mathematical notations when solving online assignments instead of depending on a description of the topic with lengthy paragraphs and multiple graphs (Arockiam et. al., 2013).

Interfaces should adapt accordingly to the role of the user logging into the system, assigning the right privileges to the right user on the right interface, therefore maintaining order and security in the e-learning system. A user can be a learner entity in some courses, or an instructor assigning assessments and posting grades. Each of these roles require certain functionalities to be available on their screens as they are two different roles. To specify the right UI requirement, it helps to understand and sort out which courses are self-instructed (where the learner/instructor roles interface customization is not required, and the learner goes through the material of education self-paced) and which of the courses are composed of an instructor entity and learner entities. In the latter system, the e-learning experience involves collaboration between the two roles while maintaining the restrictions of each (Babu, 2003). Therefore, each requires a different set of requirements.

Factors That Affect the E-Learning User Interface (UI)

Since age is an effective element in designing e-learning UI, then users of the targeted ages must be able to comfortably access the elements of their interface, and communicate easily with the e-learning system factors. Designing an e-learning system for middle or high-schoolers is not a similar process to that of designing the exact same system for university scholars. Although the purpose is the same but the age factor has its impact on the design of both types of e-learning systems. Middle/high school students are prone to distraction in levels higher than that of university students. The design of a page for the first type mentioned, needs to be concise and attractive to the eyes of the user, while for the latter mentioned, the design of the e-learning interface may compensate the absence of these two features by supplying richer content for the scholar. The realization of these category of requirements is important because it assists in defining the right elements that makes the system adapt to the user's needs and not the other way around. Basically, E-learning UI design requirements shifts the designer's focus from the tool itself to the students using that tool. Slides, videos, URL links, multimedia, and static or dynamic screen displays can be used to present the material of learning to the intended audience (Learning Technologies, 2017).

Yet, it is not only the age or interests but the skills and usage background of the user. The designed e-learning system maybe proposed to a user who do not have enough technical background to use advanced tools. The user can be novice in terms of using technological facilities, while other users can be IT professionals. Simplicity is a requirement in this case to help the user adapt to the proposed system and to encourage continuity of use. Ease of use can be one of the strongest motives for the continuity of using an e-learning system. One of the main reasons of having instructors or students draw back from using e-learning tools is the complexity of usage where they would describe the system as "too hard to use". Even the simplest tasks of uploading, downloading, or posting a question or comment can sometimes be an operation of multiple procedures that the average user may easily get fed up with.

Another factor is the country or culture of users. This affects the default language, the general theme and layout of the system. This also defines the type of presented content; whether it goes with or against political, religious, or cultural matters. It can even affect the terms of which the system's users can communicate.

E-LEARNING TEACHING METHODS REQUIREMENTS

The person using the e-learning system is either a dependent or independent learner. The first requires an instructor or a trainer, but the latter one usually pursues information on his/her own. Dependent learners in this context are learners that require another instructing entity to guarantee the continuity of their learning, while independent learners are those who can continue their e-learning self-paced without the essential need of an instructing figure. Classifying the type of learners should simplify the selection of the teaching methods required (Babu, 2003). Figure 2 shows how (on the left) students are recipients of learning centralized upon an instructor, in other words dependent on the instructor methods, but in correctly designed e-learning systems (on the right) learning is shifted to a process that allows the student to grasp chances of interaction with instructors, experts, library, etc.

In traditional education processes, away from Information and Communication Technology (ICT), students had to go to school, find the right classrooms, pay attention to the instructors, and spend time in libraries. In order for all of that to be suitable for students, requirements elicitation was rather a difficult process to apply to e-learning because of the extended domain range over the web. The attention went from escalating requirements to an unreachable level to moderating them on the user level as in Figure 2. Every aspect in e-learning requirement is now down to the user needs.

