www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume - 3 Issue - 8 August, 2014 Page No. 7861-7868

A Review on Basic Principles of an E-Assessment System.

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ABSTRACT : Assessment is the basic fundamental activity of all learning environments. Therefore all learning management systems (LMS) provide the assessment facilities like (e.g., the formation, implementation, and valuation of multiple choice tests as well as programming assignments).This paper mainly elaborates the principles of service oriented paradigms, those are applicable for routine evaluation of programming assignments as well as multiple choice questions. The most prominent aspect of this assessment solution is, it can assess the programs written in any programming languages. Moreover, it can be easily interfaced with different existing learning management systems. This paper also presents the design of a flexible e-Assessment system based on the Design Methodology Management(DMM) technology which provides a framework for the system development.

Keywords - Computer science education, e-Assessment, eduComponents, service-oriented architecture, web services.

INTRODUCTION

In fact, nowadays all universities are trying to upgrade their teaching methodologies to support e-learning. E-Learning is process by which various course materials are supplied online also it is an activity by which various objective/subjective tests are held online. E-Learning is an enhancement achieved from collaboration of various latest information and communication technologies (**ICT)**. That means E-Learning is a medium to provide a better learning environments which include programming assignments and laboratory sessions as essential components , since they provide opportunities for students to take perfect grip on the knowledge which they obtain from the lectures and to apply it to the practical problems. However, we were dissatisfied with some aspects of this traditional way of teaching, and assessment, which may be sketched as follows:

Before classroom sessions

- the teacher designs the assignments according to the state of the course
- the exercise sheet may be distributed as a printed document could be made available online, in the form PDF files,
- Students can practice these sheets as their homework.

During classroom sessions

- students can explain the solved assignments at the blackboard,
- tutor and peers give (spontaneous) feedback,

The above mentioned learning methodology is especially not feasible for lengthy programming assignments as it requires too much time, so very small number of programming assignments can be checked out. This situation is also unsatisfactory for students, because their queries could not be discussed in detail due to time constraints. So we need a Content Management System, we call it as a plone [3], and it can be automatically coupled with the assessment process. Due to which it is possible to give immediate feedback for students, which could be an additional motivating factor (cf. [3]). So in order to construct a full-fledged assessment system we need to couple certain important module with existing learning management system, those modules are called as **eduComponents**. Some important eduComponents [3] are enlisted below.

- **ECLecture** is a portal to manage lectures, seminars, and other courses.
- **ECQuiz** plays an important role in the creation and delivery of objective tests containing multiple choice questions.

- **ECAssignmentBox** provides the space to write or upload essay-like assignments.

The **eduComponents [5]** modules are used as standalone components, or in combination with existing learning management system so as to improve the standard functionality required in an e-learning environment.

1.1 Structure of This Paper

This paper is organized as follows: Section 2 will elaborate the state of art regarding with the existing system. Section 3 will provide a brief review on programmer's design to model an E-Assessment system while section 4 will discuss the expected outcome of proposed system. Finally we will conclude this paper with conclusion in section 5.

2. LITURATURE SURVEY

The assessment process summarizes all activities those are helpful for teachers, so that they can help learners to learn and to quantify the learning progress. In other words, assessment quantifies and reports the understanding, skills, and attitudes of an individual beginner, of an educational institution. In computer science education, what so ever systems are in existence till now, they only automatically assess and compile the programming assignments by using their own compilers and/or interpreters. For that, they just use static or dynamic testing methodology. Also to effectively share assessment solutions already developed, these tools must be highly interoperable and portable. The first systems which support the online analysis of programming exercises were developed and used as early as 1960. But it fails to provide security, plagiarism detection, etc. A comparative study of all existing assessment systems are summarized next (see Fig. 1). Certain criterion's based on which comparison is made enlisted below [1]:

- Which types of assignments are evaluated: objective assignments only (e.g., multiple choices, true/false) or descriptive assignments (e.g., essay like programming assignments) as well?
- Is the system premeditated for a single programming language or it can be compatible with any programming language?
- Whether the system cramped to a single test method or does it support a variety of test methods?

