

Generating a Customized Course by a Self-Adaptive Multi Agent d-Learning System

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Abstract— *Most of exist distance learning (d-learning) systems don't consider preferences, education levels, skills, or interests of different learners at designing and generating e-courses. This paper provides a design for an ongoing research in a new system for generating a customized e-course using a multi agent system for d-learning platforms, such as mobile learning (m-learning) and e-learning. It proposes an approach for tailoring learning paths for e-courses in d-learning platforms. This learning path (syllabus) is tailored as a double linked list of hyperlinks to course materials. Then, the system generates a customized e-course specially created for certain learner(s). Its delivering to an individual learner becomes a learner-customized which enhances learning outcome, interesting of learners and distance learning. This is done through using six cooperative agents to generate computer and language e-courses in training institute for variety of learners of different levels and objectives. The proposed system would be trained under supervision of an instructor after finishing its implementation.*

Keywords— *AI, Multi-Agent, d-Learning, e-Course, m-Learning*

I. INTRODUCTION

Distance learning or education is an efficient way for delivering education and driving learning, basically on an individual basis, to learners who are not physically setting in a classroom. It could provide learning when the source of knowledge and learners are separated by distance and/or time" [13]. Now, it is available in distance education, open online courses, which are wanted to be accessed at large-scale interactive learning participation and open accessing through all network technologies including the internet [22].

Learner in m-learning uses the modern emerged manufacturing tools such as smart phones, tablets, handheld computers, MP3 players, and notebooks. These because it focuses on learning while the mobility of the learner, to interact with portable technologies. Using these tools for creating learning materials and aids becomes an important component of informal learning [21]. The fast grown of tablets and smart mobiles results in similar grown of the designing and developing of e-learning for mobile devices simultaneously, and may be faster. There is difference between viewing m-learning material on smart mobile and viewing it in a tablet or laptop. It requires much planning to fulfill each device and its requirements. In the time being, M-learning could be considered as one of the efficient platforms to respond to the requirements of d-learning.

A huge number of AI applications and techniques are widely used in tutoring and education systems. The most widely technique is the intelligent agent and multi agent, which can be used in most learning platforms. An intelligent agent can be described as an autonomous calculated entity [15]. The actions of agent in the environment are typically mediated via an appropriate middleware, which provides a first-class design abstraction for multi agent systems, offering means to govern accessing resources and agent coordination [24].

In the time being, most of exist e-learning systems are course-centric and not learner-centric. So, their service can't directly or effectively match goal of the learner, because they don't care with the diversity of learner population [11]. They might be enhanced if the learning material could be adapted specifically to the needs, and preferences of certain learner and according to learning progress. Agent could be run in the e-learning environment to perform the pedagogical tasks autonomously [18].

The presented paper proposed generating a customized tailored e-course material according to the qualification, interest and objectives of the learner. Whenever, objective and profile of a learner are changed, his category (class) is updated. Then, a new learning path (syllabus) for each learner is generated as a list of hyperlink to certain topics or pages, to be used in building his private e-course. He can access e-services, anytime, anywhere, from any PC, laptop, tablet computer, pocket PC or any GSM mobile smart phones. This is done depending on running six collaborative agents.

II. RELATED M-LEARNING SYSTEMS

M-learning could be considered as an intersection of e-learning and mobile computing. It should be able to deliver dynamic and instant learning material anytime and anywhere in an efficient manner. M-learning system has to present an efficient and personalized content to the mobile learner to encourage collaborative learning. The technology of agents is suitable for developing m-learning systems, because it supports intelligent and distributed storage, allows an efficient personalized m-learning [1].

Chen and Hsu proposed in [4] a system to recommend articles of English news to learners depending on the learners' reading abilities. Their Personalized Intelligent Mobile learning System (PIMS) provides an effective and efficient mobile learning mechanism by adaptively recommending articles and enhances learning of unknown vocabularies for learners.

Wei and Yan designed in [23] an integration model for e-learning systems based on web services and intelligent agents. In this model, all applications and learning components can be distributed on the Internet and loosely connected. Due to using agents, the learning content might intelligently be customized to fit the special needs of individual learners.

Henry and Sankaranaryanan explained in [9] that the e-learning process can also be conducted using mobile devices, which is called m-learning. The differences between e-learning and m-learning are the constraints of the limited CPU, memory size, and the screen size of mobiles (which are not big enough to download or view the learning material). Also, it should be considered the availability of internet connectivity and a tutor to be physically present.