As for the teaching methods, it is a global requirement. E-learning, according to Instructional Design Expert (IDE, 2009), can be broken down to five elements. One of those elements is the e-learning content management which describes how to deliver the course material in an approach that is user-intriguing. According to the material type, the requirements differ, just like the example of the algebra e-learning system. For instance, history and language courses should lean more towards embedding diagrams, audios and visuals into the layout of the course material rather than just bulking up the text on the screen for the user to comprehend. Diagrams

Figure 2. E-learning focus shift (Intel, 2009)
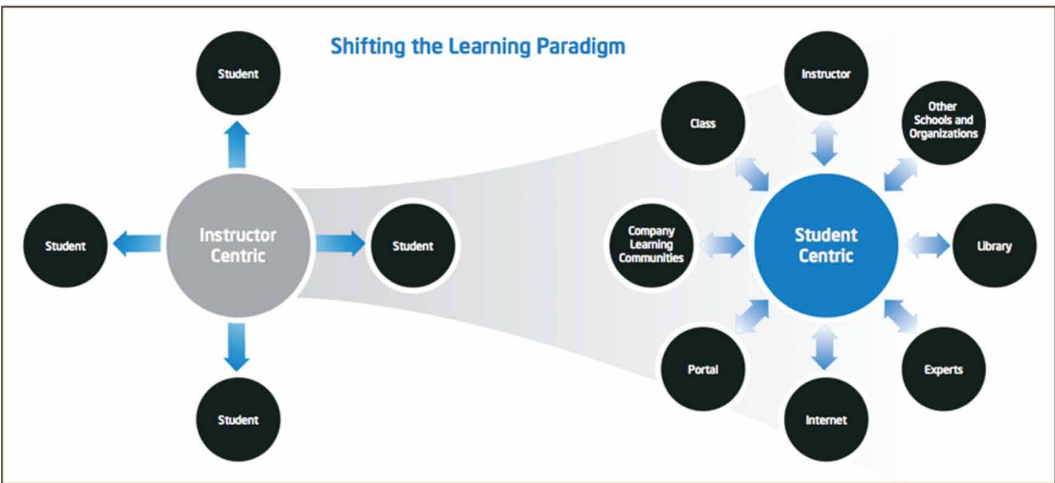
can serve as supporting visuals to enhance the concept delivery to learners. They can easily tidy up thoughts that may have been explained previously in excessive text (Butcher, 2006). Grabbing the attention of the user is also important since in most e-learning experiences, a student is usually self-instructed. Table 1 shows a statistics sample of different attention spans during web use (Weinreich et al., 2008).

E-LEARNING SOCIAL COMMUNICATION REQUIREMENTS

One of the pillars of e-learning systems is to provide a direct link of communication and interaction between experts, colleagues, learners, and peers. E-learning systems should not be referenced as "e-learning vending machines" (Mackwell, 2009). Communication is the way to fix the skill gap, to minimize the knowledge distance between instructors and learners. Mackwell (2009) reports in his online article: "Learning through digital media also has a potential for 'something liberating' in education as it helps breaks down social barriers". Hence, Learners care more about learning than worrying about their appearances or backgrounds.

Most e-learning systems support a communication tool, like a forum, to enrich the learning process. That facility is also a requirement, because e-learning systems are designed to, supposedly, shrink the distance between, not only the learner entity and learning material, but also between the learner entity and other peers of the online course. This will help involve the user in the learning process, therefore, offering a better learning experience through e-learning systems. Communicating through the system is rather easier than having to communicate externally by email or messages. Communication can be offered in many different shapes such as video conferencing, simple forum discussion, news broadcast, or comments wall.

E-LEARNING DOMAIN ENVIRONMENTS

The environment of e-learning systems is actually the audience learning environment and the teaching environment for an instructor. For both of the entities, the e-learning system should stand suitable. An instructor should be capable of using the system to effectively deliver content and the learner should be able to gain refined learning benefits. The question that has to be answered is: where will the learner entity be taking the online course? Will it be in the classroom? In a workstation? at home? Answering these questions will help identify the system requirements, because distraction and noise levels will differ accordingly. The requirements engineer does not choose the environment of the e-learning system, but rather customizes the requirements to suit the given environment.