System/Project	TRAKLA 2	Scheme -robo	Auto-Grader	Code-Lab	My-Code-Mate	Course-Marker	BOSS	AT(x)	Moodle	Black-board
Criteria										
Assessment type										
‣ objective	☐	☐	☐	☐	☐[6]	☐	☐	☐	☑	☑
‣ subjective	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑
Automatic assessment										
‣ programming assignments	☐	☑[1]	☑[1]	☑[2]	☑[2]	☑[3]	☑[3]	☑[3]	☑[2]	☐
‣ other formal notations	☑	☐	☐	☐	☐	☑	☐[6]	☐	☐	☐
‣ different test methods	☐	☐	☐	☐[6]	☐[6]	☑	☑	☑	☐	☐
Integration with other learning platforms	☐	☑	☐	☐	☐	☐	☐	☑[4]	☐	☐
Extensibility	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐
Open source	☑	☑	☐	☐	☐	☐	☐	☐	☑	☐
Support[5]	☑	☐	☐	☑	☑	☑	☑	☐	☑	☑

[1] single programming language
[2] two or more programming languages
[3] (in principle) any programming language
[4] submissions via WebAssign
[5] latest release is not older than two years
[6] unknown

Fig.1. Synopsis of systems for automatic assessment [1].

Another group of such systems are mainly LMSs that work in a vice versa manner compared to the systems mentioned before. LMSs like MOODLE, Blackboard, or OLAT are mainly designed and implemented to manage structure of courses providing course materials. They also offer tools to assess questionnaire, multiple-choice tests, to uploads files (e.g., PDF files), especially for automatic testing of programming assignments.

2.1 Functional Requirements

An e-assessment system for testing programming assignments has to satisfy the following requirements:

- It must be free from all redundant activities of data storage,
- It should automatically evaluate programming assignments in any programming languages with the help of any test methods,
- It should automatically evaluate types of assignments in other formal notations also, e.g., MCQ tests using regular expressions,
- It should have easy extension facility to provide additional assignment types, programming languages, and test methods

2.2 Non-functional Requirements

- Product Requirements: System should require proper execution speed, and should be reliable.
- Organizational Requirements: System should be implemented According to Software Engineering process standards, implementation must be in Java or Dot Net, and GUI must be User Interactive.

- External requirements: System must satisfy interoperability i.e. must work in windows, Linux or any OS.

With these fundamental requirements, in Section 3, we will state exact approach to develop concerned system.

3. PROGRAMMER'S DESIGN.

The principle on which, E-Assessment system works is Service oriented Architecture (SOA).The SOA for an E-Assessment system is shown in the figure next (see fig. 2). An SOA is a framework that integrates business processes in a secure manner, and further be treated as standardized components collectively called as services, that can later be reused and combined to fulfill changing requirements. A service may be defined in terms of business logic as a software component and its functionality is achieved irrespective of platform with the help of interfaces across the network. Service orientated architecture requires slack combination of services, in which providers communicate with their corresponding consumers by passing data in a well defined, shareable format. And thereby improves the coordination within activities between the services.

3.1 Mathematical Model

The design of the flexible e-assessment system have strong base of mathematical term Design Methodology Management(DMM) technology[2].It is a conceptual term consisting of the three key words: Design, Methodology, and Management. Some of the definitions and descriptions of DMM from research are outlined below. Design methodology is specified as the sequence (flow) in which we operate tools on data. DMM deals with data, tool and flow management. Design Methodology may also be defined as a sequence of activities that are carried out to move from one state of the design process to another, In short stated as:

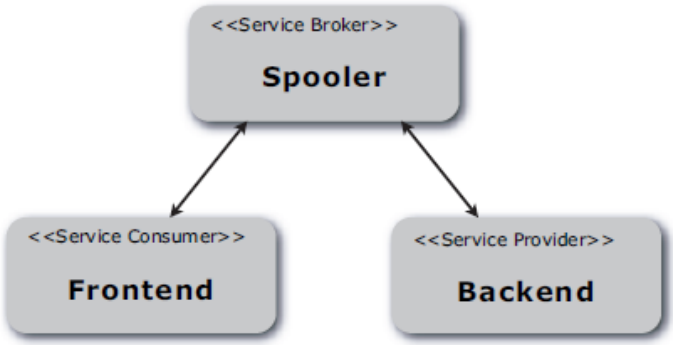

Fig.2. Roles in a service-oriented architecture and its equivalents in our approach [1].

