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AN AGENT-BASED ADAPTIVE E-CONTENT AND E-LEARNING ARCHITECTURE DESIGN AND IMPLEMENTATION

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ABSTRACT

Individual students have different approaches towards learning because of different background knowledge, learning styles and preferences. Therefore, it is difficult for instructors to understand their student best learning approach. Furthermore, web application based on multi-agents for adaptive E-Content has been proposed to assist student individualized learning content in order to enhance their learning outcome. Existing systems normally utilize the main techniques of programming scripts and hierarchical course structure to support adaptive Electronic-Learning (E-Learning) course authoring for diverse category of students. These systems need instructor to obligate significant technical skills, and additionally to employ theories of learning styles, which are challenging requirements. To facilitate instructor to contribute in authoring adaptive E-Learning courses, we have designed web application architecture for administrator, assessor/instructor, and student. Three agents namely the exam agent, message agent and E-Content agent have been created to assist instructor and student. We designed the proposed architecture to be implemented for an online adaptive E-Content and E-Learning system. In addition, we conducted user studies to evaluate the effectiveness of the system.

Keywords: *Agent-based, Adaptive E-Content, E-Learning, Instructor, Student*

1. INTRODUCTION

Traditional learning, which is learning in classroom deliver the same information to all student, since the learning material has to be conveyed to students at the same time. Thus the need to improve learning process has been focused in recent years. E-Learning is a learning system that is focused on user interaction and modeling the learning process in web application [1, 2]. E-Learning systems have become a major requirement among many organizations applied in Learning Management Systems (LMS), Virtual Universities, and online learning, with a complex design in terms of communications among different people or organizations with dissimilar goals, intentions and the potential for the occurrences of conflicts [1, 2] Adaptive E-Content refers to learning materials and activities that changes according to the student needs and achievement [3]. Multi-Agent technique is an effective way to design complex systems. This technology handles each part of the system by utilizing separate agent for each part of the system, which makes it suitable for E-Learning systems [1, 3].

Nowadays E-Learning becomes a major requirement among many organizations to use under many goals, thus in the recent years many E-Learning system has been developed to satisfy these needs. However, most of these systems are unable to organize and present learning material in a flexible way, because of student differences in the learning background, learning ability, and the preferred learning style [1, 2, 4]. Adaptive E-Learning systems improve the learning process by providing adaptive E-Content to satisfy the learner needs [3]. Many researchers have cited about the complex design of those systems [1, 2, 4]. Those systems need to be adaptive, collaborative, standardized, etc. [5]. Until now many research succeeded in reducing the complexity of E-Learning systems by using multi-agent technology, intelligent algorithms, and fuzzy logic. Those systems monitor the students' behavior, for example learning style and learning outcome, then try to adapt the E-Content for the student. The problem with current systems is the content

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adaptation, which is not efficient enough to fulfill the learners' needs. This is because in some system the adaptation process depends on certain period of time for instance, adaptation is performed just after the exam. In other systems, adaptation of the content depends on a pre-stored content in the database which makes the adaptation limited to the database.

Content adaptation is one of the major factors that determine the successfulness of the system. Therefore it is important to have an adaptation method to ensure that the system will adapt to the student needs. The method could be used by learning systems to enhance the adaptation. This research focuses on the adaptive for the E-Content for the student in the current semester as well as for student in the further semester. However, adaptation has formally been evaluated on the usability dimensions in E-Learning systems thus, it needs to be improved, especially the E-Content adaptation. The problem with the current systems is that they are not given fully adaptive solution. For example, some system provide adaptation for the student in the next semester [1, 3, 5], other systems provide adaptation based on predefined methods which made the adaptation limited to those methods [6, 7, 8, 9].

This research study is essential due to a comprehensive need for different system users consisting of adaptive E-Content materials for E-Learning with the help of agents. This concept has been applied by [1, 13]. Furthermore, this study provides additional documents in the form of course, semester statistics and message management, which have been utilized by [12]. Combining the features of these researches, our research work offer a complete E-Content features for E-Learning which is improved from [1, 7, 9, 8, 10, 11, 12, 13].

This paper is organized into seven parts. The second part explains about the researches that are related to our research work. The third part describes about the research methodology. This is followed by the fourth part, which is the design of the architecture. Part five is the implementation of the proposed architecture. Next, part six is the evaluation and discussion of the system. Lastly, part seven is the conclusion and future works.

2. RELATED RESEARCH

This part explains about three important topics. First, an overview of multi-agent adaptive E-Learning architectures based on multi-agent technology. Second are approaches of adaptive E-Content in E-Learning architectures, and finally make comparison between our proposed architecture and the existing architectures.

2.1 Overview of Adaptive E-Learning Architectures based on Multi-Agent Technology

This overview explains about existing models as follows:

2.1.1 Web Application Architecture for Adaptive E-Learning System

A hierarchy for E-Learning system has been developed [1] as shown in Figure 1. This hierarchy consists of two levels: Interface Level and Interaction Level. Interface level consists of Author Interface Agent, and Learner Interface Agent. Interaction Level is composed of Domain Teaching Material, Profile Data Base, and Learning Assessment Agent. All of those Agents are communicate over Agent Blackboard. The development in the E-Content in their system depend on measuring the Student Learning Outcome (SLO) after the exam at the end of the semester, and send a report to the assessor to decide if there is need to develop the E-Content. Their system succeeded to providing a multi-agent platform with an opportunity to develop the E-Content for the student in the next semester, but their system does not provide an adaptive content for the student in the current semester.

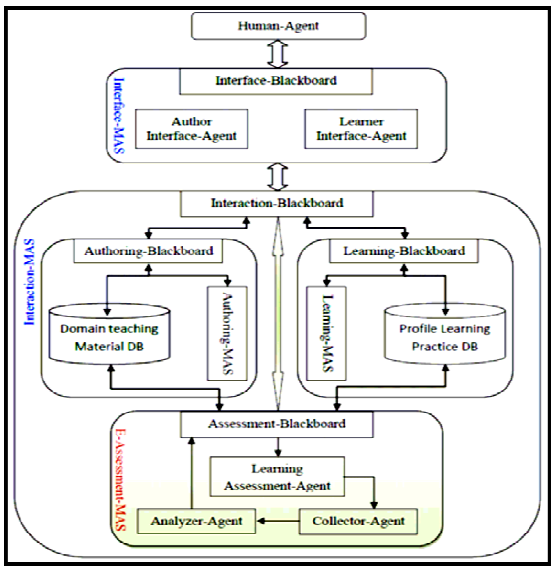

Figure 1: Salah Hammami and Hassan Mathkour Application [1] Architecture

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2.1.2 Utilizing Competency Based Ontology and Agents as an Adaptive Approach to Assist Students in E-Learning Systems

A Learning Management System (LMS) which depend on modeling the student skill through a multi-agent and adapt the E-Content according to the modeling database has been developed [6]. The flow of their system, the teacher defines the activity and providing the skill under each activity, when the student login, the system will execute activities, and the student interaction will be updated to modeling database by activity agent. According to the modeling database the system will adapt to the E-Content. Their system has succeeded in providing an adaptive E-Content system, but their system does not provide a feedback to the teacher to know how the student interacts with the activities to determine if activity needs to be modified.

2.1.3 Framework of Intelligent Tutoring System based on Multi-Agent for E-Learning

A system has been proposed consisting of three main components: Database (DB) for student model (Cognitive ability, learning style, and learning path), E-Learning Curriculum Creation Model which consist of (Examination Item DB, courseware DB), and a multi-agent to control those Databases [7]. The E-Learning Courseware Agent has an interface to interact with the learner. This agent also cooperates with E-Learning Activity Data Collection Agent (EADCA). EADCA collect the student activity from the student model database. After the student finished one course, the E-Learning Examination Agent issue a suitable exam from the examination item DB. After the exam, this agent will calculate learning ability for this student using fuzzy logic, store the approximated value in the reasoning ability database, and notify the adaptive courseware recommendation agent to suggest adaptive learning courseware for personalized students. This system succeeded in adopting E-Learning based on predefined coursework. This work did not include an interaction between the learner and the instructor, also did not include a feedback to the instructor to determine if more E-Content is needed. This framework is shown in Figure 2.

