Assessment and reuse of contents in the competence-based educational platform InterMediActor

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Abstract: - This paper describes a failure alert system and a methodology for content reuse in a new instructional design system called InterMediActor (IMA). IMA provides an environment for instructional content design, production and reuse, and for students' evaluation based in content specification through a hierarchical structure of competences. The student assessment process and information extraction process for content reuse are explained.

Key-Words: - Distance learning, Learning management systems, Student assessment, Failure alert systems, Content reuse.

1 Introduction

The assessment of the e-learning process has been studied from different points of view. Most of studies put attention in the assessment of educational software [1], the evaluation and accreditation of educative programs [2], or the assessment of e-learning institutions [3]. Nevertheless, it is difficult to find scientific works that propose assessment models for e-learning platforms. Furthermore, proposals for content specification, such as SCORM [4] or IMS Learning Design v.1.0 [5], mention the evaluation of the e-learning process as an advantageous aspect in any distance learning environment but they do not propose any guideline for its implementation.

On the other hand, the assessment tools made by developers of e-learning platforms do not consider the students' behaviour, taking into account only the results of exams and losing the main advantage in an e-learning environment: the personalized supervision of the interaction between students and system in real time.

For these reasons, this paper proposes a new model to assess the learning process in the experimental platform InterMediActor [6] [7].

This is a generic model that can be easily carried out in any other platforms. It is based on the extraction of information from interactions among students, learning contents, and assessment tools.

The goals of this work are three. First, to develop a pedagogical tool that assesses the students' learning process. Second, to develop a set of measurement devices that inform tutors about different problems during the course. And finally, to create historic records with information about students, contents, assessment tools, and the complete course, to allow its efficient reuse.

This paper is structured as follows: the next section describes the system in which this model is implemented. In the following sections, relations among elements of the system are presented. Then measurement devices for the failure alert system are defined. Finally, historic records generated by the system are shown.

2 Architecture

2.1 System's specification

The evaluation model presented in this paper is being implemented in platform InterMediActor (IMA) [8].

This platform features the use of a method for designing and using educational content based on the concept of a "competence" [9].

In a few words, a competence (figure 1) can be defined as a concrete, contextualized, grounded educational objective [10]. It is composed of six elements: advance organizer, content, objectives, self-assessment, final assessment and summary.

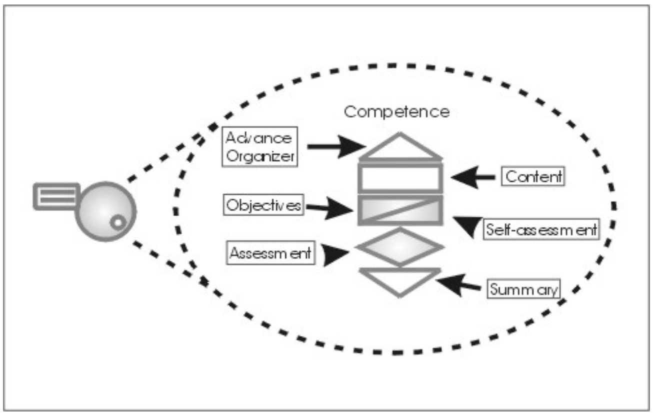

Fig. 1: Structure of a Competence.

The advance organizer introduces the content that will be studied in the competence. The content of a competence can be atomic, i.e. a content which cannot be expressed coherently in a more specific form, or aggregated, i.e. a content created by aggregation of other more specific competences. Objectives enumerate the learning objectives that a competence satisfies. Through self-assessment tests learners can measure their knowledge before they face the final assessment. Successful final assessment tests enable students to proceed with learning new material. Finally, summaries state what the learning outcome of the competence has been, in order to encourage a feeling of achievement.

Competences can be aggregated (figure 2) to get more complex contents [11]. In this way, it is possible to specify contents from the most basic levels (atomic competences) to the most complex levels (unit and course competences).