D.M. = Tool Set + Design Flow +Constraints.

Design Methodology is also mathematically represented by the process flow graph. A process flow graph is actually used to describe the flow of information across various design processes. Formally, the graph can be represented in the form, **G = (T; S; E)**, where

- **T:** is a suit of tasks collectively known as primary nodes, represented by circles.
- **S:** is a set of specification nodes acting like an intermediary nodes, represented by rectangles.
- **E:** is the set of edges indicating specifications used and produced by each task, represented by unidirectional arrows.

Figure 3 is a specimen process flow graph showing these representations. The graph has inputs in terms of Behavioral Description specifications and is processed to produce outputs in terms of Structural Description specification. Processing includes compilation, Scheduling of the tasks and allocation of resources which collectively produce control-data flow graph (CDFG), as well as a schedule table and a functional unit allocation table.

3.2 Design Decisions

Here we go on elaborating the functionality of each component in system. Again referring the fig 2 ,we can say that an e-Assessment system composed of three components, namely Front End ,Back End, Spooler. Comparing this with the traditional approach of web services (see fig 4) we can say that front end resembles with service consumer, back end corresponds with service provider and the third component spooler carries out functionality of service broker. Starting from the backends, Backends are basic functional units of SOA; we can also call them as building blocks of a SOA, which provide all the assessment functionalities over standard Internet protocols (TCP/IP) irrespective of platforms and programming languages. That means, Back Ends provide services that encapsulates and implements all aspects regarding the exact testing in self contained manner. Front End is another vital component in a SOA which is actually the Learning Management System which we are going to develop. Common functions of a frontend are

- To provide storage for assignments and solutions,
- To treat submission periods and resubmissions properly,
- To communicate the results to the students.

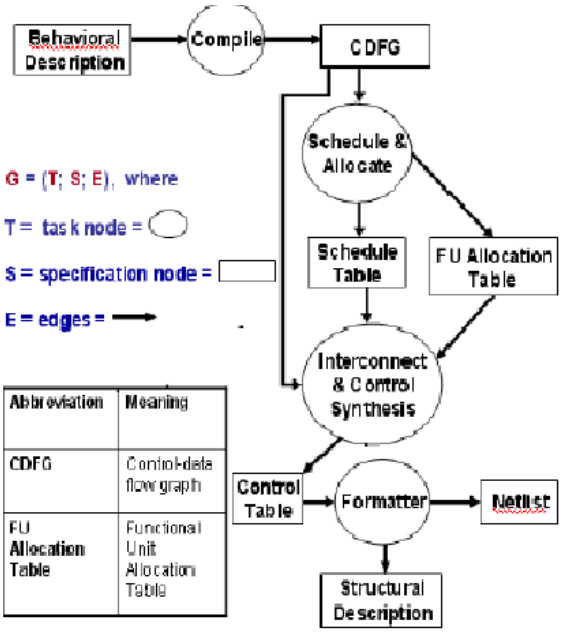

Fig.3. Process flow Graph. [4].

Third component in SOA approach is called as spooler. It enables uniform access to the backends and manages the loose coupling between frontends and backends and thus avoids too many point to point connections. It provides the following functions:

- To add assessment services for testing,
- Produce results of tests performed by a backend,
- Show status information.

3.3 Architectural Overview and Data Flow architecture

Figure below (See Fig. 4) shows the architectural overview of the proposed system. Assessment system is based on a three-tiered architecture.

- Client Tier: At the client tier, we have the web browser that is capable of sending requests and receiving a response from the server.
- Middle Tier: This tier is the web server tier. All Java classes and other business logic are located at this tier. The web server serves HTML pages to users and responds to user requests.
- Database Tier: The third tier is made up of the database and the file server. The file server holds the submitted files of the user, while the database stores information related to users, courses and wizard states.