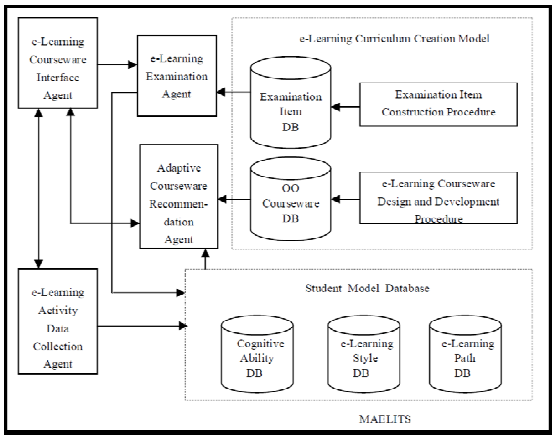

Figure 2: Xu Daomin [7] Framework

2.1.4 Design of an Intelligent Multi-Agent System for Supporting Collaborative Learning

A support model for a collaborative E-Learning has been proposed [8]. Their work consists of two stages: recognition stage, and reaction stage. In the first stage, the system receives the learner activity such as messages, collaboration on forums and the shared document by the learner and stores these activities in the learners profile for analysis. In stage 2, the system determines the recommendation for learner in order to improve the learner collaboration. The authors have developed seven layers repository to link between the previous stages. This repository depends on fuzzy logic to determine in which way they can increase the learner collaboration. Their system succeeded to provide an adaptive E-Content to enhance the student to collaborate. However, their system does not provide a development for the E-Content which is provided by the instructor.

2.1.5 Model of E-Learning System with Intelligent Agent

A system consisting of three main agent, Adviser Agent, Personalization Agent, and Content Managing Agent to provide a suggestion of the E-Content has been designed [9]. Their system start with a student login, once the student log in, the system provides a test the result of the test will passed to the advisor agent, based on this mark the advisor agent suggest content for the learner. The content management agent observes the learner, to understand the level of the learner at the similar time the Personalization Agent observes the student learning style where the two observations helps to

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give a better suggestion of the content. Their system provides an adaptive content for the learner, but their approach is depend totally on the system to determine the needed of adaptation which make their system poor in terms of interaction and feedback between the learner and assessors. The workflow of the model is shown in Figure 3.

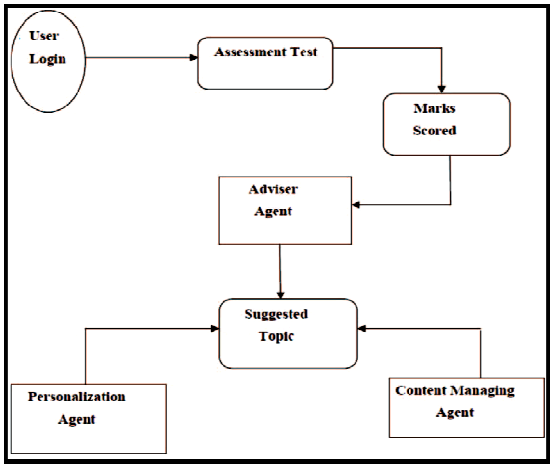

Figure 3: E-Learning System with Intelligent Agent Workflow

2.2 Approaches of Adaptive E-Content in E-Learning Systems

The adaptive in E-Content in E- learning systems is achieved by:

i. Assessor Controlled: in this way the system send student learning outcome report to the assessor, and the assessor adapt the content depend on the report [1, 11, 12, 13].
ii. Database Controlled: the assessor insert for each course many level for example course 1 level 1,2 and 3, course 3 level 1,2 and 3, and so on.

When the student login to the system, it initialize a new quiz to select the student level. Depending the student level the, system will show the suitable course for the student [2, 6, 7, 9, 10].

2.3 Proposed Architecture

Our proposed solution will consist of three main agents, and agents interface. The proposed agents are:

i. Exam agent will issue an exam from the exam DB. The exam will be issued after each lesson or depending on instructor request. After the exam, the message agent will send the student result to the instructor to determine if more content is needed to be added. If more content needed, the instructor can send this content by message to all students or to specific students.
ii. Message agent will increase the interaction between the learner and the instructor. This agent will allow the instructor to send messages, extra material, and quizzes. This agent will allow the student to request extra content, and questions from the instructor or from other students.
iii. E-Content agent will take the extra material from the instructor message and add this content as extra material for specific lessons, so the student in the next semester will view this content as supported documents.
iv. Agents Interface will show the agents messages to the user system admins, assessors, and students.

Through those agents user can get an adaptive content all time for current and next semester student and, we will get a two direction feedback student instructor, and instructor student.

2.4 Comparison between Proposed Achitecture and Existing Architecture

The comparison between our proposed model and the existing model is explained in Table 1. The comparison is made by:

i. Using the agents for administrators
ii. Using the agents for assessors
iii. Using the agents for students
iv. Providing each course statistics
v. Providing each semester statistics
vi. Message management
vii. Represent the agent like human embedded system

3. RESEARCH METHODOLOGY

Our research methodology consists of a few steps. First, we need to analyze the existing system in order to obtain the important features from those systems. Second, design three level platforms each platform for certain type of user administrators, assessors, and students. Third, design agents interface to facilitate the communication between the agents. Forth, design the proposed agents exam agent, message agent and E-Content agent. These steps will produce our model design. To implement our design, first we start with syncing the existing

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feature. Second, implement the three level platforms. Third, implement the agent interface. Fourth implement the agent namely the exam agent, message agent and E-Content agent. Finally, the E-Content Model is produced. The described steps are shown in Figure 4.

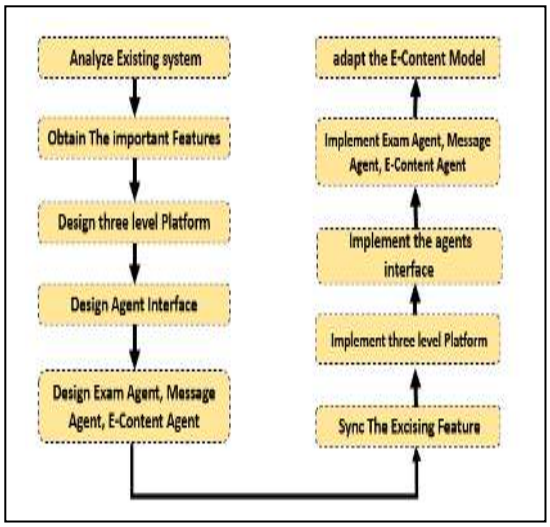

Figure 4: Research Methodology

4. ARCHITECTURE DESIGN

We will implement the three tier architecture in our system. The explanation of the design is as follows:

4.1 System Architecture

The system architecture is shown in Figure 5, this architecture consist of:

i. Three different types of user system administrators, Assessors, and Students.
ii. Authentication interface this layer is reasonable for user login and user permissions.
iii. Authentication interface will control the authentication and authorization for each user.
iv. Exam agent will issue an exam from the exam DB. The exam will be issued after each lesson or depending on instructor request. When the exam complete, the message agent will send the student result to the instructor to determine if more content is needed to be added. If more content needed, the instructor can send this content by message to all students or to specific students.
v. Message agent will increase the interaction between the learner and the instructor this agent will allow the instructor to send messages, extra material, and quizzes to the student and this agent will allow the student to request extra content, and questions from the instructor or form other students.
vi. E-Content agent will take the extra material from the instructor message and add this content as extra material for specific lessons, for the student in the next semester to view.
vii. Authentication layer for facilitate agents communicate with databases.
viii. Agent interface to view the agents' messages.

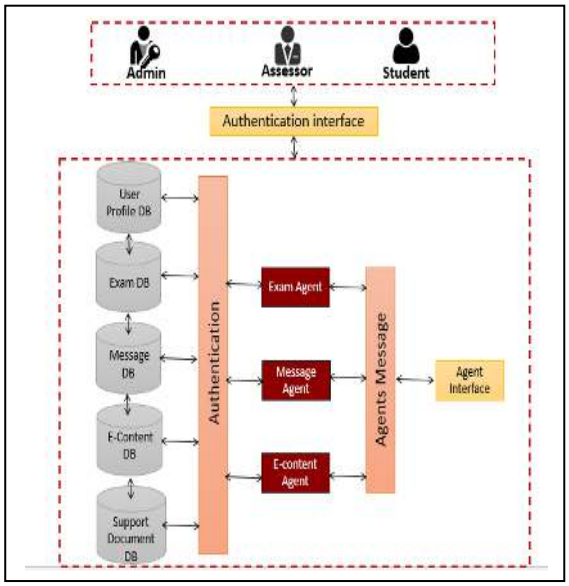

Figure 5: System Architecture

4.2 Activity Diagram

The process starts when the student selects a course. The E-Content agent send get course details request to the web server. The web server returns the result to the agent, the agent send the course details to the student.

