A Multi_Agent Advisor System for Maximizing E-Learning of an E-Course

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***Abstract*—Web-based learning environments have become popular in e-teaching throw WWW as distance learning. There is an urgent need to enhance e-learning to be suitable to the level of learner knowledge. The presented paper uses intelligent multi-agent technology to advise and help learners to maximize their learning of an offered e-course. It will build its advices on the performance and level of education of learners including past and current learning. Most of advices are to guide learner to make exercises as quizzes or passing tests in different level of difficulties.**

Keywords—AI; Agent; Multi_Agents; distant learning; e-Learning; e-Teaching; Education; e-Course

I. INTRODUCTION

In the time being, Distance learning is the hot issue in computer science. Online learning through the web has become popular in the decade [1]. E-learning is nowadays recognized as one of the efficient methods to respond to the requirements of open and distance learning. In the e-learning system, several traditional learning styles should be combined with the learner-centered approach. It needs a good notation to represent the requirements of the e-learning system [2].

In the dynamic changes information environment without prior modeling, it can independently plan complex operation steps to solve practical problems, can independently discover and obtain the available resources the learners needed and then provide the corresponding services under the circumstance that the learners do not take part in [3].

An agent is something that perceives and acts in an environment. The agent function for an agent specifies the action taken by the agent in response to any percept sequence [4]. Intelligent agents are task-oriented software components that have the ability to act intelligently. They may contain more knowledge about the needs, preferences and pattern of the behaviors of a person or a process as in [5].

The agent has to collect users' personal interests and give fast response according to the pre-specified demands of users. The personal agent can discover users' personal interests voluntarily without bothering the users. It is very suitable for personalized e-learning by voluntarily recommending learning materials [6].

Intelligent agents should have the ability of adaptive reasoning. They must have the capability to access information from other sources or agents and perform actions leading to the completion of some task. Also, they must control over their internal state and behavior and work together to perform useful and complex tasks. Thus, they should be able to examine the external environment and the success of previous actions taken under similar conditions and adapt their actions [7].

Educators, using Web-based learning environments, are in desperate need for non-instructive and automatic ways to get objective feedback from learner in order to better follow the learning process and appraise the online course structure effectiveness. On the learner side, it would be very useful if the system could automatically guide the learner's activities and intelligently recommend online activities and resources that would favour and improve the learning. The automatic recommendation could be based on the instructor's intended sequence of navigation in the course material, or, more interestingly, based on navigation patterns, of other successful learners [8].

Currently, the state of intelligent is focused on one-to-one learning instruction. Some examples include ACT systems [8], DEBUGGY [9], and PIXIE [10]. Specifically, the kind of learning modality used is centered on learning by being told [11].

There are too much work done in the field of e-learning and e-teaching based on agent. Gascuena and Fernadez-Caballeroe [12] introduced an Agent-based Intelligent Tutoring System for enhancing E-Learning/E-Teaching, where agents monitor the progress of the students and propose new tasks. De Antonio presented architecture of intelligent virtual environment based on agent technology [13]. Also, a similar one for nurse training is offered in [14]. Tang offered the implementation of a multi-agent intelligent tutoring system for learning the programming languages [15]. According to Java Agent for distance education (JADE) frame work, Silveira and Vicari carried out their system Electrotutor which is Electrodynamics distance teaching environment [16].

Since the students and teachers are on different time and spare in an e-learning environment, the learning status of a student is difficult to be controlled by teachers. In current learning platforms, they neither analyze the causes of learning inefficiency of users, nor generate new learning material and testing. The former keeps the learners from not using these learning systems anymore because they are confusing; the latter leads to out-of-date materials and the learners could not get any new knowledge [17].

In the proposed work, there is multi-agent system that could get learner profile knowledge at his logging to the e-course. Then system can help users and advises them in their on line learning. It will enhance e-learning of e-courses through advising learners for better navigation through e-course contents by offering some links or jumping over course

resources, or by guiding learner to make exercises in a quiz or passing through an exam.