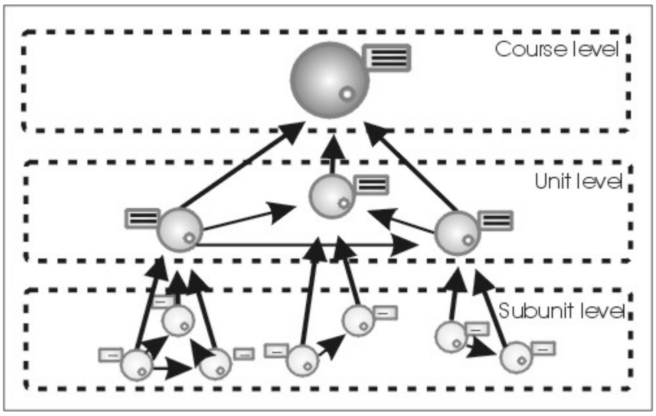

Fig. 2: Content's specification using the aggregation of competences

Once an atomic competence is created, a set of questions must be defined to evaluate its content. Nonetheless, students won't usually study an atomic competence, but aggregated competences at unit level. These aggregated competences are evaluated using questions collected from the different atomic competences integrating them. In this way, an aggregated competence has a wide set of questions against which learners can be assessed.

IMA uses two tools to assess learners: final assessment tests and control questions. Final assessment tests are questionnaires presented to students when they finish a unit. If a student passes the exam he/she will be able to proceed to new units. If the student fails the exam they must repeat their work in that unit. A test is composed of some questions that the system extracts from the set of questions available for that unit.

The control question tool is a single question that the system asks students to record their attention level. When a learner is studying the content of a competence unit, the system automatically makes a control question, and records the response and the time needed to answer.

The self-assessment test tool helps learners in the learning process. The self-assessment test is an exam resembling the final assessment test, but the student's results are not recorded. Guaranteeing student anonymity, the system encourages students to use this tool.

Both tools select questions randomly. Nevertheless, each question has an initial weight that will be incremented each time that the question is used. In this way, the system avoids problems of "question underused or overused". In each assessment the questions with less weight will be more likely selected selected. In addition, all questions have been defined as close question with multiple selections.

In conclusion, the environment of this proposal is characterized by: the specification of contents by competences and two assessment tools, the first one analysing the students' learning process (control question), and the second one allowing students to proceed to new competences (final assessment test).

2.2 Relations among competences, students, and assessment tools

Basic elements fleshing out the learning process in the IMA platform are: competences (contents), students, assessment tools and tutors, as proposed in [12]. From these, information inherent to their interaction during a course can be extracted (figure 3). These relations are defined below.

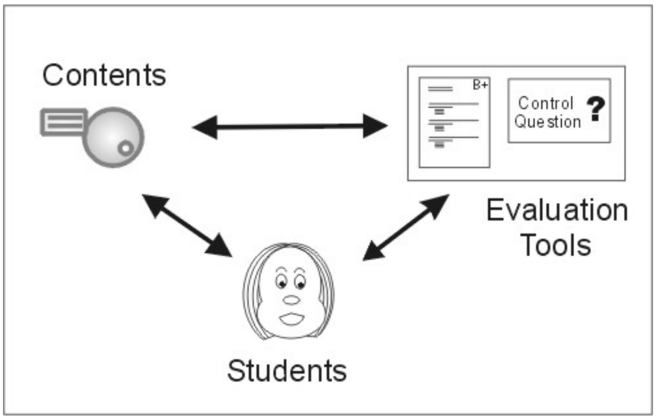

Fig. 3: Relations among competences (contents), students and assessment tools.

Student-Contents Relation (figure 4): this relation is produced once a student interacts with the contents of a unit competence. This relation is analysed with regard to a student.

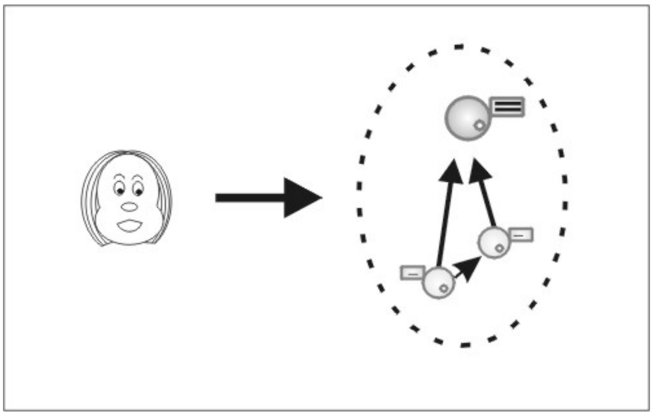
Fig. 4: Student-Contents Relation.

The piece of information extracted from this relation is the percentage of units visited by a student. To extract it, the system measures the quantity of units viewed by each student and the time needed for their study.

Student-Assessment Relation (figure 5): this relation is produced when a student interacts with assessment tools.

As previously mentioned, the system has two assessment tools: control questions, and final assessment tests.