After the student view the course, quiz request is sent to exam agent. The agent sends two request to the web server:

i. Save the course time.
ii. Get course quiz.

The web server save the course time and notify the course agent to update course report, and get the quiz for exam DB and send it to the exam agent, then exam agent will start the exam.

When the student submits the answer, the exam agent send two request to the web server:

i. Saving exam time.

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ii. Calculating exam result.

The server will calculate the result and notify The E-Content agent to update the course report. Then send the result to the exam agent to show the result to the student. This process is shown in Figure 6.

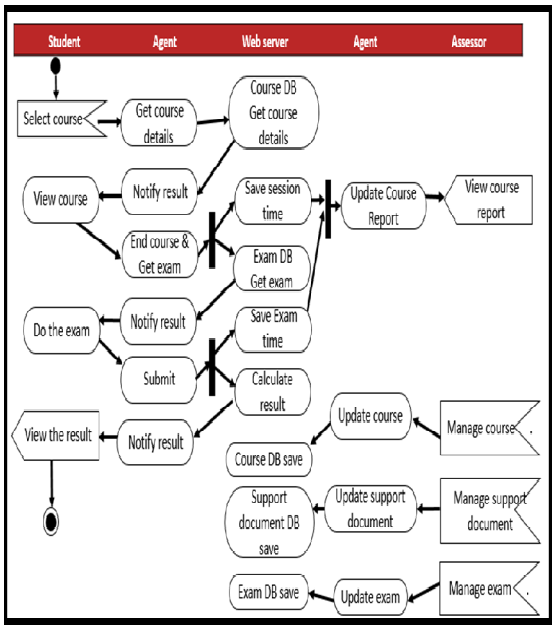

Figure 6: Activity Diagram

4.3 Class Diagram

To achieve proposed architecture in our system we need to conduct:

4.3.1 System Class Architecture

The proposed class architecture is shown in Figure 7. The classes that are created for the system are:

i. User. Which can be system administrator, assessor, student user can be differentiate using "user type" attribute.

ii. Courses. This class responsible to differentiate between courses, this class is related with:
- Users Class. This relation is responsible to give the right course for each user.
- Course Details. This map the class with its lesson.

iii. Course Details This class will contain the details for each course, This class is related with:
- Support Document: for each lesson.
- Question: each lesson quiz.
- Result: quiz result.

iv. Messages which will handle the message between the system admin assessors and student.

v. Student Mark which will be reasonable for student mark report.

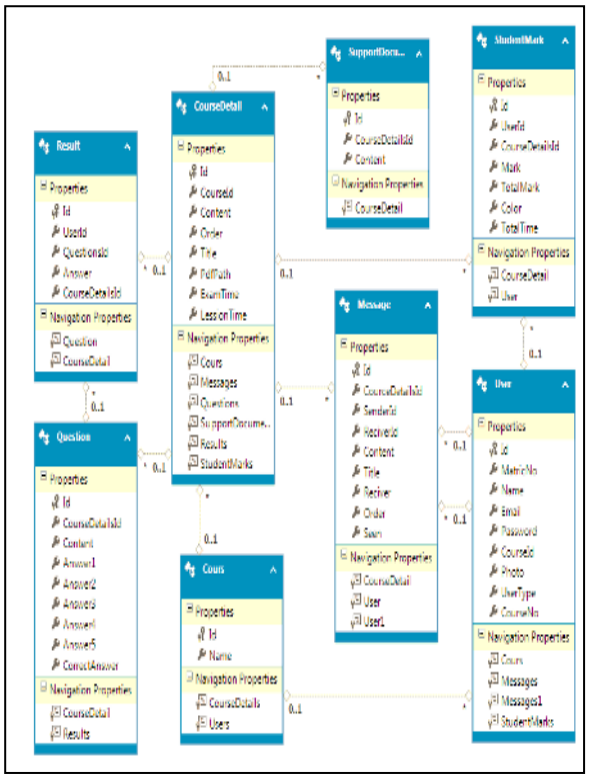

Figure 7: Class Diagram

4.3.2 Classes Functionality

Each class that is shown in Figure 8 has four main functions:

i. Fetch all the records from the database "GetALL".

ii. Fetch the record by its id "GetByid".

iii. Save / Update "Save".

iv. Delete the record "Delete".

We implement a base class that contains those functionality and make the other classes (User, Cource, CourseDetails, Question, Result, Support Document, student mark and messages) inherit form the base class.

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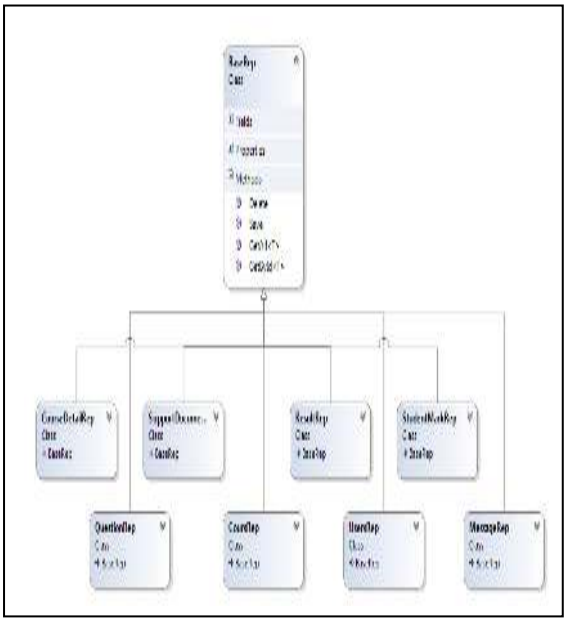

Figure 8: Functionality Class Diagram

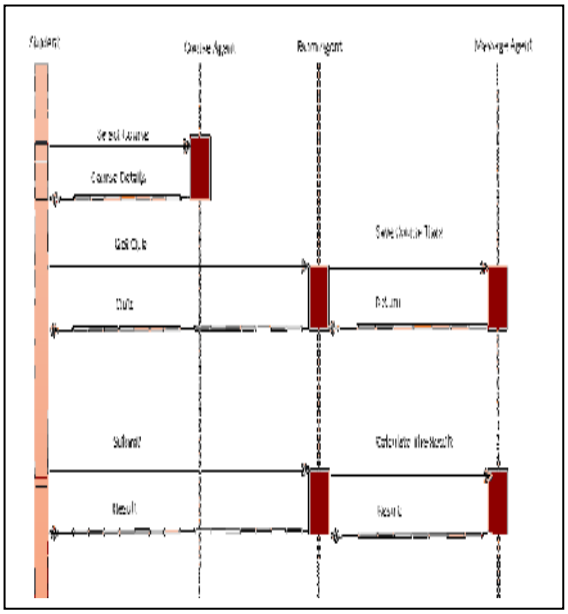

Figure 9: Sequence Diagram

4.3.3 Sequence Diagram

The steps in sequence diagram are as follows:

- Student send Select course to course agent. The course agent will get the course details and send the result to the student.
- Student send quiz request to exam agent. The exam agent send save course time to the message agent and get the exam for that course then send it back to the student.
- When student submit his answer to the exam agent. The exam agent will send the answer to the E-Content agent. The E-Content agent will calculate the result and send it back to the exam agent. The exam agent will send the result to the student.

The steps is illustrated Figure 9.

5. IMPLEMENTATION

The system starts with a login page as shown in Figure 10.