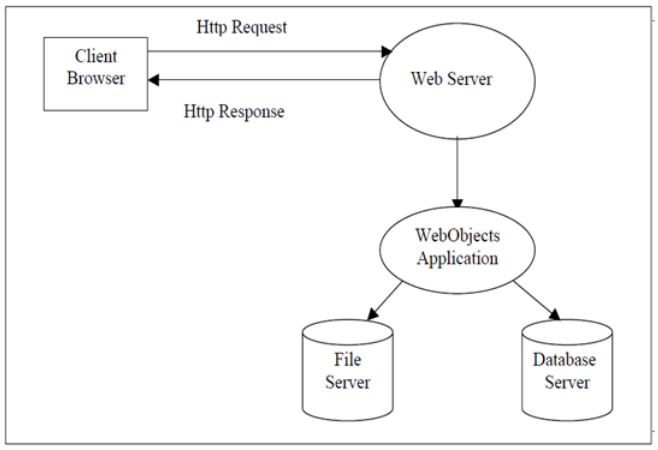

Fig.4. Architectural overview of a system. [11].

Next fig shows the data flow diagram of a proposed system. Work flow of system is explained as follows

- Students and instructors connect to MOODLE through a web browser.
- At front end two services are created by which instructor creates MCQ tests and programming assignment exercises.

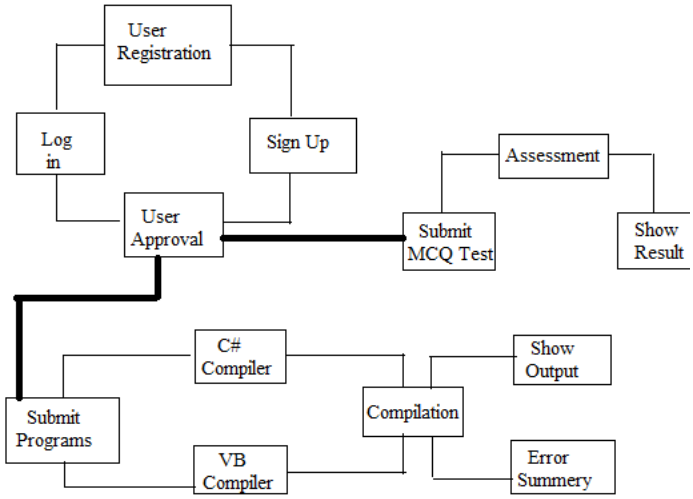

Fig.5. Flow chart of proposed system.

As described in figure above (see fig.4), this system contains three primary modules.

- Tracking User Activities.
- Present online MCQ Test to the user and assess it.
- Present Programming Assignments to the user and evaluate it.

3.3.1 Tracking User Activities

In this module, we first see whether the user is already registered or a new one. In the formal case we directly provide a Log in facility for that user while in later case, user may fill up the sign up form to continue the registration. After the successful login also, user may not be approved for accessing the services so now its turn to an administrator to approve that user. For the same, administrator just changes the status associated with the user to 'yes' and then that user will be an authorized user to access the services.

3.3.2 Present Online MCQ Test as a Service to the user

After successful completion of previous activities, user can enter in this phase where he/she is able to access the services which expose the online MCQ test to the user. Here we expose an xml file containing questionnaire to the user. User can solve individual questions and submit it in proper time interval. After completion of test, user may get competency report with time interval details. The execution of this module is truly based on principles of SOA, where user first refers this MCQ assessment service trough the web site via SOAP protocol. After the completion of test, user may log out or can switch over to the third module by staying log in. User can SMS test result to any number via COM port connected, which will be an additional benefit of the system.

3.3.3 Present Programming Assignment to the user as a Service.

After successful approval by an administrator, user can directly enter in this phase. Or user can reach in this phase after the termination of second module also. That means, after the successful approval by an administrator, user has two choices either to go on dealing with MCQ assessment service or directly attempt the programming assignments. In this phase, user can upload programming assignments on various dot net languages(C# or VB) in the ECAssignmentBox developed at the web site. When user press the 'Check Syntax' button in the system, depending on what programming language is used, the assessment is carried out by an appropriate compiler (either C# or VB compiler). In case of failure, the exact error summery is presented to the user through summery box provided below the ECAssignmentBox. Or in case of successful compilation, user can see the out by pressing 'Show Output' button in the system. Thus, this system is basically helpful for both, teacher and students. By using this system, teacher can create assignments, publish those to users, and also grade the assignments those are submitted by the students. If we consider student side, this system allows students to read the assignments and to solve it, and to observe the feedback if any.

