A SOFTWARE TOOL FOR WEB-BASED DISTANCE LEARNING SYSTEMS DESIGN

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ABSTRACT

Today, distance learning is becoming a popular alternative to traditional programs, due to advances in computers and communication technology. Most of the available computer aided learning systems cannot provide appropriate materials for remote learners. These systems use classical methods to handle vague information in the knowledge representation and decision-making. The proposed project consists of two parts, the first part(*) presents an attempt to introduce a software tool for development of a web-based distance-learning course. The second part covers the design of a fuzzy decision making system to deal with vague information. A fuzzy decision making process is used to update the leaner model and specify his/her learning level to provide appropriate teaching materials to each learner. Such a system can deal with uncertainties in the learner's degree of understanding in each unit. It provides a powerful educational tool that can assist the learner to move from one learning unit to the other according to his/her learning level.

Keywords: Computer aided learning, Web-based distance learning, Fuzzy-based decision-making.

(*) The first part will be represented by: Alla Bakhit and Samar Salim, students at computer eng. Dept./ Philadelphia University

1. Introduction:

Advances in computers and communication technology have changed traditional methods for learning and skills training. Since 1960's much money and efforts have been invested in designing computer-based learning systems. The role and use of information and communications technologies in education is currently the focus of much attention[1]. Students may not have opportunities to attend traditional learning programs for a number of reasons, such as; limited funds for running such programs, limitations on laboratory facilities, and insufficient support of qualified instructors[2]. The development of computer systems has opened up new possibilities for education and training. Computer-based education and training techniques are now well established, and provide an environment to create interactive interfaces, and real-time software can monitor every response made by the learner or the system. Also, due to the progress of computers and communications technologies, it is possible to handle transmission of text, image and voice through internet. The use of internet has the advantage that it is not restricted to the time and place. People can study at any time and any place as they wish. Therefore, as the number of students entering higher education increases along with the requirement for great cost efficiency, the potential benefits of web-based learning and training are great[3-5].

Recently, distance-learning classes range from self-based learning materials and threaded discussions delivered over the web to synchronous classes where teacher and students communicate through text, audio, or video. Teaching at a distance provides fewer opportunities to gauge the subtle reactions of students so apparent in a face-to-face classroom[6-10]. On the other hand, real educational processes deal with uncertainty in human knowledge and decision making. However, most of the available learning systems cannot provide appropriate materials for remote learners. These systems use classical methods to handle vague information in the knowledge representation and decision making[9].

Fuzzy set theory incorporates precise techniques for solving such problems. In fact, fuzzy logic concepts have been used in several expert systems for knowledge representation and reasoning. A fuzzy-based system has been designed and implemented as an instructional tool[8]. In this system the capability of fuzzy logic is combined with artificial intelligence concepts to produce an intelligent educational package.

Several efforts have been made to develop computer-based learning and training systems [1-12]. However, computer animation alone will not provide users with opportunities to obtain real-sense learning and training. For that reason, there is a need to explore more advanced technologies to improve distance-learning systems.

This paper outlines how a fuzzy decision maker can be used in web-based distance learning. The system software will check the learner's information and his/her knowledge levels to provide the appropriate teaching materials to each learner. The teaching materials are prepared to cope with various learners. Using such a system will enable users to move from one learning unit to the other according to his/her learning level and test score in each unit.

2 System Design:

Distance learning systems provide people with instant access to courses whether they are at home or at work. The world wide web (www) technology is very suitable for building distance learning systems. Using the web as both a library and a virtual classroom is a logical way to set up distance learning. The proposed system software is to be established on a web server. The learners can access the server from a personal computer (client) connected to the server. In the proposed system, only text and images are used, therefore any web browser can meet the system requirements. The system software at the server side can be viewed as having three parts, as given in Fig.(1). These parts are, teaching materials, learners' information, and a decision-making module.

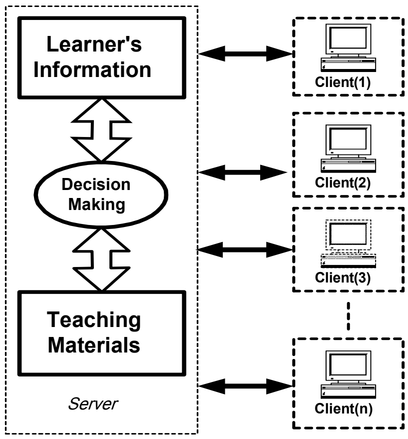

Fig.(1): System Design Layout.