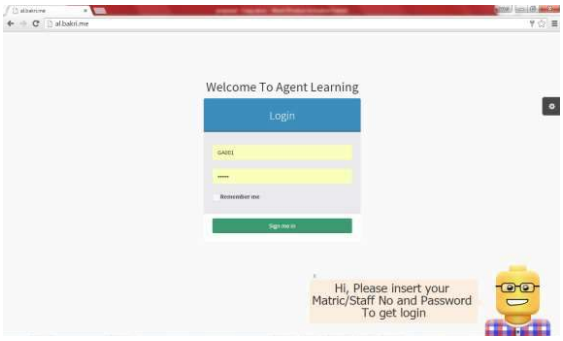

Figure 10: Login Screen

The agent will show a welcome screen and ask the user to input matric number or staff number, and password. When the user input his matric/staff number, and the correct password the system will redirect him to a control panel.

5.1 Administrator Simulation

The first screen that will be shown to the administrator is the report screen as in Figure 11. The report will tell the administrator how many system administrator, assessors, and students are engaged to the system, and will show how many courses exist in the system.

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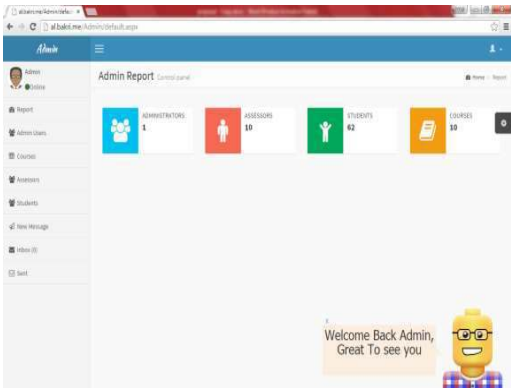

Figure 11: Administrator Report Screen

When the administrator press admin user link, the system will redirect him to the administrator user management page as in Figure 12.

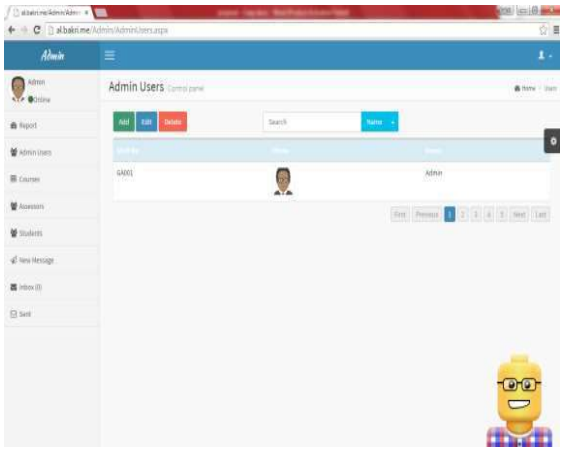

Figure 12: Administrator User Management Page

Administrator user from this page can view, add, edit, and delete administrator users. When the administrator press courses link, the system will redirect him to the courses management page as in Figure 13.

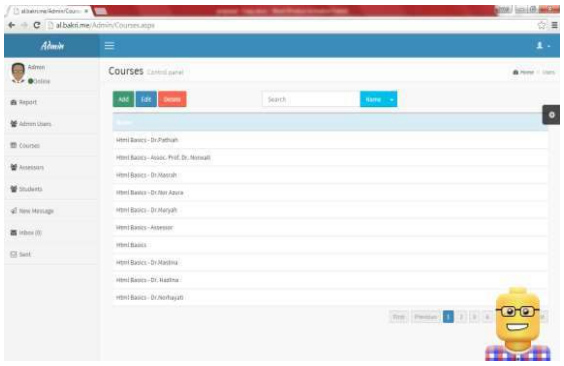

Figure 12: Administrator User Management Page

The administrator from this page can view, add, edit, and delete courses. When the administrator set the mouse over one course the agent will show the course statistic as in Figure 14.

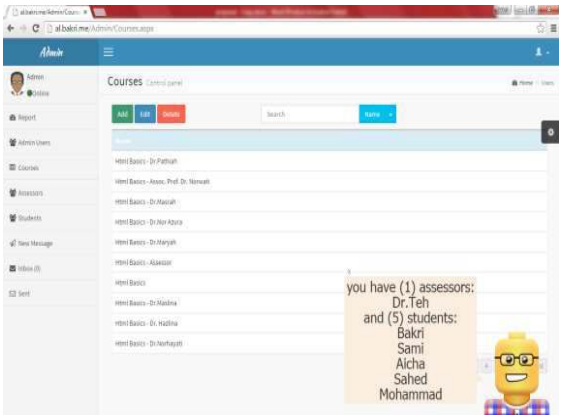

Figure 14: Course Statistics Screen

An agent will show the administrator, assessors and students who are engaged with this course. When the administrator clicks on the assessor link, the system will redirect him to assessor management page as Figure 15.

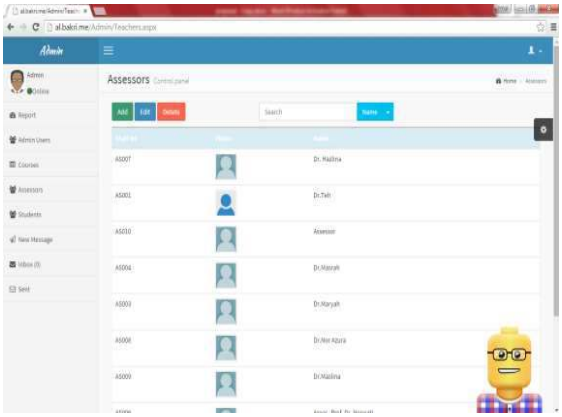

Figure 15: Assessor Management Page

The administrator user from this page can view, add, edit, and delete assessors. When the administrator press students link, the system will redirect to the Student management page as in Figure 16.

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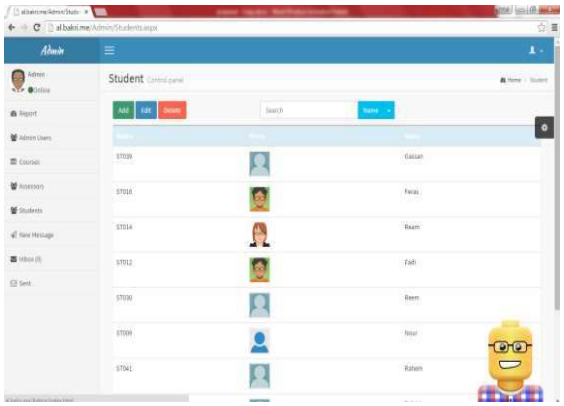

Figure 16: Student Management Page

Administrators from this page can view, add, edit, and delete assessors. When the administrator press new message link, the system will redirect him to new message page as in Figure 17.

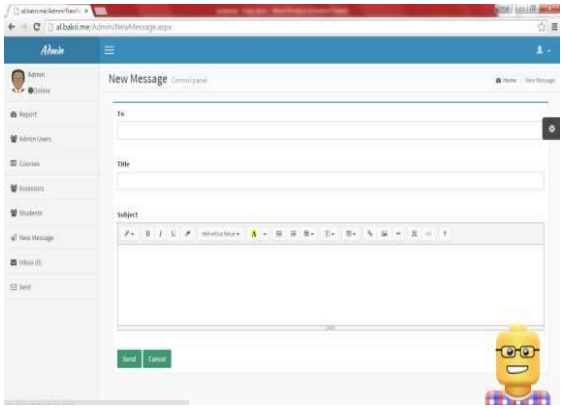

Figure 17: New Message Page

The administrator from message inbox page can view the received message. The message inbox page is shown in Figure 18.

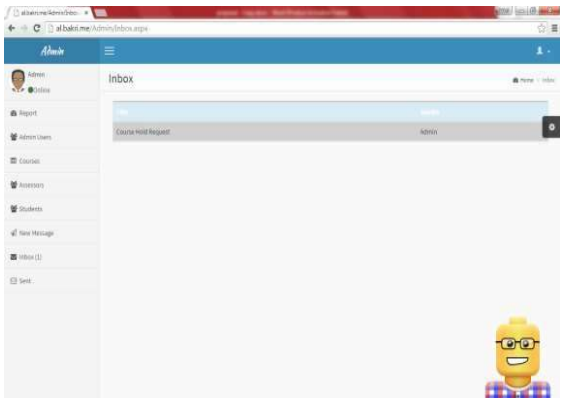

Figure 18: Message Inbox Page

The administrator from message sent page can view the view sent message. Message sent page shown in Figure 19.

