

Tuesday, 5 December 2006
SMAP '06, Athens, Greece

ADDING ADAPTIVE ASSESSMENT CAPABILITIES TO AN E-LEARNING SYSTEM

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1. Introduction

- ❖ Web-based intelligent educational systems (WBIESs) use Artificial Intelligence (AI) Techniques in order to adapt mainly to student needs for self-study.
- ❖ As WBIESs we consider either web-based intelligent tutoring systems (ITSs) or adaptive hypermedia education systems (AHESs) incorporating intelligent techniques.
- ❖ E-learning environments provide facilities mainly for helping course generation and management and refer to both the tutors and the students.
- ❖ Adding “intelligent” facilities for tutors in e-learning environments make them a kind of intelligent e-learning systems (IELSs)

>> Introduction

A system, in order to facilitate adaptive support, should be designed to meet the following operational criteria for adaptability:

- ❖ Adaptive presentation of learning content.
- ❖ Adaptive use of pedagogical devices.
- ❖ Adaptive communication support.
- ❖ Adaptive assessment.
- ❖ Adaptive problem-solving support.

2. COFALE (Cognitive Flexibility in Adaptive Learning Environments)

- ❖ COFALE is an adaptive e-learning environment supporting cognitive flexibility. COFALE is based on ATutor, an open-source, web-based learning content management system (LCMS) designed and maintained by ATRC (Adaptive Technology Resource Center).
- ❖ COFALE manages to successfully accommodate the first three requirements (Adaptive presentation of learning content, Adaptive use of pedagogical devices, Adaptive communication support).

3. Extending COFALE

To make COFALE meet our needs, we made some modifications and extensions to it, presented in the following sub-sections:

- Domain Knowledge
- Test Creation
- Student Assessment

We call the extended system EX-COFALE (EXTended COFALE). To test our system we implemented a course on 'radio safety' for the needs of the Nurse Department of the Technological Educational Institute of Patras.

3. Extending COFALE

- Domain Knowledge

- ❖ COFALE uses a tree-like structure to represent domain knowledge. COFALE can alter the domain knowledge tree presented to the user depending on the user model. What it does is to hide certain subtrees, which are not appropriate for a certain user.
- ❖ EX-COFALE goes a step further. It can re-arrange the branches of the tree, based on the user's model, thus achieving something like concept sequencing.

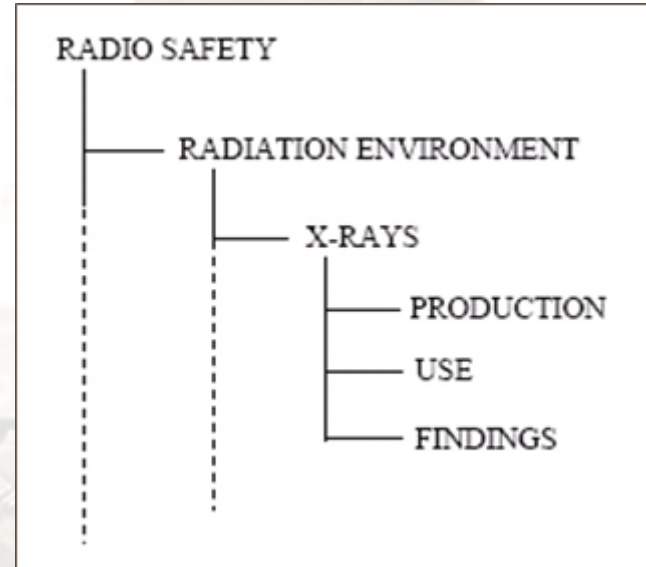


Fig. Part of a Domain Knowledge Tree

3. Extending COFALE – Test Creation

Ex-COFALE has more functionality as far as test construction is concerned:

- (a) The tutor can associate a test to a specific learning goal (set of concepts).
- (b) The system can now fully automatically create a test.

The tutor should only create and store questions in the system's database.

Also, he/she may define the number and the difficulty levels of the questions to be included in a test for each concept.

This is done via a rule-based expert system.

3. Extending COFALE

>> Test Creation

- ❖ As far as creation of test questions is concerned, we added the capability of defining associations between a learning concept and corresponding questions. A test has each question associated with a specific learning concept. More than one question may refer to the same concept. Questions may have different difficulty levels assigned to them.
- ❖ The questions are created once, while in COFALE the tutor had to create the same question for different tests more than one time.

