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Designing an Innovative Training Tool: A Formative E-Assessment System for Project Management

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1. Introduction

Learning is the only way of developing the necessary competences in the new economy and e-learning is a strategic instrument in this process. E-learning platforms must not be just tools of content distribution of pedagogical resources and not taking into account the real interests of the learners: "…without personalization, e-learning is only ever going to be a generic mass produced experience and will tend towards a model of teaching that makes the computer a virtual lecturer, rather than a virtual personal tutor" (Ashman et al., 2009). In order to correct this drawback of e-learning, coming from the lack of personalization, researchers and educators try to use various methods: evolutionary algorithms, personalized e-testing rules, adaptive feedback or exploiting recommender engines, connected to learning applications. All these methods are briefly described in this paper, in the context of e-assessment in project management (PM) domain. The interest towards the e-assessment services in e-learning environments is explained by the applicability of the e-assessment in various types of education, from formal education, in schools and universities, to work-based education and preparation activities for obtaining professional certifications. The interest for the PM domain is explained by the strategic importance of project, as main form of organization in current economy.

In order to improve learning effectiveness, the formative dimension of e-assessment has been increasingly developed: it isn't regarded only as an evaluation tool, but also as a learning tool. Formative assessment is defined as "an ongoing process of monitoring learners' progresses of knowledge construction" (Hsu et al., 2010) or "the process of seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go and how best to get there" (Assessment Reform Group (ARG), 2002). Its value was greatly appreciated by researchers: formative e-assessment promotes self-reflection and students can take control of their own learning (Pachler et al., 2010). The authors argue that it fills a knowledge gap, that's why formative e-assessment has an important role in learning and training. It is well-used in organizational learning (Bodea & Dascalu, 2010), being known as "assessment for learning" (Birenbaum et al., 2009).

This chapter proposes an adaptive formative e-assessment system, useful in preparing for project management professional certifications. The chapter has several parts. The first one is introductory. In the second part, the authors briefly present a set of formative e-assessment systems used in project management training. In the third part, some theoretical models used in the implementation of the systems are revealed, as well as the state of the art in e-assessment. In the fourth part, the main technical and functional considerations of the developed system are presented. The fifth part consists of the main experimental results. In the sixth and the seventh parts, the future directions and the main conclusions are drawn.

The proposed e-assessment system proved to be an efficient one, from the point of view of its performance and utility. Compared to other e-testing approaches (such as dynamic testing), our solution turned out to be more suitable for large item banks. As a formative learning tool, our solution helped the students to obtain a lower rate of failure and a sharper learning progress curve. There are a few shortcomings of the proposed system, from the point of view of the trainers: they would want to benefit from predefined tests, to add video materials within the solution or to build criteria for rules creation. Still, these improvements can be solved in the feature. The results of the system's evaluation are good enough, that is why one can consider that our e-assessment proposal is an improvement in the area of adaptive e-assessment. Thanks to its formative value, it can be easily used by firms to develop employees' competences.

2. Formative e-assessment in professional training

Without minimizing the importance of practical experience and portfolios, one can state that certifications awarded by well-known professional associations are a proof of professional competences. E-assessment applications are useful tools in the preparation processes for obtaining such certifications. In the field of project management, the Swiss branch of International Project Management Association (IPMA) offers an e-assessment tool, useful to the individuals who are eager to get certified: "X-AM" (http://www.sts.ch/index.php?option= com_content&task=view&id=21&Itemid=42). The users can also see, in addition to navigation buttons and time limits, a navigation table, in the left side of the screen: see Figure 1. The table groups the questions in four categories: the current question, the questions which didn't receive any answers yet, the questions which were answered and the so-called marked questions (to which the user may want to return, as she/he is not sure of the validity of the given answer). Thus, "X-AM" becomes a flexible application, oriented towards the users' needs.

Another useful e-assessment application for project management is the one offered by Queendom (http://www.queendom.com/tests/access_page/index.htm?idRegTest=1130): the application is useful in professional trainings, as it determines the user's profile: whether the user has a suited behavior for projects-based work. The Queendom e-tests resemble to quizzes (see Figure 2): they have 196 questions, graded using a five-point Likert scale (from "Strongly disagree" to "Strongly agree"). Actually, the e-tests check the behavior competences from the IPMA Competences Baseline (International Project Management Association, 2006): the leader competences, the management competences, the interaction or decision competences.