The proposed software tool can be accessed by the course instructor, the authorized learner and by the web guest. The guest can view the course outline of available courses, and can go through the registration process to attend any course. The authorized learner (through password verification) can access the teaching materials of any course in his list. The course instructor can add and update the teaching materials through the software tool, as shown in Fig.(2). The teaching materials have three contents; brief (Rank A), normal (Rank B), and details (Rank C). These materials are prepared to cope with various learners attending the course.

Fig.(2): Teaching Materials Editing.

2.1 Teaching materials:

The teaching materials used in the system are related to the course "intelligent systems design" given in Philadelphia University-Jordan.. Each educational unit consists of several pages of HTML text and JPEG images. As shown in Fig.3, each page consists buttons such as;

- NEXT: a request to view the next page.
- BACK: a request to view the previous page.
- DETAILS: a request for more details about the given materials.
- SEARCH: a request for searching words and phrases in the teaching materials.
- E-MAIL: authorized learner is automatically listed in the mailing list related to this course. Then, learner can communicate with the instructor and learners.
- TEST: either self test or unit test.
- EXIT: a request to stop learning.

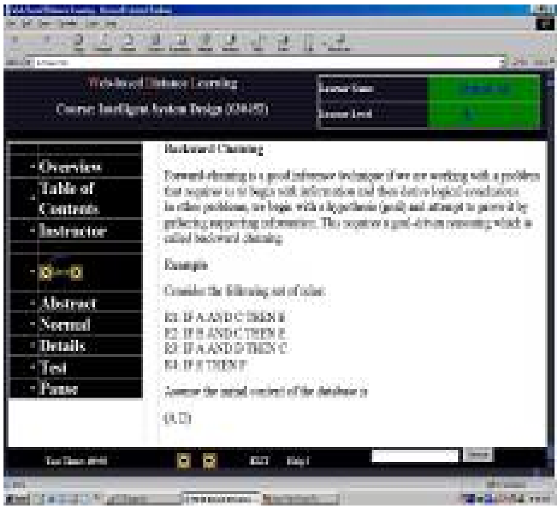

Fig.(2): Learener Screen.

2.2 Decision making module:

One of the most important requirements that precede the design of an attractive distance learning system is to adopt software deal with all tasks in the system, which include;

- check if the learner is authorized to access the learning system or not.
- check the learner information, to provide appropriate teaching materials to each learner.
- manage the teaching materials.
- check the learner's degree of understanding.
- analyses the collected information about each learner to update his/her knowledge level.

2.3 Learners information:

It is necessary to update the learner model by the system in order to provide appropriate teaching material to each learner according to his/her knowledge level.

3. Fuzzy Set Theory and Learning:

In fact, human thinking and reasoning involve vague information; therefore, educational systems should be able to cope with such vagueness. The aforementioned vagueness is related to the following source:

- information provided by the learner.
- the current knowledge level of the learner.
- the evaluation of the leaner level.
- the experience of the instructor.
- the objective behind the course materials.

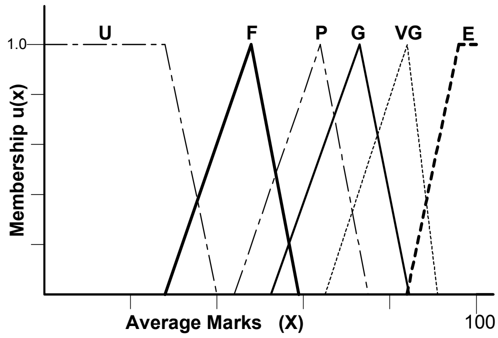

Fig.(4): The fuzzy notation of "test result".

The knowledge representation used for decisions learning management has a great importance in designing virtual reality based educational systems. The sequence of the educational events that is based on the instructor's experience is the core of such educational systems. Therefore, it is important to model the experience of the instructor in such away that the educational system should be flexible, easy, and at the same time enables the learner to deal with the course materials which are suitable to his knowledge level.

