
e-Learning Functionalities: From Components to Services



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Abstract

e-learning environment provides learning services such as Course Management, Assessment, Content delivery, Collaboration etc. Initially, these services used to be desktop services and have taken a new form of web components with the evolution of Internet Technology. Like any other web components, e-learning functionalities are also shifting towards Service oriented Architecture (SOA) for more availability and accessibility. This paper discusses about e-Sikshak as case study for implementing the e-learning functionalities as components. The paper also discusses the use of SOA in offering e-learning services as an extension to componentization work carried out.

1. Introduction

“Everything changes but change itself.”

This maxim reflects the dynamic nature of web-based architectures. The client server architecture replaced monolithic systems. But the client-server architecture itself evolved into a model where each subsystem of the server works in dual mode. It acts like a server to a lower tier subsystem and it itself become a client to a higher-level subsystem. This differentiation of subsystem into levels or tiers gave physical form to an abstract idea- the idea of components. Components are pieces of code having a defined functionality that can be integrated into an existing architecture with out remoulding it.

In the context of web, the components have taken a new meaning altogether. They cannot only be integrated into the existing system but also their physical presence within the integrated system is not required. The components can exist anywhere in the web, but their services can be accessed as if they are locally available. Thus components have undergone another phase of evolution. Today they are no longer just components, but they are evolving as web services embodying the transparent nature of web. This transformation have become possible due to the emergence of XML and its various implementations.

e-learning environment is a combination of services and technology that utilizes these services to deliver learning environment to the user. The process of evolution has also touched e-learning technologies. The evolution of e-learning technology is still continuing as the components are being succeeded by services.

e-Sikshak – A case study

e-Sikshak is an e-learning framework developed by authors in which each functional subsystem can act as a component for other e-learning tools. The functionalities supported by e-Sikshak are Course Management, Assessment, Collaboration, Formula Editor and Query Handler. These functionalities have been encapsulated into components that can communicate with the other e-learning tools or among themselves through XML layer.

The development of components can be divided into two categories i.e. client side applications and server side applications. Client side applications are developed using graphical user interface (GUI) oriented technologies like applet/swing and server based applications are developed using server side technologies like Servlets and Java Server Pages. Applet is used to develop the GUI extensive utilities like chat, white board and Formula Editor in which communication is synchronous. Applets are the Java programs, which get downloaded at the client machine and are made to run inside any browser with a JVM, regardless of the underlying operating system. Servlets are used to develop server side applications like bulletin board, e-mail, assessment, query handler and virtual lab, in which the services of external resources (like data base, XML file) are needed. The approach adopted to develop the e-learning functionalities as components was

- i. to resolve the database dependencies
- ii. to establish the communication with other e-learning tools
- iii. to make the functionalities available as packages to integrate with other e-learning tools.

We will see the implementation carried out for the above three points

- i. To resolve database dependencies, XML was chosen for data representation and exchange between different databases. The data about the database to be connected is put in a structured and well-formed XML document. The metadata is structured into database instance information containing host name, IP address, port, and username/password. An interface has been developed to input the database information, which creates a XML document. The developed e-learning functionalities read the database information from the XML document and make connections to the corresponding database.
- ii. Now the first problem of resolving the database dependencies was addressed. But still one more problem remains, which is more crucial i.e resolving environmental dependencies. Environmental dependencies exist because of the different data base schema in the other e-learning tools. The software components have their own database schema for maintaining the information. We took an approach, which is similar to resolving the database dependencies. XML document is modified with the necessary structure to map the components' database schema with other e-learning tools' database schema. All the e-learning functionalities, which are developed as components are shipped with a service internal to the component to enable the integration.
- iii. The third step is to integrate the developed components into existing framework. For this the components need to be available as packages that can be easily deployed. To integrate components, required parameters need to be passed to and from the e-learning tool. Depending on the component, the required parameters can be session details. The session details contains currently logged user name, his role in the e-Learning environment, course details etc. These parameters are

usually passed while making the request to the required services of the components. The software components are made available as WAR or JAR files, which can be deployed across all application servers.

We have developed the e-learning components such as Course Management, Assessment, Collaboration, Formula editor etc., which are tested with two e-learning environments. One of them is an open source e-learning tool **Claroline** and another one is the test bed developed by us. Claroline has MySQL as its database and test bed has Oracle. The applications are implemented with the paths for addressing the query issues related to MySQL and Oracle. The software architecture of the components to interface with the other e-learning tools is shown below (fig1).