II. E-COURSE DELIVERY

One of the main goals of e-teaching is that the learner learns more and better to enhance teaching as well as learning. E-teaching should be able to facilitate the learning facilities, and to take into account in learning to introduce concepts to each learner.

The presented system incorporates multi agents, collaborated together to help in maximizing the learning process of an e-course. The course tested in this system is the Programming Language Concepts, as taught in Computer Science Department in Umm Al-Qura University, in Saudi Arabia. The task of the system is to enhance e-course navigation, which, by the way, improves e-learning process.

The main goal of the proposed system is to maximize the course learning. It will acquire knowledge directly and indirectly about learners. Direct knowledge includes preferences and level of education of learners (current knowledge). While indirect knowledge includes learner's ability and efficiency of learning (new knowledge), which is gathered from results of any assessment (exercise, quiz or test). All of these knowledge are stored in the learning KDB.

Before using the system to navigate course materials (domain), the learner should open an account, and get a password, to be able to log in. The learner should feed the system with some personal knowledge, to be stored in the Learning KDB. This knowledge includes historical education level.

At logging in the system to navigate the material of the e-course, the learner will see the menu which include main topics of the course, which represent the main part which is the theory pages. Each of these pages could posses with any media: text, graphic, image, audio, video, or even links to an external page.

Also, the e-course material includes two important parts: quizzes and tests which are all considered assessment for each topic or the whole course topics. Quizzes are created from exercises, in a way to complete the understanding of the theory material pages. Delivering of any part of the e-course (material, quiz, or test) and relative advices is done inconsequence manner as will be described in section IV.

III. STRUCTURE OF MULTI-AGENT E-LEARNING SYSYTEM

The proposed e-learning advisor system is structured basically, as shown in Fig. 1, from three modules; each of them represents a knowledge level. The domain module includes the material and assessments (exercises and questions) of topics of the e-course to be taught to the learner. While the learning module represents the knowledge that already known by the learner (personal knowledge, historical learning level and the newly acquired knowledge from the coming e-courses) . Finally, pedagogical module holds rules and strategies of teaching the course materials (fundamentals of teaching).

Strategies of pedagogy specify how the sequence of materials, what kind of feedback has to be given during education, when and how the course contents (problems, definition, example, and so on) have to be shown or explained [18].

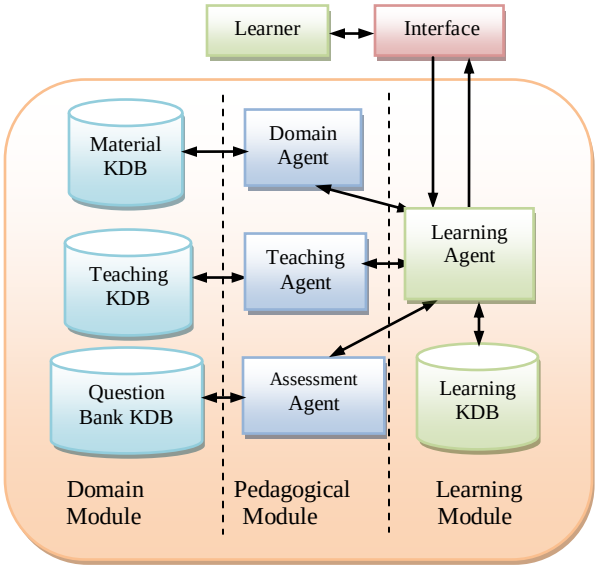

Fig. 1. Strucure of the muti-agent advisor system.