The user might be restricted to use the e-learning system during limited hours of the day, or maybe the user has limited access to certain webpages or plug-ins. All of these restriction and consideration may come in handy when eliciting the right requirements for the e-learning system. The system engineer could also consider the profession of the users, their technical background, and their area of work to incorporate skill developing courses into the system (IDE, 2009).

SAMPLES OF E-LEARNING SYSTEMS

Some of the e-learning systems used on the academic and social levels are the blackboard and the OCS. The online course systems all offer courses of different intellectual aspects. The General layout and functionalities show resemblance. All of the systems illustrated depend on the login credentials to identify the role of the entity signing in. However, looking closer at the details in Figure 3 and Figure 4, it comes to notice that the effect of the environment is clearly emerging.

A good example to study the importance of e-learning systems through is in the engineering schools. In engineering education, students carry-out experiments using a lot of simulation tools

like the network packet tracer, SPICE, AutoCAD, and more. In such major of education, e-learning systems make use of the Information and Communication Technology (ICT) to integrate the simulation interface into the e-learning system in order for students to carry out experiments that in other ways would have not been possible in hardware labs due to lack of the hardware itself or other essential resources (funding, room, tolerance of error… etc.). This is why the college of engineering depend on commercial open source Virtual Learning Environments (VLE) as Banday et al. (2014) explain to deliver complex engineering material based on mathematics and science.

The First e-learning system to review is the Engineering College Online Course System (OCS) built using Moodle (http://moodle.org) as shown in Figure 3. This system offers the latest activity and news on a side view to the logged in entity in order to give the feeling of connectivity and ease of access. This system also supports social communication through in-course forums and Direct Messaging (DM).

In Figure 4 is the blackboard (BB) (http://www.blackboard.com)online course system. As figured, it gives the option of selecting the language. The on-screen calculator serves the scientific classrooms environment, and shows ease of access to essential tools.

In the both observed systems, the most noticed aspects were discussed to show requirements being applied according to the environment needs. It does not mean that one is better than the other. Comparison to decide preference is best done to systems of the same environment and with common entities involved. Evaluation is not only bound to the appearance of the UI despite its importance, but it is an overall process that covers all aspects of the e-learning system.

METHODOLOGY

Although the traditional methods of design consist of three main stages: preparation, illumination, and verification. These three stages intersect in wide areas (Ryan, 2012). Therefore, it is hard to re-assure each stage and conclude that the system is done and ready for launching. Developing e-learning systems is not an average top-down approach where the customer is interviewed, the scope of learners is defined, and the system is directly built. The different software requirement models are all eligible