Hashemi et al. presented in [8] a learning management system model. In their model, the learning environment could be structured according to learner context information such as his desire view of the system.

Taharim et al. discussed in [20] the conceptualization of the relationship model of interaction design, playful interaction, kansei engineering and mobile usability in mobile learning. This model could provide the prescription and motivation in designing mobile application for teaching and learning.

Yusoff and Dahlan explained in [26] the integration of two platforms: the augmented reality (AR) and the concept of learning engagement through mobile based AR. They proposed an effective guideline in building the prototype to be used among students in generating the focus during learning process through AR environment.

Gil and et al. discussed in [7] an important issue, which generates the need of using decentralized distributed architectures in which mobile devices can share architecture resources to carry out the activity covering the concerns identified by different stakeholders. This issue can be addressed in the design and implementation of an architectural for m-learning applications, which is a result to the dynamic nature of the learning field.

Yushun and et al. proposed in [25] a programmable facility for assembling mini-courseware and extracting dynamic learning resource. Also, they focus in importing learning resources in Ubiquitous Learning Object. Castellanos and Sanchez presented in [3] a framework that allows tablets and smart mobile to download resources of digital library.

III. ARCHITECTURE OF THE LEARNING SYSTEM

The multi agent systems are constructed from Semi-autonomous agents. Those agents interact together towards achieving individual and/or collective goals or to cooperate to resolve some problems. They could be heterogeneous or homogeneous. They always have common goals or at least have a degree of communication between them [2].

The proposed system is designed to provide a tailored customized e-course for each learner(s). This is done to reason with learner knowledge level, objectives, requests, wishes, and target. It includes six agents cooperate together to perform its task. Figure 1 shows the structure of the proposed system, which emphasizes the role of each agent and their cooperation. While, table 1 describes the roles of those agents.

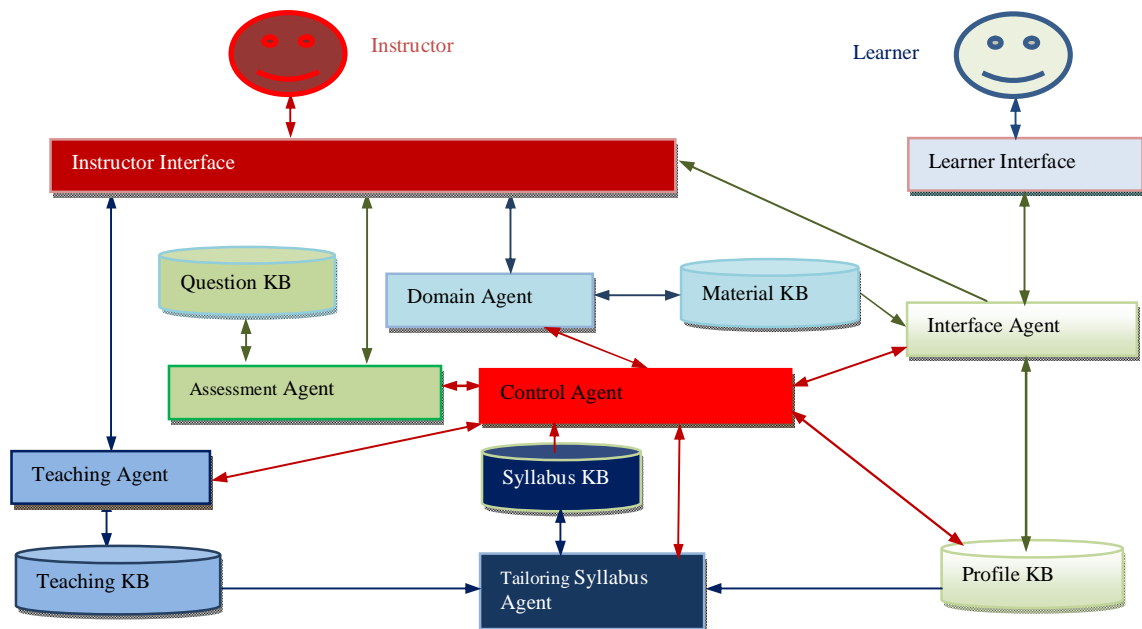


Figure 1: Architecture of the Multi Agent System.