The presented system includes the following knowledge Databases (KDB) and agents:

- Material KDB holds the e-course material or pages. Each page could include text, graphics, audio, video, or links to external pages
- Question Bank KDB holds question and exercises in two level of difficulties for each topic of the e-course.
- Teaching KDB holds the perquisite and the sequence of presenting each topic. It also holds guidance and advices.
- Learning KDB holds account and personal information of and learning performance level of learners. It includes historical and new learning knowledge of learners.
- *Learning Agent* [Lagent} is the main agent in the system. It is responsible of many tasks including managing the learning process, controlling all other agent in the system.. Also, it interacts with the learner to acquires his account personal information and stores it in the learning KDB and consult all materials, assessments and advices to him. It receives assessment results from Aagent and evaluate learning efficiency of learner and update the learning KDB.
- Domain Agent [Dagent] receives a request to consult pages of certain topic from Lagent.
- Assessment Agent [Aagent] which is an external agent system for creating an assessment (quiz or test) automatically [19]. It receives a request from Lagent to build an assessment to be conducted to the learner, under some conditions. This agent selects exercise or questions randomly to creates quizzes or tests with two level of difficulties for each topic(s) from the course

material. It also grades the assessment and gives correct answers for each question.

- Teaching Agent [Tagent] retrieves the prerequisite of each topic or page in the course material page. It also retrieves learning level and performance of each learner from learning KDB through Lagent. Then, it passes its advice and guidance as a message to learner.

IV. The Learning Process

The learning process is done in the presented system as shown in Fig. 2. Sometimes, the system offer its advice for all learners, while navigating certain page, as help, or suggesting alternative pages, or guidance page

The main target of the proposed system is to advise the learners of an e-course to read certain pages or to navigate through some suggested links. Those pages or inks, which represent actions to be done by learners, will help them to improve their knowledge and understanding of e-course materials.

Suggestion of those actions is triggered by events (learning activities) done by learners such as starting or finishing certain part of e-course material, jumping to advanced part of e-course material, attempting to perform a simulation, passing through an assessment (quiz or test), and accessing certain part of e-course material or even external link.

According to learner's level and performance in the Learning KDB, Lagent will decide if the learner needs an advice. This decision is done by accessing the learning KDB, to enable Lagent to evaluate the performance of the learner,. This KDB includes his level of education (already known knowledge), prerequisites (knowledge should be known before learning) for each page-material accessed by learners, assessments (quizzes, exercises, tests) should be passed by the learner in what minimum correctness percentage and maximum time.

In this case, Lagent will constitute its advice to the learner accordingly. If the learner has to be advised, the agent will look up in the e-course for the materials or media that should be taught to that learner to maximize his learning for that e-course.

This advice will guide the learner to access a link(s) which will include a media. This media could be one of t following classes: theory page(s), an assessment(s), and/or event voice or video files. All of these classes may be included in the same course, other courses, or Web sites.

Finally, the agent offers its advice to the learner. If the learner followed the advisor agent, his learning and performances will be improved.

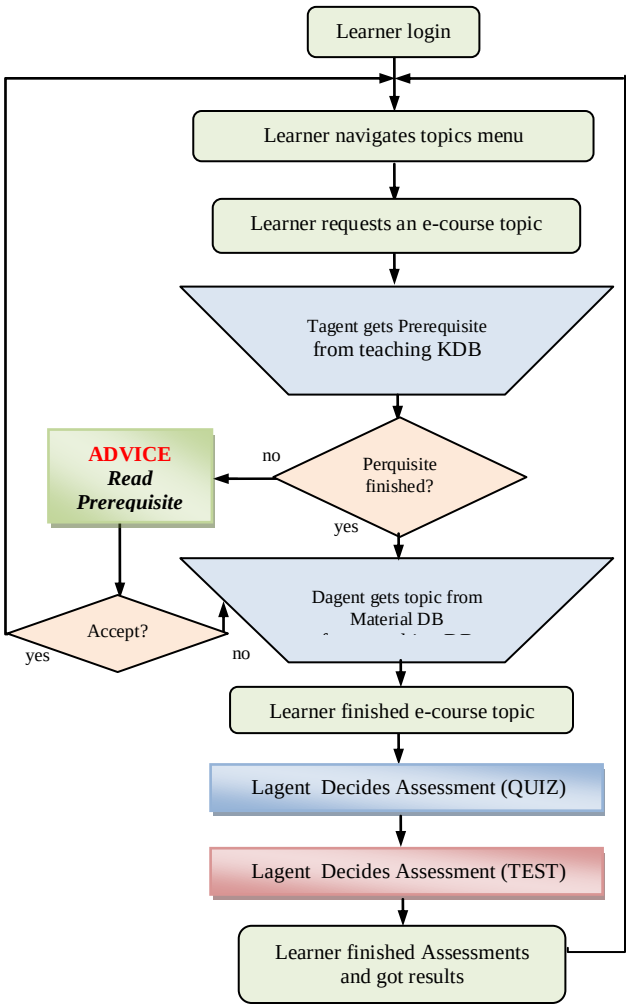

Fig. 2. The Learning Process.