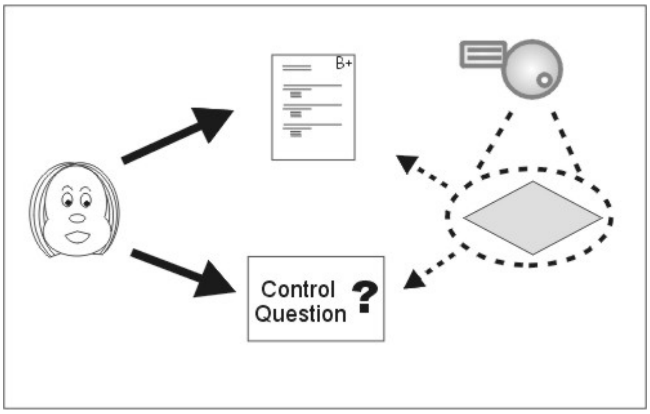

Fig. 5: Student-Assessments relation.

a. *Control* questions: IMA randomly extracts a question from the pool of questions available inside those subunit competences that the student has already passed. The system considers a subunit competence as studied when all its content has been viewed by the student. In this way, it is impossible to ask questions from contents as yet unseen, as recorded in the Student-Contents relation. This relation considers the next items of information:

1. Answers chosen in the control question (result), and
2. Time needed to answer.

b. *Final assessment tests:* once a student finishes studying a unit, the system automatically creates a questionnaire with question from atomic competences belonging to it. This questionnaire is the final assessment test for the unit. Information extracted from this interaction is:

1. Result for each question.
2. Time needed to answer each question.
3. Assessment test mark.
4. Time needed to answer the test.

Content-Students Relation (figure 6): describes the relation between several learners and a unit competence.

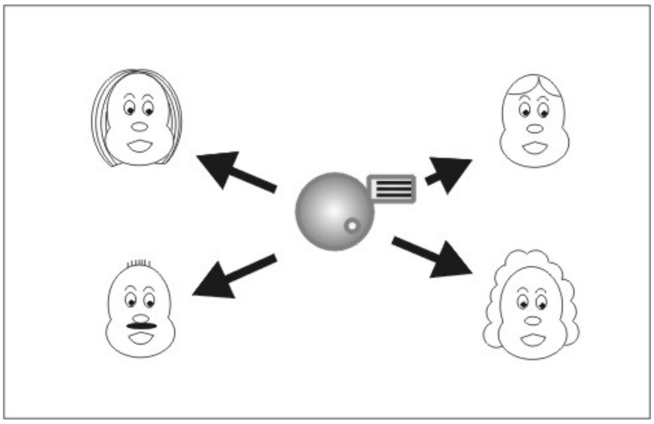
Fig. 6: Content-Students Relation.

It is analysed with regard to a unit competence. The system draws conclusions about the content of a unit analysing interactions of several students with that unit. Information items extracted from this relation are:

1. Mean time of study for the unit.
2. Mean percentage of the unit visited by students.
3. Student average mark in the unit.

Content-Assessments Relation (figure 7): in this relation unit competences and assessment tools are related.

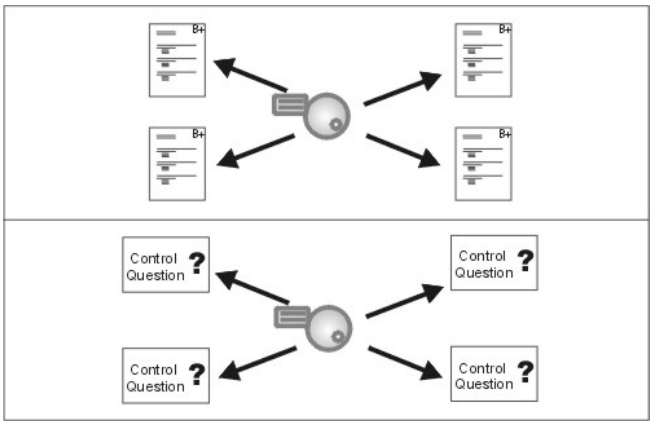

Fig. 7: Content-Assessments Relation.

Because assessment tools use questions extracted from the different competences integrating each unit, it is possible to know the level of representation of these competences in assessment tools [12].

Assessment-Students Relation (figure 8): this relation operational once several students have interacted with the evaluation tools.