All material offered by the institute are collected in material KB, by domain agent from the instructors. They are prepared as isolated topics. Each topic is stored in a separate file (page) in material KB. Also, it has a class, its main attributes are: topic-id, topic-name, topic-hyperlink, prerequisite-topic-id, sub-objective, original-course-name. Most of these topics reside on our site. Some might found other sites on the WEB. Object of those classes are stored in the teaching KB.

Each topic has its questions stored in a question KB to be used in assessment creations. They are categorized by their topic-id. Each topic has a sub objective, while; its original course has an objective. All objectives and sub-objectives are consulted to learner to select his objectives from a list of objectives of all courses and topics in the site

TABLE I
DESCRIPTION OF ROLE THE SIX AGENTS IN THE SYSTEM

Agent Name	Description
Domain Agent (DA agent)	Responsible of acquiring material from the instructor and filling the site pages of material KB by text, audio, video, and graphics. It might also have links to external pages in the WEB, if needed
Teaching Agent (TA agent)	Responsible of acquiring the prerequisite topic for each topic in the course material pages. It collects this information from the instructor the Teaching KB. It reviews if a course material is suitable to certain learner or not. In addition, it filters the generated syllabus by removing the repeated and contradicted material. This filtering process is done under the instructor supervision of, only in the training sessions
Assessment Agent (AA agent)	Responsible for creating assessments such as quizzes or tests, ElSayed [5]. When the learner completes certain topic or a whole course, CA agent sends a request to AA agent to create special assessment. Then, AA agent selects exercises or questions from the question bank with random function to produce an assessment in different levels of difficulties. The AA agent will mark the solved assignment and give marks and correct answers for all exercises and questions in the assignment.
Interface Agent (IA agent)	Responsible for the interaction with the learner for acquiring his profile and personal information. The agent then, stores this information in the learning profile Knowledge KB. In addition, the agent will receive a stream of hyperlink to topics of an e-course, one at a time, from the CA agent to consult a customized e-course. During training sessions, the agent consults the generated tailored learning path of an e-course to the instructor for his agreement.
Control Agent (CA agent)	The learning process manager and controller. It initiates the work of other agents and collects their gains. In addition, It Analyses knowledge profile of the learners, and updates their profile record. For example, it gets results of learner tests from AA agent and evaluates efficiency of learner answers, and then it updates his profile KB accordingly. The CA agent also reads the special learning path (tailored syllabus) for each learner and passes these data to the IA agent for consulting the specified pages
Tailoring Syllabus Agent (TSA agent)	Responsible for generating a special learning syllabus for each learner. It acquires the profile knowledge of the learner to get his objectives and sub-objectives. Then, it finds out the hyperlinks for suitable materials and their pre-requisite from teaching KB. Also, it finds out a classification for that learner. Finally, it tailors a customized personal syllabus relevant to learner classification, as a double linked list of hyperlinks to the selected materials

IV. GENERATING A CUSTOMIZED E-COURSE

After passing personal information from certain learner to his profile KB, the system consults a list of objectives and sub-objectives (drawing from teaching KB with each topic or course). Then he can select one objective or more. When the system couldn't find a suitable readymade learning syllabus for the current learner, it calls an algorithm to tailor a new one, especially for that learner. It is trained by an instructor to be able to perform its task.

A. Supervised Training Session

Before starting to generate an e-course, the system is passed through a training sessions supervised by an instructor, for watching reviewing, and correcting its performance and also for evaluation of its results. Figure 2 shows the algorithm navigated by the system at training sessions supervised by the instructor. It should be noted that after passing the supervised training sessions (dark Red path in Figure 2), the system will perform the same process of generating customized.

The system is collecting interests and objectives of a learner and save them in his profile KB, by the IA agent. When the learner starts a learning session, he tries to start learning any available e-course. If the requested e-course is suitable to his level and objective, the system consults it according to the already exist learning path syllabus.

While, if he asks for learning of non-suitable e-course, the system start preparing for a suitable learning path. Then it consults the topics included in the double linked list of tailored learning path to the expert instructor for reviewing, evaluation and modification, if needed.

B. Navigating Profile KB of a Learner

After passing the supervised training stage, the system can automatically tailor a new learning path and generate customized training courses relative to the objectives of each learner. It builds a customized course according and relative to knowledge level and skills (past), preferences (present), learning performance, and objectives (future) of the learner.