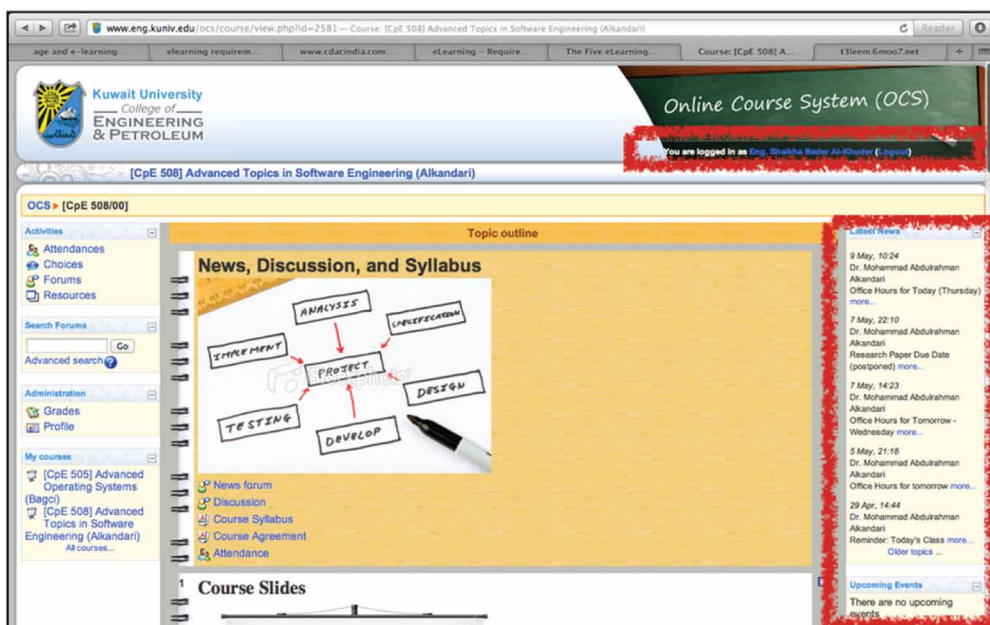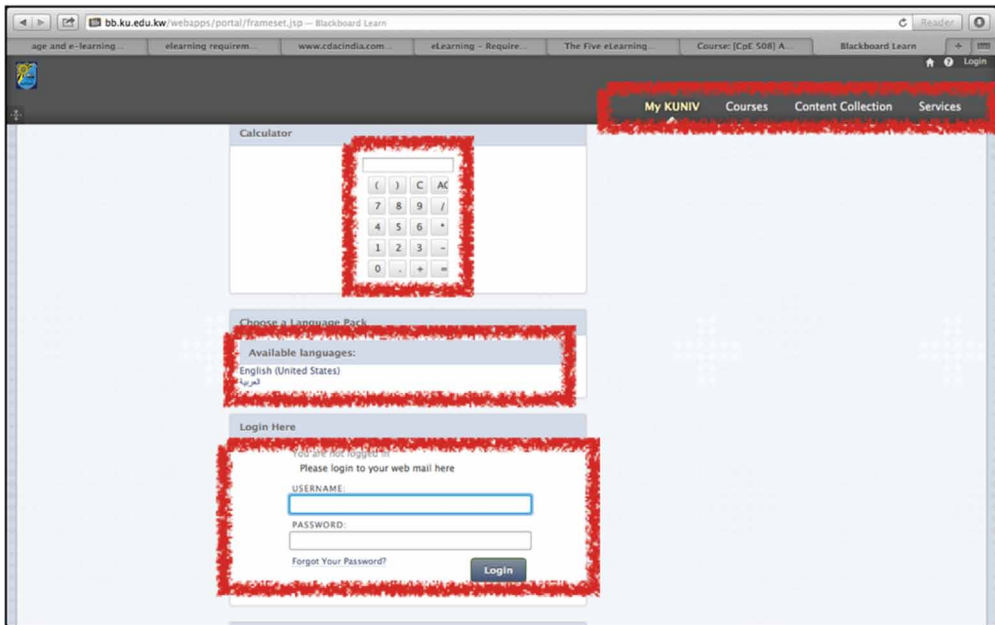**Figure 3. Kuwait University's Engineering Online Course System**

Figure 4. Blackboard System, Kuwait University Science College Online Course System

to use here, but the human interaction factor is of a heavier weight in e-learning systems. The proposed approach is inspired by the framework suggested by Zualkernan (2006).

The proposed approach takes the process of requirements elicitation through three different study stages:

- **First:** The learning environment;
- **Second:** The interaction discipline;
- **Third:** Building knowledge.

The Learning Environment

The framework proposed by Zualkernan (2006) is constructed through the keys of adaptation and fitness. Adaptation in this context means the routines that the learner performs in the physical environment that makes him/her "fit" for this particular environment like a doctor(learner) in a hospital (environment). According to his framework, a good learning environment is that which provides these opportunities:

- Information;
- Successful actions;
- Cognitive constraints and learning styles;
- Learner goals and intentions.