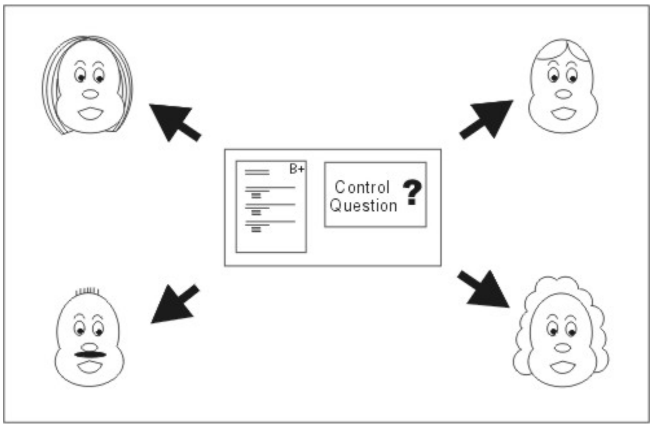

Fig. 8: Assessment-Students Relation.

Actually it relates students to questions asked to them (either in tests or control questions). In this way, the items of information seen below can be extracted:

1. Percentage of right questions, and
2. Distributed Percentage of selected items (i.e. A. 80%; B. 8%; C. 2%; D. 10%).

Assessment-Content Relation (figure 9): this relation is established between questions and unit competences. It is analysed with regard to questions.

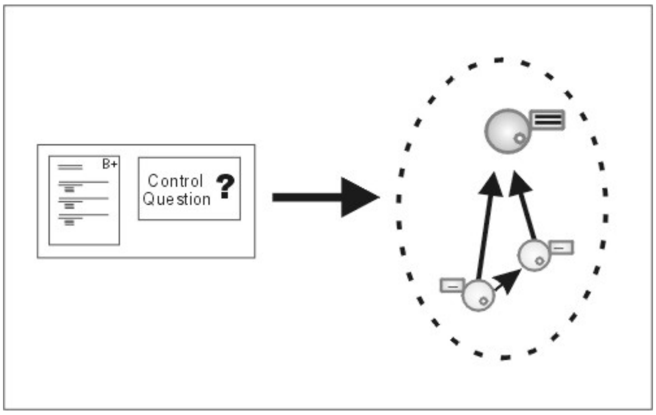

Fig. 9: Assessment-Contents Relation.

Through this relation it is possible to know the frequency of use of a question.

3 Results

3.1 Failure Alert System

IMA stores information extracted from these relations (table 1) in XML documents defined for each student, unit competence, and question.

Student	Contents	S1. Time of study
		S2. Percentage of visited unit
	Assessments	S3. Control question result
		S4. Time of answer in the control question
		S5. Exam's mark
		S6. Time of answer in the exam
Content	Students	C1. Mean time of study required by a unit
		C2. Mean percentage of unit visited by students
		C3. Students' mean mark in a unit
	Assessments	C4. Level of representation of the content in the assessments
		C5. Distributed percentage of marks obtained by students
Assessment	Students	A1. Percentage of right answers in a question
		A2. Distributed percentage of answers by item in a question
	Contents	A3. Use frequency of a question

Table 1: Information extracted from student-content-assessment relations.

IMA combines these metadata using XSLT stylesheets that allow the creation of gauges. These gauges will help tutors to supervise the development of a course. Gauges defined in IMA are:

1. Content not very clear o very complex.
2. Content very easy.
3. Question not very clear or wrong posed.

4. Problems in the learning process of a student.

In an e-learning process it is as detrimental to have a lot of complex content as to have a lot of easy content, because both situations induce students to leave the course. For this reason the firsts two measures have been defined.

The system considers a piece of content not very clear or rather complex when a high percentage of students (greater than 80%) attain any of the pattern of results shown in table two:

Mean time of study	HIGH	LOW
Mean percentage of unit visited	HIGH	LOW
Marks	LOW	LOW

Table 2: Patterns describing either unclear or very complex content.

The system considers that content is very easy when a percentage of students greater than 80% attain any of the pattern of results shown below (table 3):

Mean time of study	LOW
Mean percentage of unit visited	LOW
Marks	HIGH

Table 3: Pattern describing very easy content.

In both cases, the content supervisor receives a message from IMA in which a possible problem is alerted.

Another frequent problem in an e-learning environment is the existence of ill-posed questions in assessment tests. Due to the fact that students cannot interact with their tutors when they face assessment tests, it is necessary to provide a method to detect this sort of questions.

IMA considers as ill-posed those questions with a very low percentage of success, and a distribution of answers either around an average wrong answer or uniformly distributed over every answer (table 4). Also, when IMA finds an ill-posed question, it checks whether this may stem from the content it refers to being unclear. If there is no such problem, the system considers that question as ill-posed in itself.