The system will try to find an exit category of learners, according to objectives and other knowledge. If it successes, it can find readymade learning path for that category. After that it can consult the readymade e-course relative to that learning path. If it fails to find a category, it will start new classification to tailor a new learning path, as will described next.

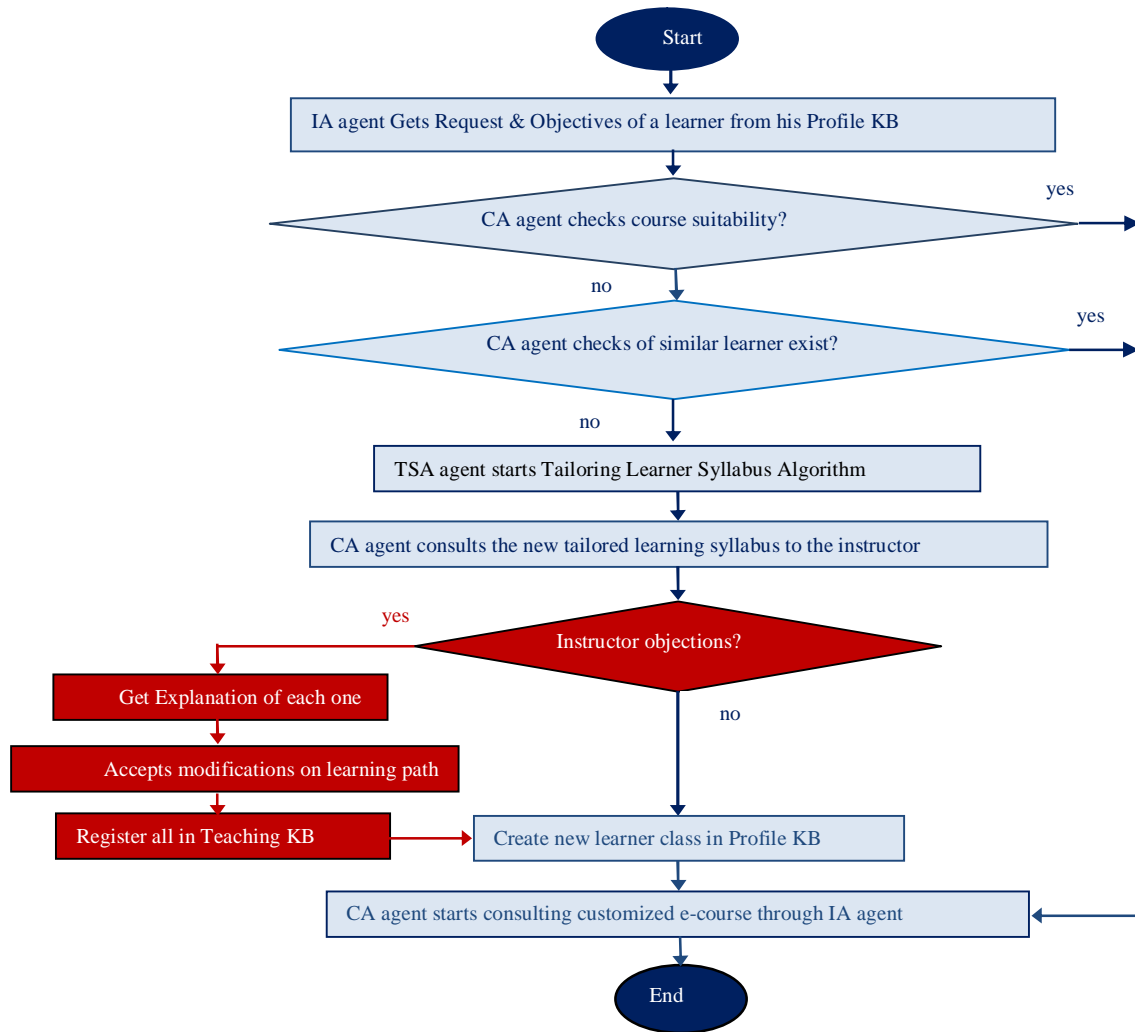


Figure 2: Instructor Supervising a Training Session.