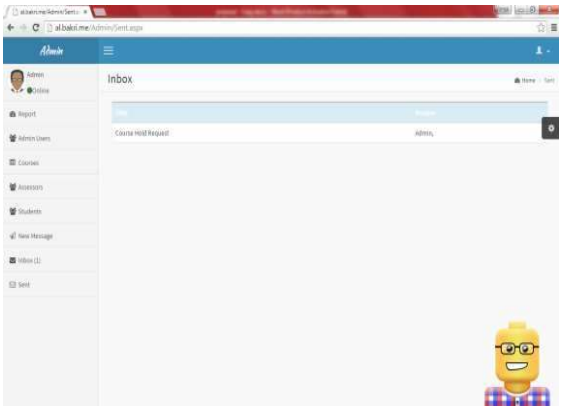

Figure 19: Message Sent Page

5.2 Assessor Simulation

The first screen that will be displayed is the report screen when the assessor login, as shown in Figure 20.

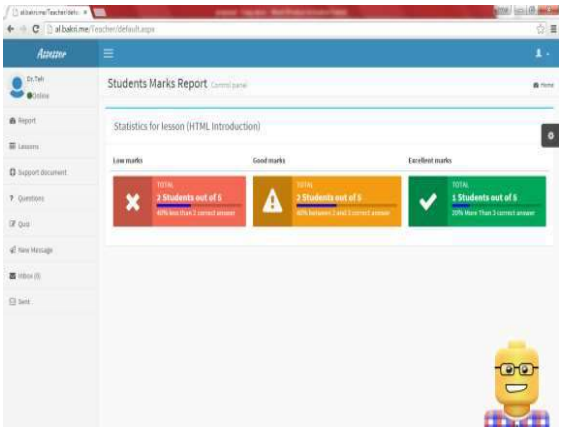

Figure 20: Assessor Report

The report will show the assessor how many student get low, good, and excellent mark for each course when the assessor set the courser over one report box the agent will give more explanation to the assessor as in Figure 21.

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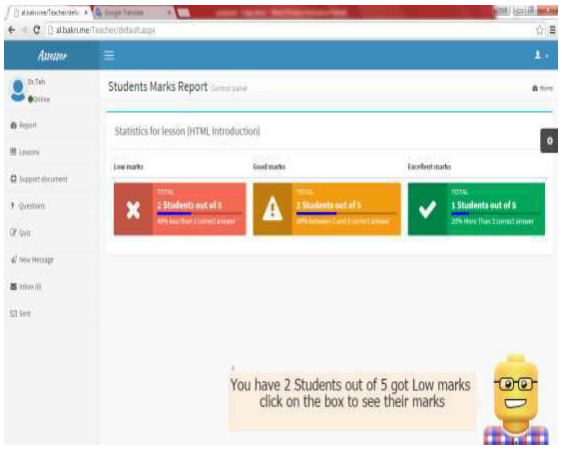

Figure 21: Assessor Report Explanation

When the assessor clicks on the box, the system will redirect to the statistic details as in Figure 22.

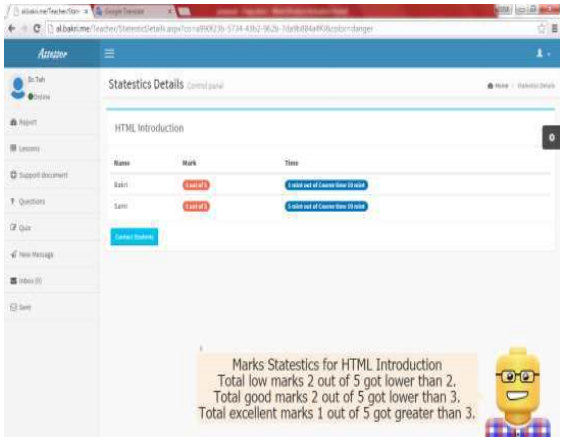

Figure 22: Assessor Statistic Details

Assessor statistic details page will show the assessor the names, marks and the total time that has been spent for that course. The agent will show the administrator the summary of report for the specific course and the system will allow the assessor to send message to the current student. When the assessor clicks on lesson link the system will redirect him to lesson management page as shown in Figure 23.

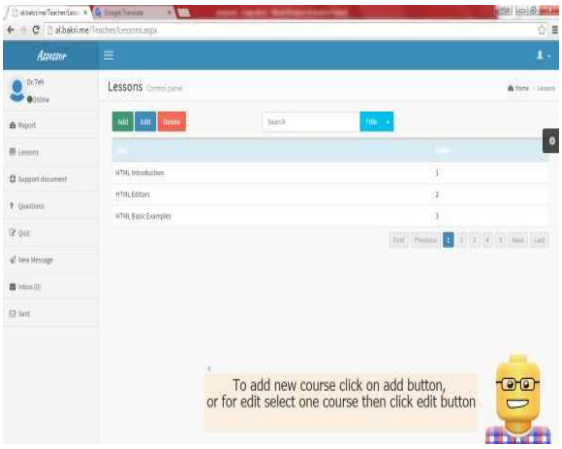

Figure 23: Lesson Management Page

When the assessor move the mouse over one course agent will show the lesson time and exam time for this lesson as in Figure 24.

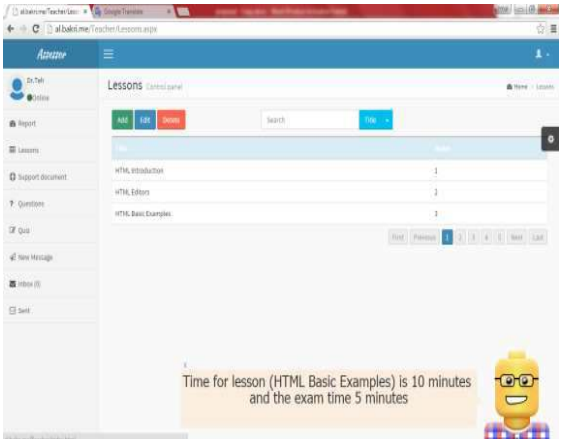

Figure 24: Lesson Management Agent Hint

When assessor clicks on support document the system will redirect him to support document management page as shown in Figure 25. The agent will show the assessor the statistic for selected lesson. The assessor can view, add, edit, and delete support document for any lesson from this page. When the assessor clicks on questions page the system will redirect him to question management page.

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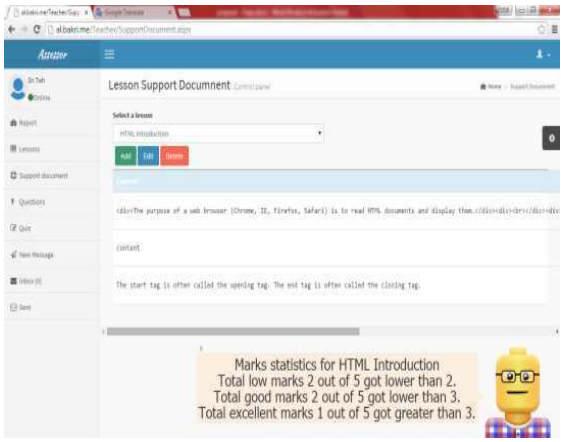

Figure 25: Support Document Management

Assessors from question management page that is shown in Figure 26 can view, add, edit, and delete questions for any course. The agent will show exam time that has been set for the selected lesson. When the assessor clicks on quiz the system will redirect him to quiz management page.

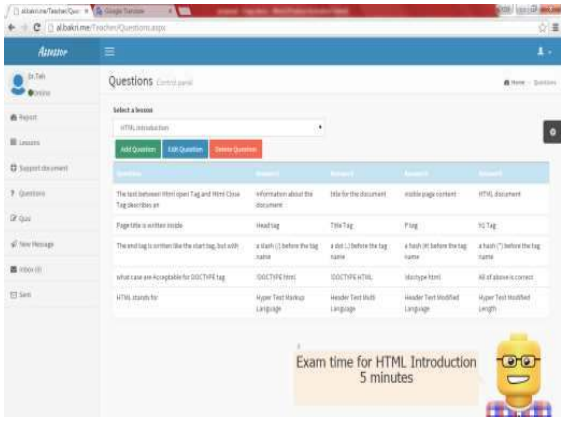

Figure 26: Question Management Page

Assessor can view, insert, edit, delete quizzes form quiz management page in Figure 27, and select to send a quiz for particular students or for all students. When the assessor clicks on new message the system will redirect him to new message page.