V. Advising Through Assessments

The system will improve the learning process by an intelligent agent for advice and assistance. It causes learners to be as have an e-course suitable to their level of education, learning ability and assessment results. The intelligent agent will guide learners to their needed course materials to decrease any learning confusion. Fig. 3 and Fig. 4 demonstrate the advising process

A. Advising Actions

Testing scores of learners is always used to estimate their efficiency, and is divided into different levels in the traditional learning. During the learning activity, the behaviors of learners can be recorded in a database. This information can find out learners adaption to the teaching material and modify the level of learners.

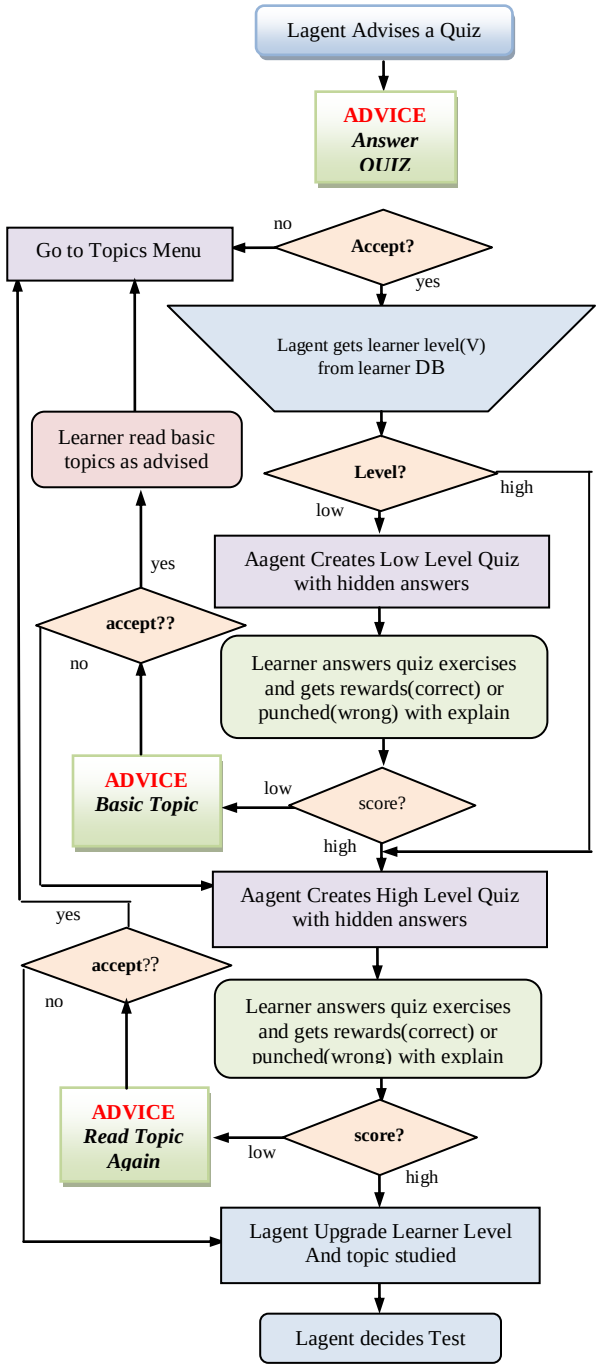

Fig. 3. The Quiz Process.

Sometimes, certain learner gets bad results after passing through an assessment (exam or quiz). This event will trigger an advising action. That event will activate Tagent, which will try to locate one sequence of action from previous sequences of actions taken with the event.