Also, it uses pre assessments to evaluate learner knowledge before starting a new e-course. After navigating an e-course, it evaluates learner by post an assessment. In both situations, it updates learner profile. For each learner and similar (class of learner) there is a suitable learning path. Class of learner is reviewed and updating after finishing any learning path and assessment evaluation. Figure 3 presents the algorithm of Navigating the Learner Profile.

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//Navigating the learner Profile to get his objectives and skills.
1. IF the learner has a main objective
- MOVE course name (CN) of training course-of the same objective- to variable CN.
- FIND the Perquisite Course Name(CNPRE).
//Checking learner profile,
- IF learner finished PreCN,
  MOVE the syllabus of CN course to the learning Syllabus
- ELSE MOVE the syllabus of PreCN course to the learning syllabus
- GO to GENERATING a CUSTOMIZED e-COURSE.
ELSE GET all sub-objectives of the learner as attributes of a learner CASE.
2. IF there is a CLASS for the learner CASE
- MOVE syllabus of the CLASS to Learner Syllabus,
- GO to GENERATING a CUSTOMIZED e-COURSE.
ELSE CALL TAILORING a Learning Syllabus.
3. GO to GENERATING a CUSTOMIZED e-COURSE.
  
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Figure 3: Navigating Learner Profile KB

C. Tailoring a Special Learning path Syllabus

To generate a customized e-course especially for certain learner(s), the system perform two tasks. The first, is tailoring a new learning path as a double linked list of hyperlinks, each to certain page, while the second is consulting these pages any time, a learner wants.

Figure 4, presents the structure of each node in the double linked list, created to hold the new tailored learning syllabus. It has two pointers in two directions: one direction points toward the former topic, while the other direction points towards the next topic. While, figure 5, shows a flow chart to presents the algorithm used for tailoring a new special learning path for the current learner and next similar ones. The learning path is a double linked list of filtered hyperlinks to the material of the customized e-course.

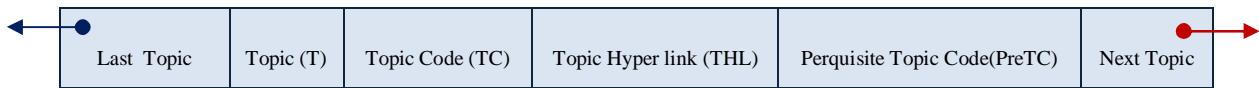


Figure 4: Structure of a Node of Learning Syllabus double linked list.

D. Consulting a Customized e-Course

At this point the system has a learning path as a double linked list syllabus for the current learner, stored in the syllabus KB. Any time, he login for learning the IA agent will get each hyperlink of certain topic from his syllabus linked list, by the CA agent, load it and present it to him. Figure 6 shows how the interface agent generates and consults a customized learner-based e-Course. The learner can navigate pages of certain topic or even pages of the whole course at any time. Each time, he finished certain topic; it is optional to him to pass through an assessment in that topic. If he agrees, this assessment is prepared and evaluated by the assessment agent. If he passes the assessment or he does not like to pass through it, he can go forward to next topic. The same process is done after navigation of all topics in the presented customized e-course. When the learner finishes all topics of his course, the interface agent updates his profile, as he gets new experience. This is done in the profile KB, and should be considered at generating next customized course.