Several papers [8,9] have mentioned that the modeling process of the instructor experience and course related physical world is not an easy task. Due to the knowledge acquisition vagueness, it is essential to use an efficient tool that is capable enough to model this knowledge in order to build a flexible decision rules. The fuzzy logic is the most suitable tool to deal with vague knowledge and the process of decision-making in the educational system.

In fuzzy sets, a linguistic variable takes on words or sentences as values. For example, let the variable x be the linguist variable "learner average result", then the following terms; Excellent (E), Very Good (VG), Good (G), Pass (P), Fail (F), Unsatisfied (U) can be constructed as shown in Fig.(3) . Each term in the set is a fuzzy variable. Now, if x in an element of a fuzzy set, then the associated grade of x with it's fuzzy set is described by a membership function $\mu(x)$, which takes values between zero and one.

In modern educational systems, the fuzzy set theory concepts can be used for solving problems related to the:

- modeling of the learner.
- modeling of the instructor experience.
- identification of the learner knowledge level during each educational unit.
- modeling of real world environments.
- algorithms for on-line 3-D graphic generation.
- real-time control of the changing virtual reality.
- decision making for learning path selection.
- overall evaluation of the learner.

4. Decision Making Process:

The flexible educational system provides an easy way to make possible the transformation from one learning level to another according to the learner background. In this case, three educational paths can be used;

- Learning path (A); includes a summary of the educational unit, which is quite enough for high quality learners.

- Learning path (B); includes the usual information as that given by the instructor for normal learners.
- Learning path (C); includes a detailed information that facilitates the learning process for beginners.

The above educational paths allow the high quality learner to go through the educational units so easily with minimum time while slow-witted learners take more time with high effort to pass each educational unit.

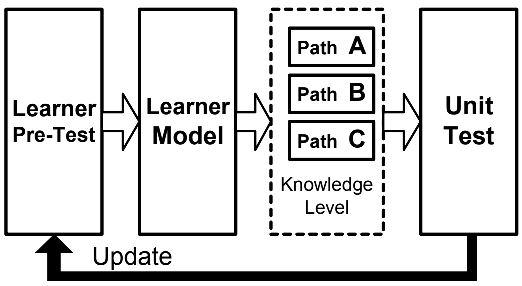

Fig.5: Block diagram of the proposed learning system.

Figure (5) shows a block diagram of the proposed educational system. The course material should be distributed for several educational units according to the syllabus adopted by the institute and the instructor's experience. The operation of this system can be summarized as the follows;

	CLA	CLB	CLC
TE	NLA	NLA	NLB
TVG	NLA	NLA	NLB
TG	NLA	NLB	NLC
TP	NLB	NLC	NLC
TF	NLB*	NLC*	NLC*
TU	NLC*	NLC*	OUT

NOTE : (*) Stay in the same educational unit
(C) Current , (T) Test , (N) Next ,
(L) Learning Path

Table(1): Rules for fuzzy decision making.

- A pre-test must be taken by the system to specify the learner knowledge level, which enables him to enter the first educational unit.
- Feedforward learning according to the current educational level of the learner.
- The system will test the learner ability at each educational unit to update his/her model and to specify the new learning path for the next educational unit.
- According to his/her test in the current educational unit, the learner with grade "Good" or "Very Good" can transform from knowledge level (B) to (A) or from (C) to (B) in the next educational unit, while the learner with grade "Fail" will transform from the current learning path (A or B) to learning path (C) and remain at the same educational unit, as given in Fig.(6).
- If the test result at a certain educational unit is (Unsatisfied) then the learner at knowledge level (A) or (B) will remain at the same educational unit and at learning path (C) regardless of his/her learning path.
- If the test result of the learner at knowledge level (C) is (Fail) then the system will advise the learner to leave this educational package. grade (Good) or (Very Good) can transform from knowledge level (B) to (A) or from (C) to (B) in the next educational unit.

A set of fuzzy rules that combine the current learning path and test result can be defined as given in table (1). In general, a rule is an implication statement expressing the learning level, test result and learning path in the next educational unit. For example, the rule;

IF CLB AND TVG THEN NLA

This means that if the current learning path (CL) is path (B) and the test (T) is very good (VG) then the next learning path (NL) is path (A). In this system 18 rules have been used to specify the decision making process.