Then the agent will advise the current learner to visit and read some pages, which include important course material.

As example of advice, if the event is passing through an assessment, the advice is navigating a sequence of pages or media. It is not applicable to advise a learner by certain page or media that could directly be reached form the current page or media or by shortcut. So, the system takes care at offering its advice, not to include that case.

Tagent checks test results of assessments (as passed from Aagent) for each learner. According to these results, the *agent* will find the appropriate learning sequence for each learner and advises him through the learning process. The *agent* will advise the learner to get efficient learning time with useful e-course material.

B. Passing Through a Quiz

After navigating all pages of certain topic, Lagent will decide to enforce learner to pass through assessments like quizzes and test. Each quiz consists of 2-4 exercises. There is two level of exercise. The quiz level is specified, as shown in Fig. 3, according to the performance level of the learner.

Lagent gets the level of performance of the current learner from the learning KDB and decides the level of quiz. It asks Aagent to create the suitable quiz accordingly. Exercises will not be not too difficult. In the low level quiz, exercises will be small and in similar words as taught in topic. It will be accompanied with helpful figure or images. While in the high level quiz, question will be more difficulty.

While the learner is making exercises of a quiz, he will input his answer for each exercise to the system. The system reaction will be accompanied by reward or punishing for a correct or wrong answer for any assessment. This is always done through blinking text or image to show certain media such as a text, table, video, audio, picture or even graph. This is done as in the most of the learning systems. Then, Lagent gives its advice to the learner according to his results, as shown in Fig. 3.

C. Passing Through a Test

When the learner finishes the high level quiz, Lagent will update the learning KDB according to quiz results. Then Lagent will advise learner to pass through a Test, as shown in Fig. 4. It will ask Aagent to create a test consists of multiple type of questions.

Tagent is able to create exams from bank of questions randomly for certain topic(s). There are four types of questions: True/False questions, Multiple Choice questions, Fill in the Blanks questions, and Non-standard questions.After finishing the exam, Tagent will evaluate answers and pass scores to Lagent. Then Lagent will update learner level and performance in the learning KDB. Also, it stores that the topic is navigated and tested by that learner.

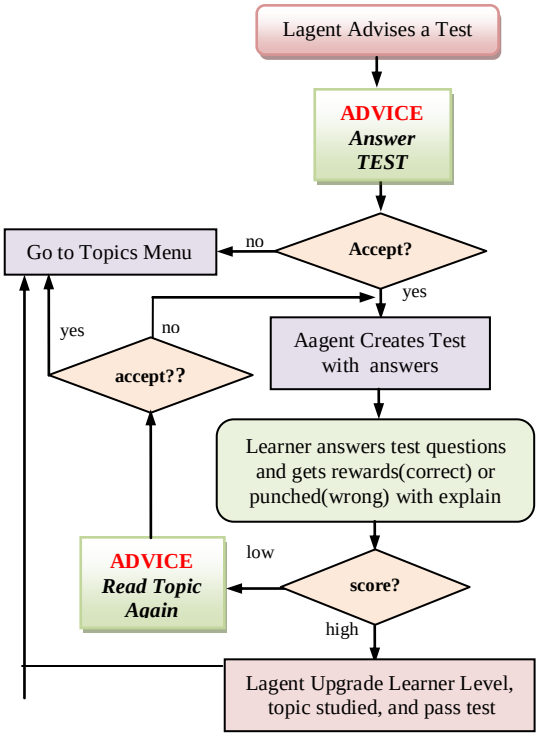

Fig. 4. The Test Process.

VI. CONCLUSION

The presented paper provided a multi-agent based advisor system to guide and advise learners of e-courses. It is suggested to advise learners in the Concepts of Programming Languages course. It is based on multi-agent technology. Agent built its advice on the past and current knowledge learnt by learners. It calls another agent was built to create quizzes and exams automatically in different level of difficulties and grades answers. Future work will extend applying that system in Computer Sciences courses. Also, it will be upgrading it to offer more adapted e-course.

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