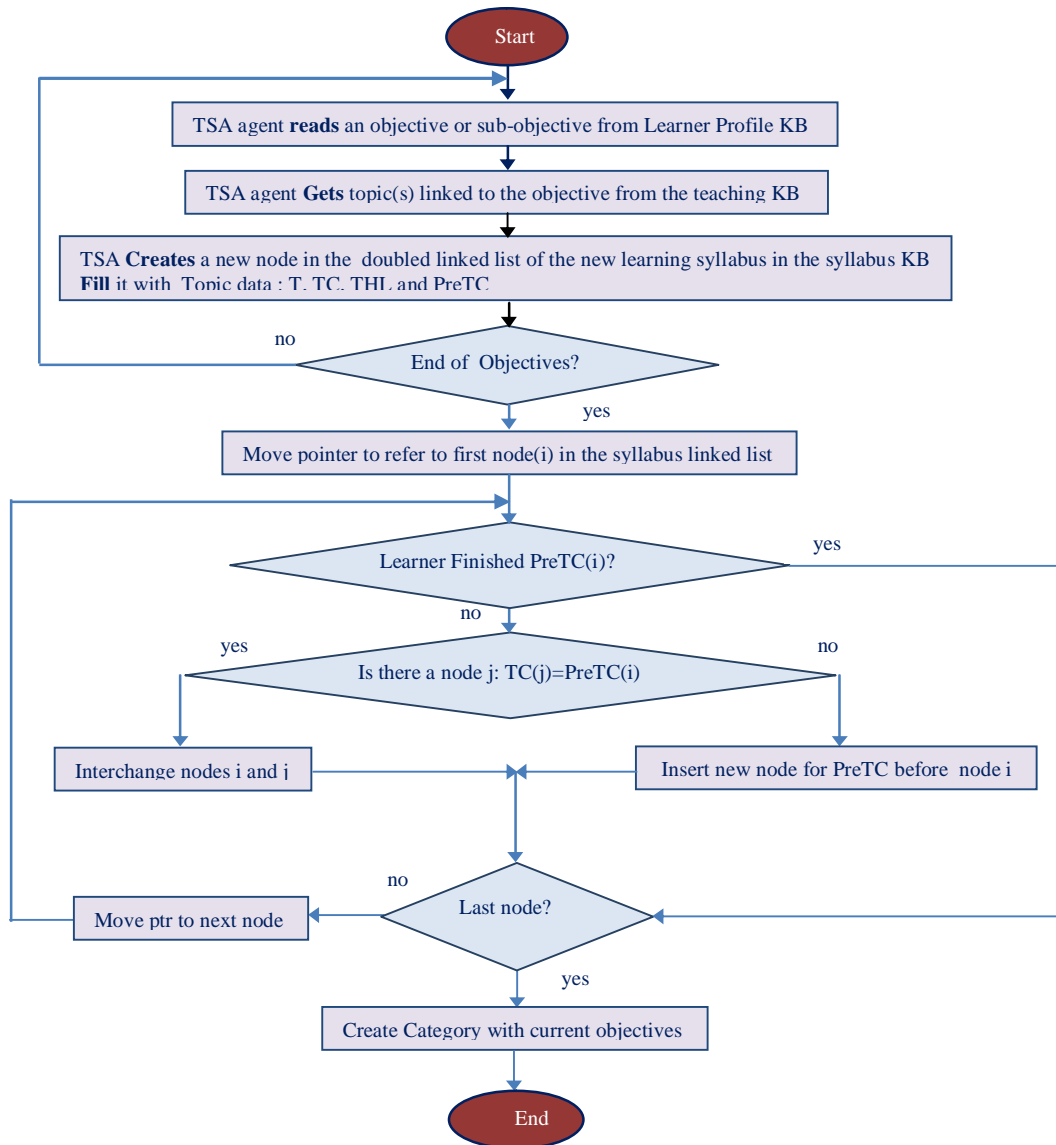


Figure 5: Algorithm for Tailoring a syllabus.

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// generating a customized e-Course using the tailored Syllabus.  
FOR each topic in the learner Syllabus table DO  
-   CONSULTE Topic pages to learner.  
//After Navigating the presented topic by the learner (optional for //each learner, he may go to next topic, and his profile is updated).  
-   CONSULT an assessment in Topic Material to learner and EVALUATE Learner Answers.  
-   IF learner passes the topic assessment or navigate  
    UPDATE learner Profile and GO to next Topic in the Syllabus  
    ELSE REPEATE Topic Again.  
//After Navigating all topics in the course (optional for each learner, //he may finish studying, and is profile is updated).  
-   CONSULT an assessment in Course Material to learner and EVALUTE Learner Answers.  
-   IF learner passes the course assessment.  
    UPDATE learner Profile, Finish the e-course.  
CONTINUE.
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Figure 6: Algorithm for Generating and presenting a Customized e-Course.

V. CONCLUSION AND FUTURE WORK

This paper proposed a multi agent based system, designed for generating a customized e-course in distant learning including e-learning and m-learning. It presented building and tailoring of a learning path (syllabus) for each learner according to his profile, request, objectives and interest. Then, it generated a customized special e-course for training in d-learning platforms. It used six cooperated agents to perform its task. It is trained under supervising of an instructor before being able for his mission.

Delivering of e-courses in this way might improve learning outcome objectives, skills, and experience which resulted in satisfaction of learners and enhancing education. In future, this design will applied in regular high education in university level in credit hours studies. Future work will include enhancing the architecture of the system and improving its security such as reading IP address of the learner.

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