3. Extending COFALE

>> Test Creation

- ❖ In the course of “radio safety” there are different questions, with different difficulty levels associated with the sub-concepts Production, Use, Findings of X-Rays. The only thing the tutor has to do, regarding test creation for the above topics, is to check these topics for which the system will collect questions from the database and generate a test. He/she also has to assign this test to a specific student model.
- ❖ A revisional test is made by the tutor, after he/she selects together all the concepts he/she wants the system to generate a test for.

3. Extending COFALE – Student Assessment

Student evaluation (or assesment) refers to the evaluation of the knowledge level of a student after having dealt with a learning goal, how well a student has learnt the concepts related to a learning goal.

- ❖ COFALE allows for evaluation of students based on the tests provided for each learning goal. It allows for a learning goal level evaluation based on tests with predefined indistinguishable questions. There is no explicit representation of which concept each question refers to (or examines). The system cannot be aware of those associations to use them.

3. Extending COFALE

>> Student Assessment

In EX-COFALE, a student is evaluated at two levels:

- (a) the concept-level
- (b) the goal-level

The concept-level evaluation deals with the level of understanding of the individual concepts of a learning goal test.

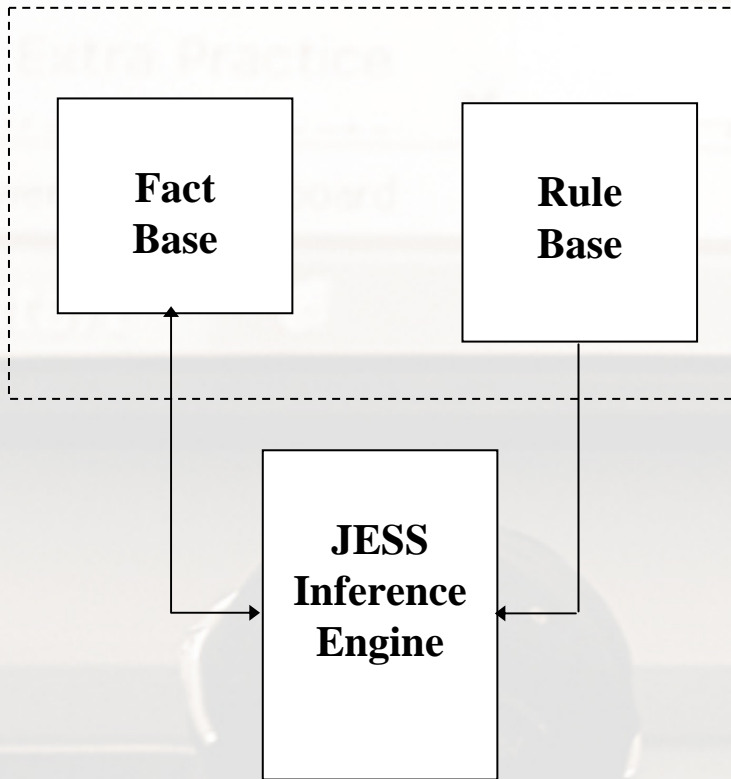
The goal-level evaluation deals with the level of understanding of a learning goal as a whole.

EX-COFALE allows for on-line test creation, even if a student has not completed the study of all of the concepts related to a learning goal.

This is achieved via the above mentioned rule-based expert system.

3. Extending COFALE >> Student Assessment

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The structure of the ES

The knowledge level of a student, as far as concept is concerned, is classified in one of the following three categories:

- (a) low (0-49),
- (b) medium (50-70),
- (c) good (71-100).

The knowledge level of a student, as far as learning goal is concerned, is classified in one of the following five categories:

- (a) low (0-30),
- (b) average (31-49),
- (c) good (50-70),
- (d) very good (71-85),
- (e) excellent (86-100).