3.4. Transition Diagram.

Fig 6 is the simple transition diagram[4] which shows possible changes in the state. As we have mentioned above, the assessment of student submissions is the semi automated process, i.e., the assessment is done by instructors, who use ECAssignmentBox for grading student's work and giving feedback. ECAssignmentBox therefore constructs the special workflow for student's submissions. The following workflow states are defined:

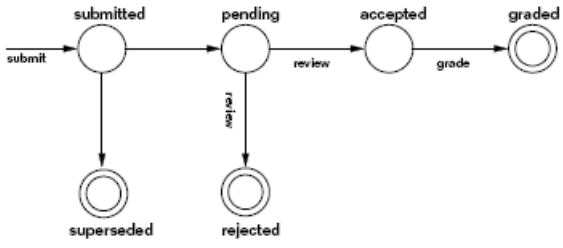

Fig.6: Transition Diagram [4].

1. Possible states during the submission period;

students are allowed to resubmit another version:

- Submitted: An answer is sent by the student, but it may be time-waited for later submission. This is the initial state of an assignment.
- Superseded: This state is generated if the student has submitted another version of assignment.

2. Possible states during the assessment process; students are no longer allowed to submit another version:

- Pending State: The assignment is undergoing through the review.
- Accepted State: After completion of review, assignment has been accepted.
- Graded State: The solution has been reviewed,
- Rejected State: The assignment has been undergone through review process and has been finally rejected.

4. RESULTS AND DISCUSSION.

Following are the main objectives of an e-Assessment sys- tem.

1. Create an environment where students can submit their programming assignments and receive appropriate feedback on areas for improvement.
2. Support the submission of test cases along with an implementation file fostering the use of test driven development in classrooms.
3. Create a wizard-based user interface for students to carry out tasks such as submitting an assignment and viewing reports for already submitted assignments.
4. Enhance the user interface so that it will provide additional functionality for instructors and teaching assistants for conducting computer science courses.
5. With the help of the system, instructors will be able to create the assignments, prepare student's score files and maintain their rosters.
6. Support the automatic evaluation of programming assignments.
7. Evaluate the use of this system in a classroom environment using student grades, surveys of student and direct measurement of performance on authentic testing tasks.

4.1 Expected Outcome.

An E-Assessment system should give an immediate feedback to the assignments submitted by the students For example, in the system, if student submits program of Fibonacci numbers in the Haskell programming language. When the particular function, suppose 'fib' is called with value of n=8, the expected answer would be 21 but if suppose system received is 21.So the system should automatically give feedback for it.
ECAutoAssessmentBox in the system automatically tests submissions to programming exercises and immediately offers feedback. Also an E-Assessment system must be able to compare the assignment submitted by various individuals. In short it should give automatic feedback for the student's submitted assignments. Proposed system should also effective at capturing following types of activities.

1. It should allow teacher to create Assignments at server side.
2. It should allow students to log-in.
3. It should allow students to view assignments after successfully log-in.
4. It should allow student to submit the assignments.
5. It should give automatic feedback for each submitted assignments.

5. FUTURE WORK

The functionality of system should be extended so that we can maintain the log for tracking student's submission activity in the situation where large no of students are assembled together for the tests. This would simplify data mining process to track students working behavior. Moreover, this system could be designed in such a way so that while solving objective test, questions could be available in random manner instead of sequential approach.

6. CONCLUSION

This paper reports a novel service oriented approach for schematic E-Assessment system. E-Assessment is the process by which study materials, MCQ tests, programming assignments are made available to the

learners and also evaluate and assess the test attempted by the learners. This whole functionality is encapsulated as a service. In this service-oriented architecture, all common aspects related to the assessment e.g., submission, storage, and result reporting are encapsulated as a web service. Only the specific concerns related to the testing itself e.g., for programming tasks: which programming language is used also the details of interpreter or compiler and test method etc. are realized as full fledged web site so called backends[4]. We just go on referring the service through our website via SOAP protocol which is performing the role of mediator. In short, this system works on principles of automatic testing [9].

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