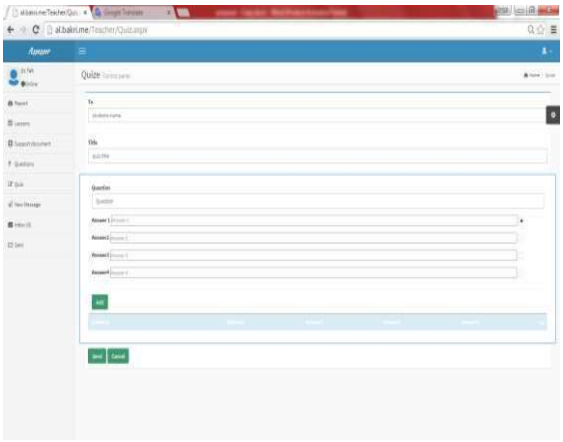

Figure 27: Quiz Management Page

Assessors from new message page in figure 28 can send new message to the administrators or to the students as well. Assessors also can choose whether they want to add this message as support document under any course.

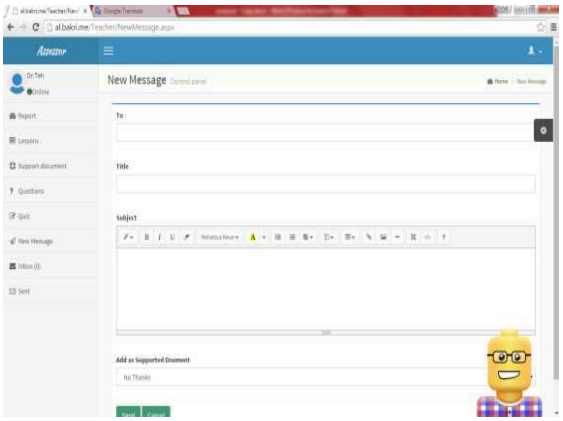

Figure 28: Assessor New Message

The assessor from message inbox page can view the received message page as shown in Figure 29.

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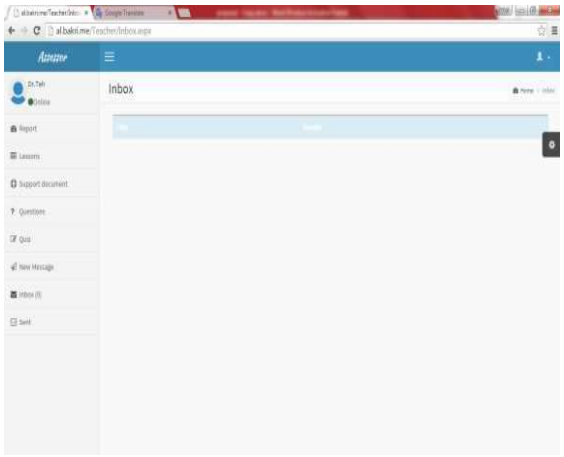

Figure 29: Assessor Message Inbox

The assessor from message sent page can view the view sent message. Message sent page shown in Figure 30.

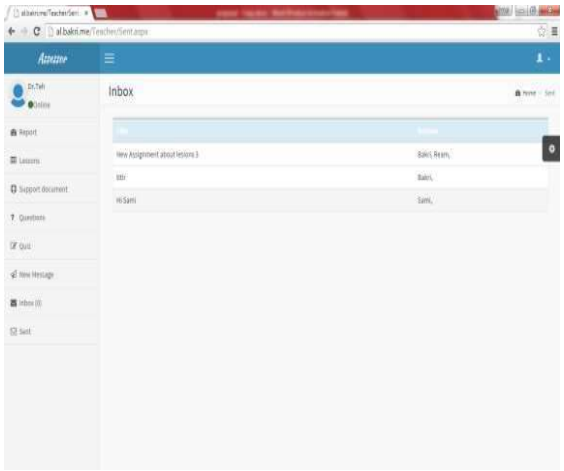

Figure 30: Assessor Message Sent Box

5.3 Student Simulation

The first screen displayed when the student login the system will be lesson list page as Figure 31. Agent shows the student his last lesson performance, and gives him some suggestion.

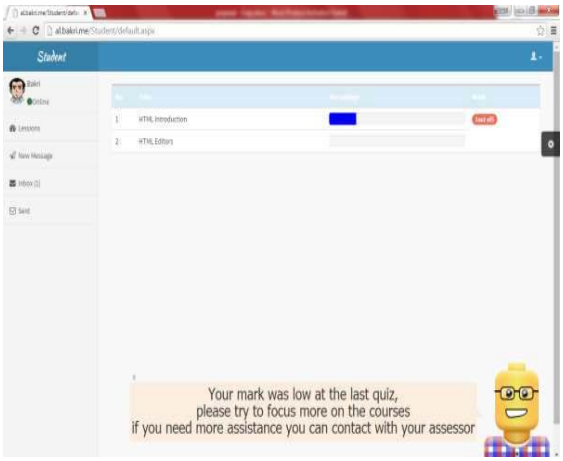

Figure 31: Lesson List Page

When the student clicks on lesson the system will redirect him to lesson detail page as in Figure 32. The student can view the course and can any time send message to the assessor. When the student clicks on next the system will redirect him to the exam page.

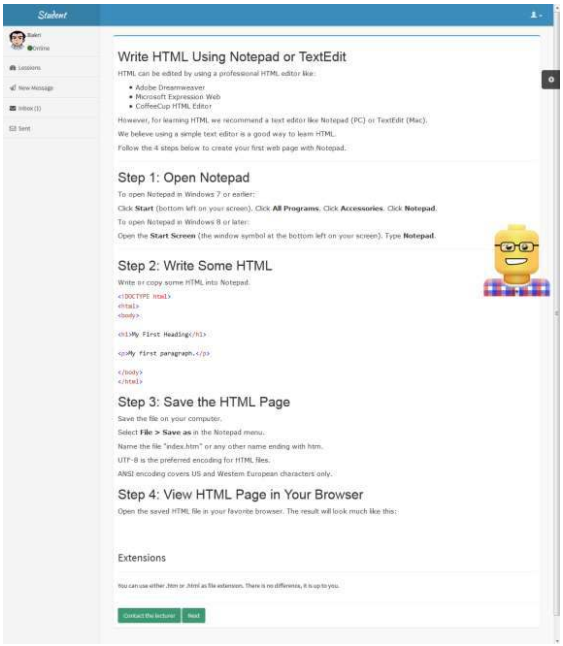

Figure 32: Lesson Details Page

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In the exam page as shown in Figure 33, the agent will show remaining time for the quiz, and when the remaining time become 2 minutes the agent will show different message to notify student about remaining time. When student submit his answer the system will display his mark and redirect him back to lesson list page. When the student click on new message link the system will redirect him to new message page.

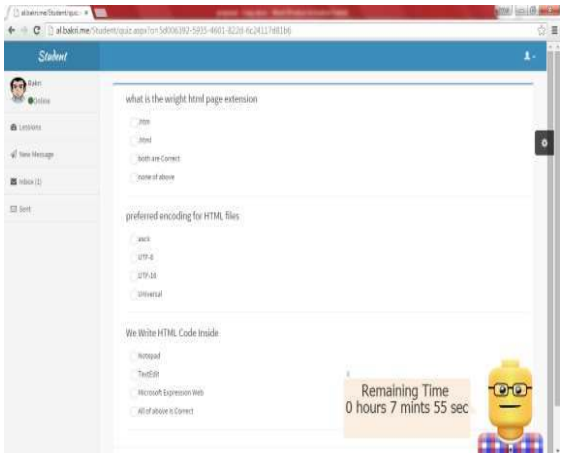

Figure 33: Exam Page

Students from new message page can send new message to the administrators, assessors or to other students. New message page is shown in Figure 34.