Percentage of right answers	VERY LOW	VERY LOW
Distribution of answers	CONCENTRATED	RANDOM

Table 4: Wrongly posed question.

Finally, IMA detects problems in the learning process of students. To find these problems the system must be sure that there is not a problem with content being either very complex or very easy. Once the system is sure that there is a problem with only a particular student, it sends a message to his/her tutor alerting about either of two possible problems: on one hand, if the system finds a situation similar to that shown in table five, it sends a warning about content being too easy, i.e. the student knowledge level is higher than the level of contents studied; on the other hand, when IMA detects the results showed in table six, it sends a warning about content being too complex (but in this case it could also mean any other problem, so only the interaction between student and tutor can shed light on it).

Time of study	LOW
Visited unit percentage	LOW
Mark	HIGH

Table 5: Content very easy for a student

Time of study	HIGH
Visited unit percentage	HIGH
Mark	LOW

Table 6: Content very complex for a student

3.2 Creation of historic records

Finally, with all data presented in table 1 IMA creates several XML historic records with information about different elements of the learning process.

For each student a log is generated recording all information about his/her learning process. Figure 10 shows (a part of) an example of this type of records:

```
<xml version="1.0" encoding="UTF-8">

<STUDENT id="S00157" studentLevel="2">
  <NAME>…</NAME>
  <SURNAME>…</SURNAME>
  <PROFILE>…</PROFILE>
  <TUTOR>…</TUTOR>
  <STUDENT_RECORD
    meanMark="…"
    meanTimeOfStudyForUnit="…"
    meanPercentageOfUnitVisited="…"
    percentageRightControlQuestions="…">
    <UNIT id="…"
          mark="…"
          timeOfStudy="…"
          percentageUnitVisited="…"
          percRightContrQuestions="…" />
    <UNIT … />
  </STUDENT_RECORD>
<STUDENT>
```

Fig. 10: Historic record for a student.

Furthermore, a historic record is created for each unit competence (figure 11) with information about its use.

```
<xml version="1.0" encoding="UTF-8">

<COMPETENCE id="c000127"
            level="UNIT"
            meanTimeOfStudy="…"
            meanPercOfUnitVisited="…"
            studentsMeanMark="…"
            percentageMarkA="…"
            percentageMarkB="…"
            percentageMarkC="…"
            percentageMarkF="…"
```

```
              levelOfRepresentation="…" />
```
Fig. 11: Historic record for a unit.

Every question will have also its historic record (figure 12). In this way it is possible to follow the use of each question.

```
<xml version="1.0" encoding="UTF-8">

<QUESTION id="Q1015"
          competence="C000002"
          weight="2"
          rightAnswerItem="A"
          responseTime="…"
          percOfRightAnswers="…"
          percAnswerItemA="…"
          percAnswerItemB="…"
          percAnswerItemC="…"
          percentegeAnswerItemD="…"
          useFrecuency="…" />
```
Fig. 12: Historic record for a question.

Finally, with all this information the system, at the end of a course, generates a historic record with information from all historic records presented before (figure 13).

```
<xml version="1.0" encoding="UTF-8">

<COURSE id="C001"
        title="…">
  <COURSE_RECORD>
    <EDITION number="01"
             supervisor="…"
             studentProfile="…"
             numberOfStudents="…"
             percOfApprovedStudents="…"
             percOfStudentsWithMarkA="…"
             percOfStudentsWithMarkB="…"
             percOfStudentsWithMarkC="…"
             percOfStudentsWithMarkD="…">
      <COMPETENCE id="c000127"
            level="UNIT"
            meanTimeOfStudy="…"
            meanPercOfUnitVisited="…"
            studentsMeanMark="…"
            percentageMarkA="…"
            percentageMarkB="…"
            percentageMarkC="…"
            percentageMarkF="…"
            levelOfRepresentation="…" />
      <COMPETENCE … />
    </EDITION>
    <EDITION>…</EDITION>
    …
  </COURSE_RECORD>
<COURSE>
```
Fig. 13: Historic record for a course.

The historic record of a course will be increased with information from each new edition of that course. In this way it could be possible to know, for example, the best contents for a specific student profile, unit competences that need to be improved, etc.

4 Conclusions

Around the concept of a competence, this work has introduced a Learning Management System, a failure alert system and a method to reuse contents based on historic records.

The methodology to deploy this system has been detailed. Nevertheless, as this system is currently under development, it will be necessary to wait before real data can be measured directly inside InterMediActor.

5 Acknowledgements

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