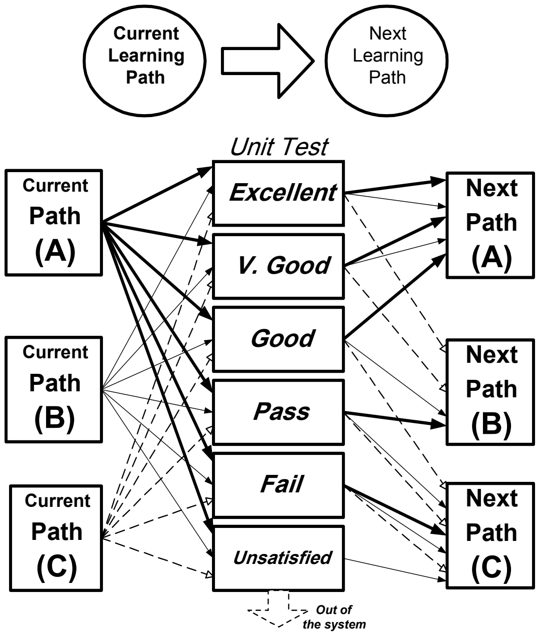

Fig.6: Layout of the decision making process.

5. Results:

In order to verify the performance of the proposed fuzzy-based decision making module, the learning system has been implemented and tested. In this test the learners were 3rd year undergraduate students with different learning knowledge levels. After the learning sessions of the educational unit a self test can be performed by the learner, before the unit test, to check the learner's degree of understanding. The unit test consisted of 33 questions representing topics both general and specific and covers the educational unit material.

- Learner contact time with given educational unit (unit # 4) ranged from 3.5 hours to about 10 hours, see table (2). Five students (2,3,4,5 & 8) were remained in the same learning levels, while the learning levels of the others were changed.
- Learners scores ranged from 35% to 92%.
- Learners with high learning level (CLA) were able to understand the teaching material given in the unit by using learning path (A) together with on-line discussion with the instructor. Learners with low learning level (CLC) were able to make good progress using learning path (C) with other materials gathered from other resources. In this case more time is required to accomplish the educational unit.
- According to the current learning level of the learner and his/her score in the unit test, the next learning level will be modified.

Learner Number	Current Learning Level	Total contact Time (min)	Next Learning Level
1	A	210	B
2	A	255	A
3	A	240	A
4	B	405	B
5	B	390	B
6	B	375	C
7	B	425	A
8	C	455	C
9	C	520	B
10	C	590	B

Table(2): Learners records

6. Conclusions:

This paper addressed the importance of using web-technology and fuzzy set theory principles in learning. Course teaching material (theories and related knowledge) can be integrated with on-line display through virtual environments. Moreover, modeling and decision-making based on fuzzy logic effectively contribute in dealing with vague information. The decision making process in this system is taken place according to the actual knowledge level of the learner. The system can provide the learner appropriate teaching materials according to his/her knowledge level.

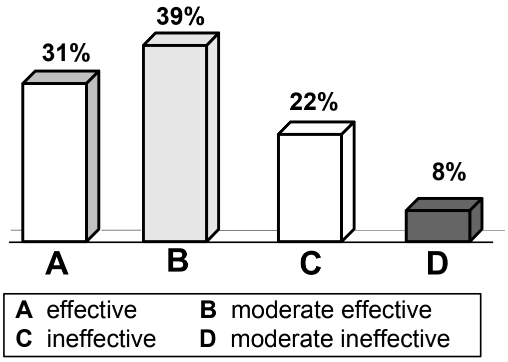

Fig.7: System evaluation.

Learners can ask the course instructor questions about the topic.

The fuzzy decision making of the proposed learning system has been implemented and tested to demonstrate its effectiveness. Students and graduates through a questionnaire have evaluated the system. Figure (7) illustrates the results on effectiveness of the system. The result shows that such a system is effective for both students and engineers for continuous learning. On the other hand, learners must be disciplined and well organized, and must have effective time scheduling. Such learning system requires effective responsibility, administrative and technical supports.

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