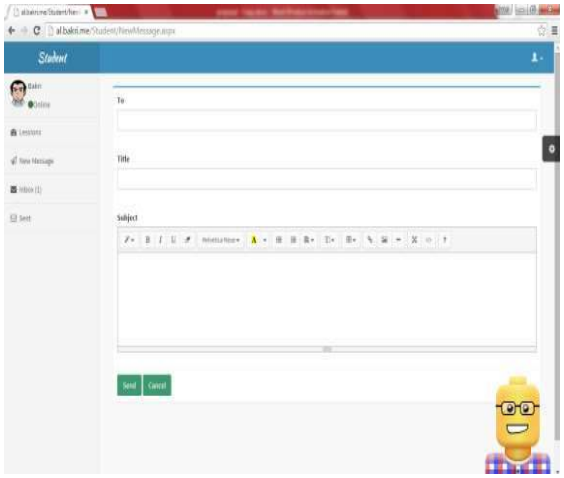

Figure 34: Student New Message

The student from message inbox page can view the received message. The message inbox page is shown in Figure 35.

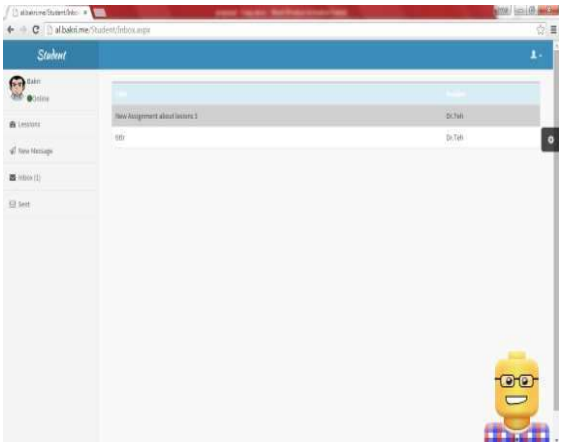

Figure 35: Student Message Inbox

The student from message sent page can view the view sent message. Message sent page shown in Figure 36.

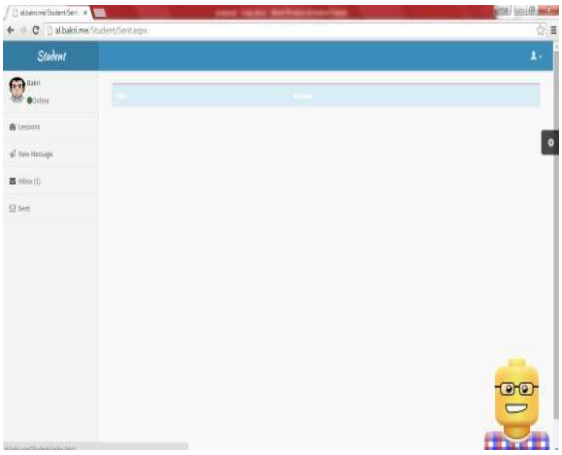

Figure 36: Student Message Sent Box

6. EVALUATION AND DISCUSSION

For the evaluation, we have distributed three questionnaires to evaluate the system usability and efficacy and target the three users: system administrators, assessors and students.

6.1 System Administrators Evaluation

The admin survey is shown in Figure 37. The summary of the survey:

i. Majority of respondents was male.
ii. Their ages 20-40.
iii. All of them familiar with E-Learning system.
iv. Three out of five respondents are using the E-Learning systems frequently.
v. Majority of respondents like the interface design.

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vi. Majority of respondents find the system is very easy to use.
vii. Three out of five respondent like the proposed agent.
viii. Almost all the respondents would like to use E-learning system with agent.
ix. Total respondents like find the provided report is enough.

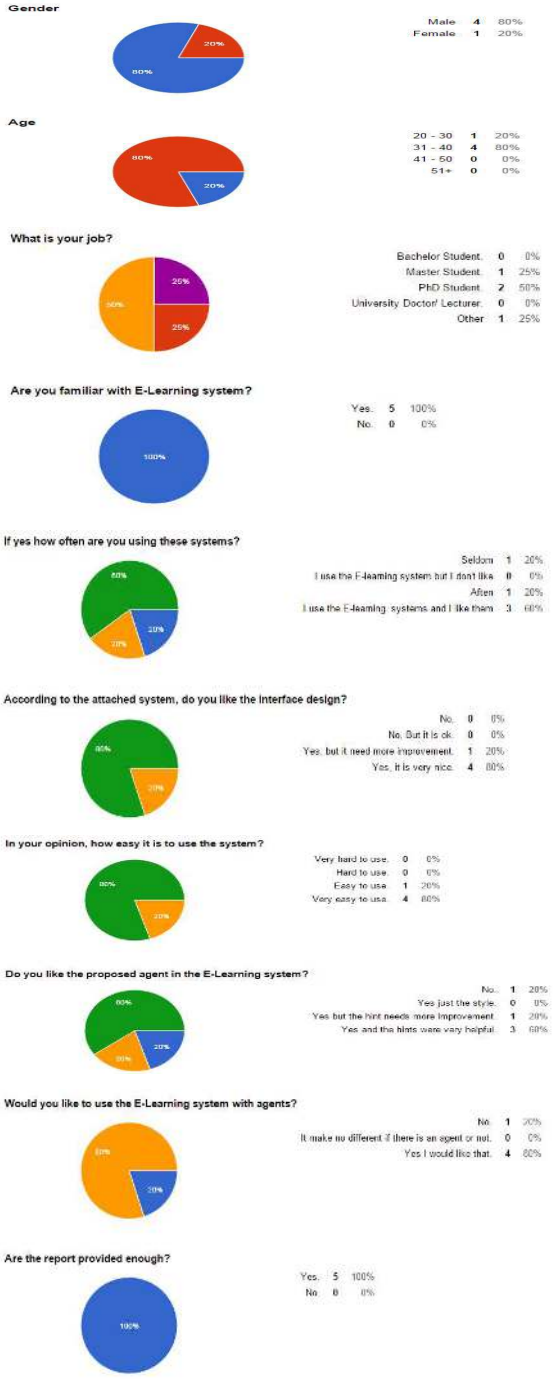

Figure 37: System Administration Evaluations

6.2 Assessors Evaluation

The assessor survey is shown in Figure 38. The summary of the survey:
i. Total respondents was female.
ii. Their ages 31-50.
iii. They are totally university lecturer.
iv. All of them familiar with E-Learning system.
v. Majority of respondents like the interface design.
vi. Majority of respondents find the system is very easy to use.
vii. Three out of six respondent like the proposed agent.
viii. All of respondents would like to use E-learning system with agent.
ix. Majority of respondents find the provided statistics are helpful.
x. Total respondents like find the provided report is enough.

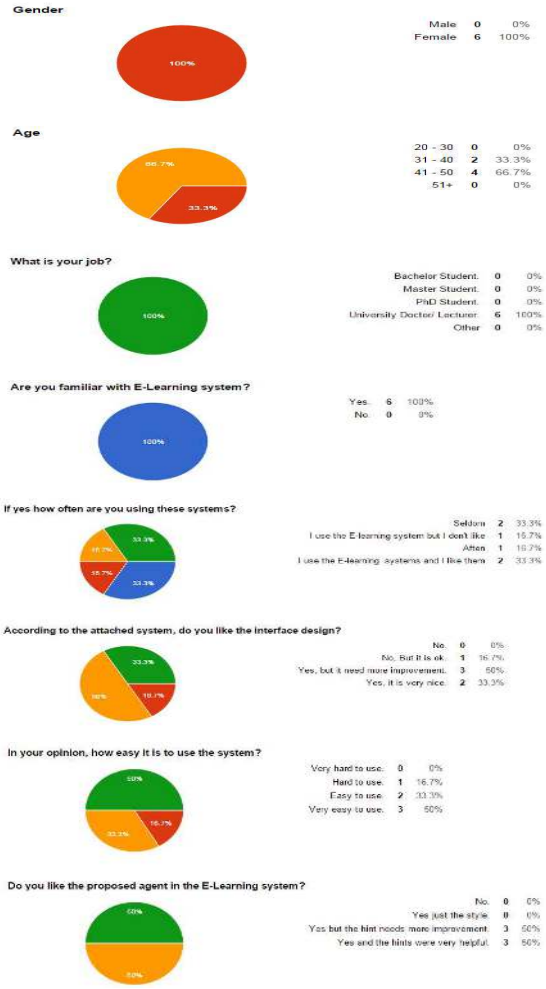

Figure 38: Assessor Evaluation
(continue next page)