Within the parentheses are the corresponding ranges of the marks to be achieved

3. Extending COFALE >> Student Assessment

The knowledge level of a student for a concept, called concept level (CL), is calculated via the following formulas:

$$CL = \sum_{i=1}^3 Qm_i * qw_i$$
$$Qm_i = \frac{\sum_{j=1}^n Qm_j^i}{n}$$

Qm_i is the average mark of the answers to questions of the same difficulty level related a specific concept

Qm_j^i represents the answer to question j (which is 100 if it's correct and 0 otherwise)

n is the number of the questions of the same difficulty associated with the concept

i represents the difficulty level (1 → easy, 2 → medium, 3 → difficult)

qw_i is the question's weight

If $CL \geq 0.5$ then the student has an acceptable level of knowledge about the corresponding concept.

3. Extending COFALE

>> Student Assessment

The weight of a question is related to the difficulty level of a question and the composition of the set of questions used for testing the concept. Table 1 presents the corresponding weights.

It is assumed that at least two questions for each examined concept exist in a test.

Table 1. Question weights

Easy (E)	Medium (M)	Difficult (D)	Question (s) Weight (s) (/100)
1	1	1	20 (E), 50 (M), 30 (D)
1	1	0	40 (E), 60 (M)
1	0	1	40 (E), 60 (D)
0	1	1	60 (M), 40 (D)

3. Extending COFALE

>> Student Assessment

The knowledge level of a student for a learning goal, called goal level (GL), is calculated from the following formula:

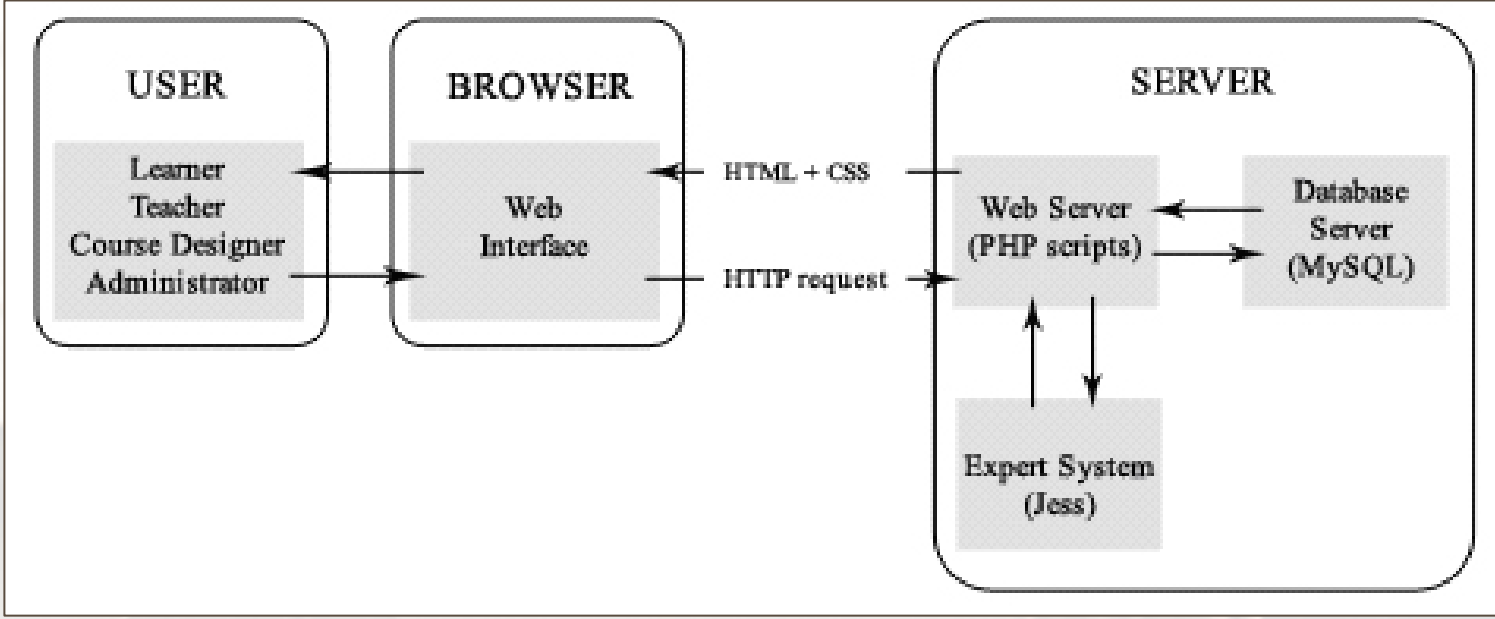
$$GL = \frac{\sum_{i=1}^n CL_i}{n}$$

n is the number of concepts that constitute the learning goal

CL_i is the value of the knowledge level of the student for concept i (i.e. the achieved mark before it is classified in one of the three levels)

If $GL \geq 0.5$ then the student has an acceptable level of knowledge about the corresponding learning goal, given that each $CL_i \neq 0$, that is there is no concept not studied at all.