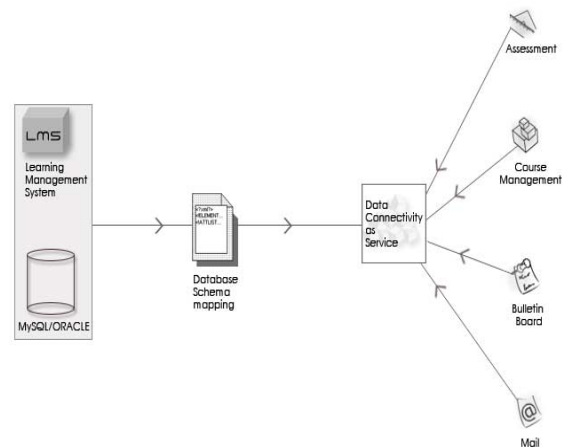


Figure 1 Software Architect of Component

2. Service Oriented Architecture

Though the components have been providing a reliable way to maintain and reuse various functionalities, they still have an element of complexity in developing and maintaining component. This is more visible in case of complex functional features to be built. The major problem with the component-based approach is that they have to be deployed along with the solution. Couple with these, the challenges of varying platforms and protocols have made components nearly impossible to be reused. It is here the Service Oriented Architecture (SOA) comes into picture. In the world of SOA, functionality reuse supersedes code

reuse, as each functional component becomes a service. The system requesting for the service is unaware of the physical location of the service and hence doesn't have to check for the deployment status, as was the case with the components.

As SOA is based on Web-Services, the dependencies nightmare or the 'version hell' does not occur. So this brings us to the key components of SOA. They are services and messages.

- i. Services-A service is a functional system that exposes properties such as
 - a. An interface to contract the service
 - b. in a platform independent manner
 - c. Method to dynamically locate and invoke the service
 - d. Modes to maintain its state across the invocations.

- ii. Messages:- The Communication between the Service providers or services and the consumers is through messages. The contract interface exposed by the Service defines the acceptable messages and the format of the messages.

In the context of e-learning environment, SOA can play a major role. The utility of SOA in e-learning can be well explained with an example. Consider a situation where users of a particular e-learning environment have to be assessed. In traditional systems the whole logic is embedded into the environment itself. In component-based approach, the assessment capability is placed within the component. But still the component needs to be physically connected with the system. But with SOA the scenario changes.

The architecture of assessment provided as a web service is shown in the Fig.2. Assessment Agent implements the assessment services, which are accessed by the e-learning environment. Assessment registry maintains course information and question for that course. As and when learners are registered to take assessment, learners' registry maintains the learners' and their courses information. To make use of these assessment services, institutes or individual users need to have specific implementation of User Interface Subsystem

as a web service. Using this web service, either instructor or learner can access and perform their operations. Once the process is completed, the results are handed back to the environment. In short, the environment is relieved of complete assessment cycle.

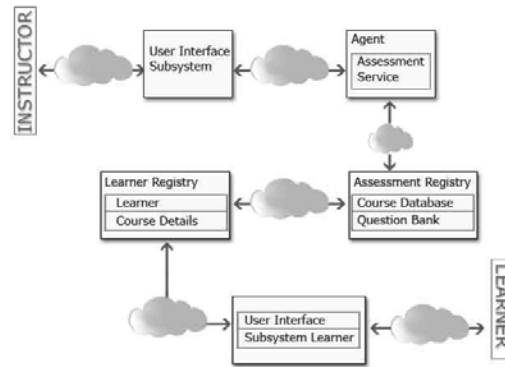


Figure 2 SOA for Assessment Functionality

3. Conclusion

e-learning has undergone a evolution and made a deep root into the conventional educational systems in many countries world wide. The concept of Virtual Universities is making e-learning as a complete solution in some cases. Technologically also e-learning has come a long way from monolithic to components and to services. Yesterday e-learning environment was viewed as a single system. Today its functionalities have been identified and concretized into components. The transition from concretized components to realized services is the course currently adopted by it. The service-orientation of e-learning could be much improved with the help of the advancements of the technology. Service-Oriented Architecture is a futuristic approach in this direction. The e-learning components that are developed by the authors do have the adaptability for the SOA transformation in future.

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