His framework then starts the design of the learning environment based on these types of learning styles: Problem-based Learning (PBL), Distributed Problem-based Learning (DPBL), Inquiry Based Learning (IBL), Role-play Simulation and Game-based Learning (RSL), Case Studies-based Learning (CSBL), Critical Incidence-based Learning (CIBL), and Project-based Learning (PRBL).

The proposed approach of this paper for eliciting the e-learning system requirements builds upon this in an agile behaviour. After deciding the style of learning, the e-learning requirements construction can be started, keeping in consideration that the four opportunities mentioned and the factors discussed in the former sections. Using these perspectives to define requirements enables the adequate design of elements of the e-learning system. A good example of this stage is to design an RSL system for freshmen of computer engineering; A cartoon robot that performs actions according to the C++ programming statements that a student types in. The environment offers the opportunities of information (C++ programming lesson), successful actions (robot animated reaction in case of correctly typed C++ commands), learning style (game), and a learner goal (understanding C++ programming).

The Interaction Disciplines

In this approach, an assumption is set: In the e-learning system, a learner can be the only entity in the learning plan (as in self-paced learning), or he/she can interact with other learners (peers). The learner can also be a part of large learning community in a social environment, or he/she can be instructed by a teacher or a trainer. In this stage of the framework, the type of interaction discipline is decided according to the goal requirement of the e-learning system.

If the aim of this e-learning system is to emphasize the self-motivation skills and abilities of the student as an individual then the system should be focused around a self-paced learning design. If the system targets interaction with peers as a main requirement, then the e-learning system must be designed around peer interaction. If system requires social and institutional values to be emphasized, then the design must revolve around a community or a social environment, and lastly, if the e-learning system requires an instructor entity and surrounding students (Instructor-led), then it should be designed to offer teaching styles and classroom attributes.

Building Knowledge

The final stage of the proposed approach is the objective of the whole requirements elicitation process. It is the stage that should be achieved after interacting with designed e-learning system and carrying out the activities that was meant for the learner to perform. According to what was offered through the environment in the first stage (the objects, information, and tools), and through choosing the appropriate interaction discipline in the second stage, the learner starts building his/her knowledge gradually as plotted by the educational organization. The learner should be able to recognize the goals of the e-learning course, and should have realized them through the e-learning experience.

Because of agility, the requirements engineer, at this stage, can observe and validate whether the requirements of the e-learning system have been met or should the requirements elicitation model go through one more iteration for each stage of the framework.

CONCLUSION

Life-long learning is the highest aim of e-learning systems; To deliver knowledge without boundaries to everyone nearby and overseas, and to give a chance to everyone across the globe. That is why this work of research is a dedicated effort to start the process of designing life-long learning in the best methods possible. Eliciting requirements for e-learning systems is not a monotonic process. It evolves with the advancement of network and web technology. This paper is an effort to enrich the development methodology of e-learning systems, and to spark the attention of software and requirements engineers regardless of the models they may select for eliciting the requirements of any system in order to develop that system correctly. To conduct the right set of requirements, it is essential to understand how the system is supposed to work and what does the audience expect. Requirements engineering for such systems is a challenging process, but with the basic requirements analysis emphasized in this paper, they can prevent such simple but effective perspectives and considerations from being overlooked.

FUTURE WORK

Proposals for developing the requirements of e-learning systems has been a serious research discipline throughout the last decade. Considering the discussed aspects in this paper, the future of eliciting e-learning systems requirements is heading towards creating optimized frameworks that can effectively design the desired e-learning system with less time and effort. The requirements elicitation framework that software engineers are looking forward to is an approach that can enhance the e-learning system as it intelligently learns more about its users. A model that can open venues for the automation of the requirements elicitation process of e-learning systems to contribute more towards getting us closer to the goal of providing adequate learning experiences nearby and overseas. Afterall, the best e-learning system engineers of tomorrow are the ones who have most surely used it today.

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