4. Implementation Architecture



EX-COFALE Architecture

A core prototype of the system has been implemented, which does not offer at the moment all designed functionalities.

5. Related Work

- ❖ ALE (Adaptive Learning Environment) is an e-learning environment that integrates an intelligent tutoring system, a computer instruction management system and a set of cooperative tools.

ALE can produce individualized courseware for students, based on their current state of knowledge, their preferences and learning styles. So, it supports adaptive content presentation.

It does not support any facility for student assessment management.

EX-COFALE provides tutor with the ability to evaluate the learner's performance and monitor his/hers comprehension of the concepts, learning goals independently.

>> Related Work

❖ aLFanet (Active Learning For Adaptive interNET)

The authoring subsystem provides facilities for the creation of instructional-based courses and optionally the possibility to define adaptive questionnaires. Course administration subsystem includes the users' management, learners/tutors assignment to the courses, permissions management and users' data privacy. LMS eLearning instruction subsystem includes an adaptive course presentation depending on the learner profile and preferences, dynamic user modeling (learner profiles refinement) and tools for learning process (collaborative frameworks).

aLFanet does not seem to provide any facilities for student assessment.

It does not provide any sensible reports to authors to help them to evaluate how learners are dealing with course activities.

>> Related Work

❖ System by Hsuam-Pu Chang et. al.

Assessment is based on the correct answers and the time taken to deliver it. All students must attend the same course. The questions' difficulty is calculated by the average performance of all the students to each of these questions.

Students get a secondary evaluation by the total study time of a course unit compared to the minimum requirement time which was preset by instructor for that particular course unit.

The object navigation frequency must be over the threshold which was defined by instructor.

It does not seem to offer automatic test creation.

In EX-COFALE more experienced learners might have good test results without having to have a thorough attendance of some learning concepts.

This system does not provide any collaborative tools for further student assessment between the other course members.

>> Related Work

❖ System by Paul Dan Christea et. al.

It uses three levels of assessment (paragraph, sub-chapter, and chapter). Tests can be adaptively (dynamically) created.

Questions are not distinguished by difficulty level; all are considered as equally contributing to the final mark.

There is a mark threshold associated with each learning item that should be overtaken by the student in order to consider that he/she has successfully passed it.

The system is rather examination-oriented.

EX-COFALE offers a wide variation and different styles of collaborative tools.

6. Conclusion

- ❖ In EX-COFALE, we introduce automated test creation and assessment based on the students' knowledge information. COFALE has been modified to allow for representation of associations between test questions and learning concepts.
- ❖ Questions are distinguished in three levels of difficulty. Assessment is done at two levels, the concept and the goal level. In the assessment process, the difficulty level of questions is taken into account, which is not the case in existing systems. To technically achieve the above, expert systems technology is used.

>> Conclusion

- ❖ Although EX-COFALE at its present design offers capabilities for adaptive assessment, it does it in a degree that can be improved. For example, answers to questions are marked as correct or wrong, i.e. by two concrete values. This may not assess correctly the knowledge level of students. A more fine grained marking would improve it. To this end, other factors related to student interaction could be taken into account (e.g. number of tries, whether system help were used etc).
- ❖ Assessment is not parameterized as far as expert system rules are concerned. An authoring unit related to expert system rules could be another direction for improvement.
- ❖ Finally, adapting the difficulty level of the questions of a test to student's current knowledge level is another aspect for strengthening assessment adaptation.

7. Acknowledgements

This work was partially supported by the European Social Fund (ESF), Operational Program for Educational and Vocational Training II (EPEAEK II), 2.2.2.a (Nurse Department of the Technological Educational Institute of Patras, Greece).

Thank you,
for your attention!