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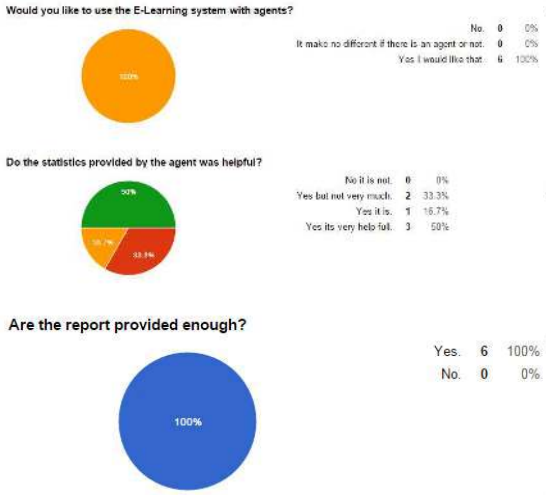

Figure 38: Assessor Evaluation (continue from next page)

6.3 Students Evaluation

The student survey shown in Figure 39, th summary of the survey:

i. Seventy five percent of respondence were male.
ii. Their ages 20-40.
iii. They are totally master students.
iv. Majority of respondents familiar with E Learning system.
v. Majority of respondents like the interface design.
vi. Majority of respondents find the system is ver easy to use.
vii. Majority of respondents like the propose agent.
viii. All of respondents would like to use E-learnin system with agent.
ix. Majority of respondents find the quizzes ar helpful.
x. Total of respondents like the agent notifications.

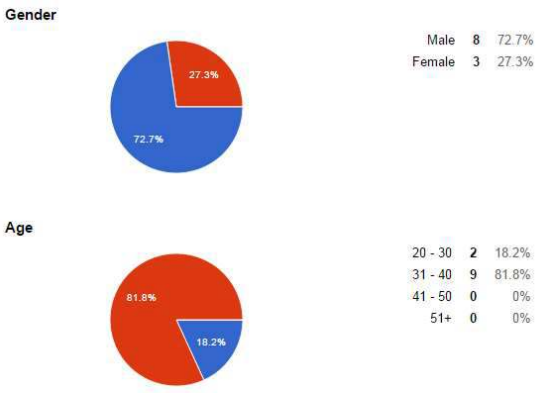

Figure 39: Students Evaluation (continue)

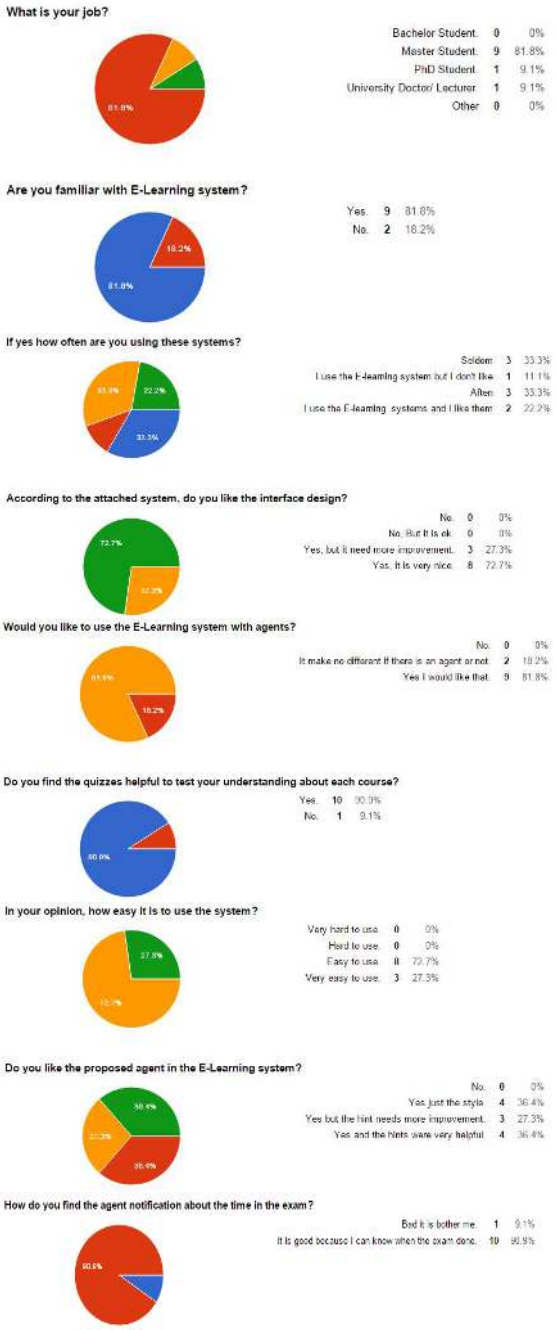

Figure 39: Students Evaluation (continued)

6.

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6.4 Discussion

Using the questionnaires we evaluated the usability and efficacy of the system. Form over 8 female and 10 male with age majority of 30-40 evaluator. The evaluators were familiar with E-Learning system. They have voted that our system is usable and easy to use. The fact that software agent lead us to such as this result because this technology facilitate the user to work in user friendly way. Agents give hints and suggestion to the users to what to do next. We found out that the evaluators voted that they like to use the systems with the help of software agents. From the survey result we can conclude that our model has been demonstrated to better provide students with educational material that is best suited to their individual learning profiles. The result also demonstrated that the provided report and statistics is reliable and helpful to better conduct the learning process, In addition, we have shown that this application enables developing and implementation of continuous improvement strategies aiming at measuring student learning outcomes related to E-Content.

There are also some suggestions given by the administrator and assessor. Administrator suggests that it would be better if the agent was hidden, so the user can get the benefits of agent without realizing the existence of the agent. Assessor suggests that graph and bar chart should be included in the report. Assessor also commented about the difficulty to use the system without any assistance/briefing by the owner. Users of the system will have difficulties to use the system if they do not understand the information being provided.

7. CONCLUSION AND FUTURE WORKS

An agent-based adaptive E-Content and E-Learning architecture has been designed for administrator, accessor/instructor and students. Each agent is provided with three different databases where they interact with. Our proposed architecture design is unique compared to existing architectures in terms of the features provided by our architecture consisting of agents for administrators, agents for accessor/instructor, agents for students, course statistics, semester statistics, message management and agent embedded as human. Studies have been conducted to evaluate the effectiveness of the system by the administrators, assessors and students. On the whole, they have voted that our system is usable and easy to use with the help of agents and the adaptive features. The proposed application has been demonstrated to better provide students with educational material that is best suited to their individual learning profiles. In addition, we have shown that this application enables developing and implementation of continuous improvement strategies aiming at measuring student learning outcomes related to E-Content. The proposed application has implement all time agent to help the system administrators, assessors, and students to use the system in much efficient way by giving hints to what to do next.

For future works, evaluators suggest to include several features in order to improve the system. First, is to provide a user manual that will be issued by the agent if the user first time login, in other words the agent will show the user how to use the system and what the statistics means. Second, is to provide graph to represent the statistics for assessor and the administrator user. Third, is to add many characters to represent the agent, so the user will be able to choose his favourite character.

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Table 1: Comparison between Existing Architecture and Proposed Architecture

		Agent for student	Agent for Assessors	Agent for system Admin	Each Course Statistic	Semester Statistic	Messages management	Human-like Embodied Agent
1	Hammami & Mathkour, 2014[1]	✓	✓	✓		✓	✓	
2	Daomin, 2013 [7]	✓	✓					
3	Nidhi Pandey, Shashank Sahu, Rajeh Kumar Tyagi.and Abhishek Dwivedi 2013[9]	✓	✓					
4	Issam Matazi and Rochdi Messoussi and Abdellah Bennane 2014 [8]	✓	✓				✓	
5	Dai Hasegawa, Yücel Ugurlu, and Hiroshi Sakuta 2014[10]	✓	✓					✓
6	Maedeh Mosharraf, Fattaneh Taghiyareh, Atiyeh Soleimani, and Fatemeh Orooji 2012[12]	✓	✓				✓	
7	M.U. Bokhari1, S. Ahmad2 2013[13]	✓	✓		✓	✓	✓	
8	S. Bhattacharya, A.Chakraborty, P. Basu, and S. Roy[14]	✓	✓	✓			✓	
9	Our System: An Agent Based Web Application E-Learning System for Adaptive E-Content	✓	✓	✓	✓	✓	✓	✓