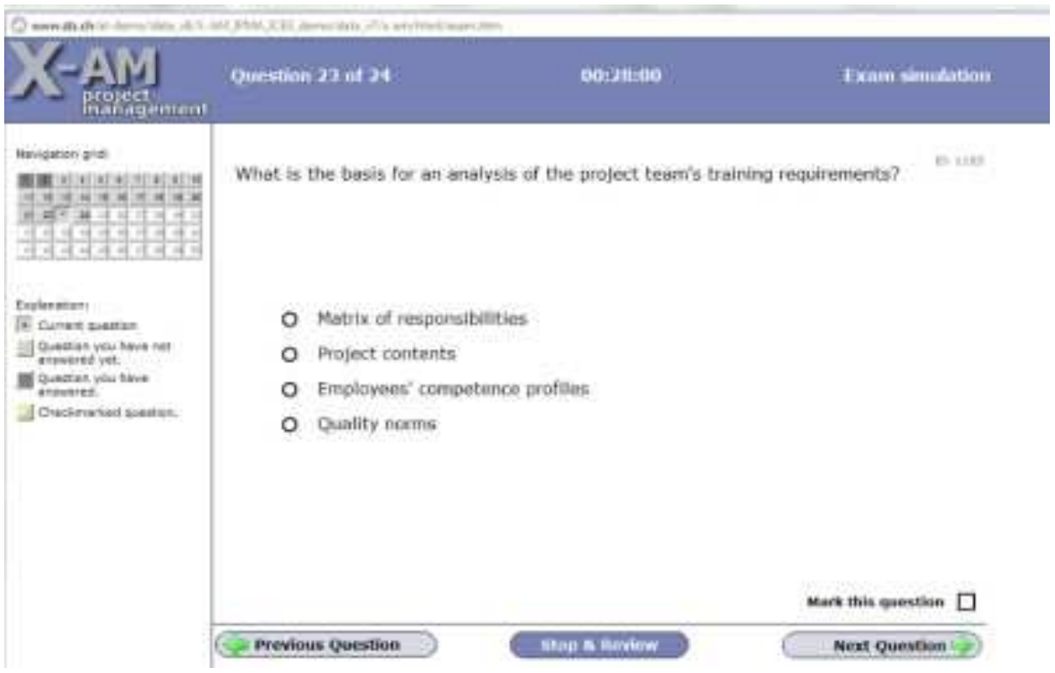


Fig. 1. "X-AM" E-assessment Application



Fig. 2. Queendom E-assessment Application

Another standardized e-assessment system used in business administration and management domains by over 200 000 students is the Graduate Management Admission Test (GMAT): see Figure 3.

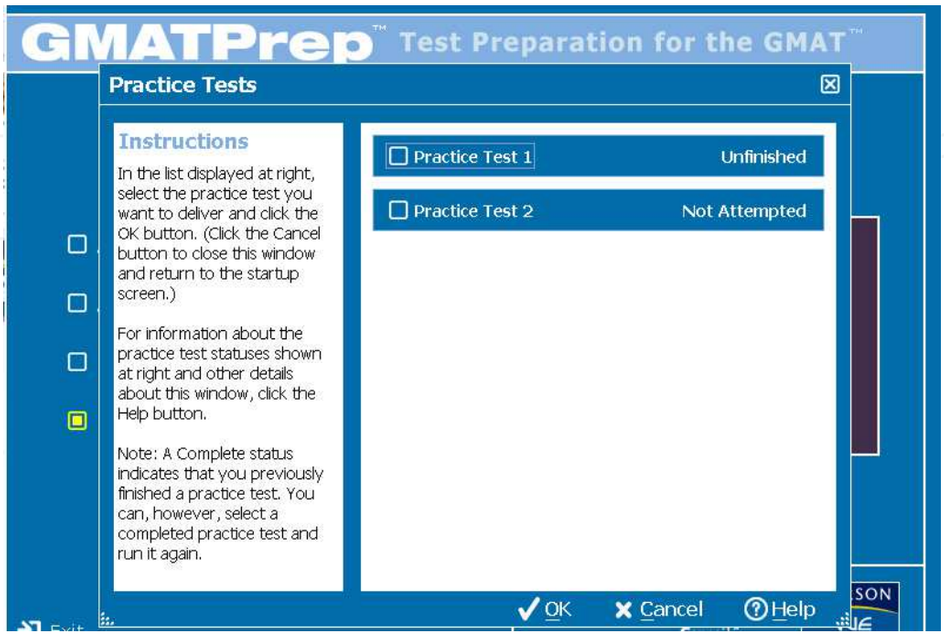


Fig. 3. The E-assessment Application used to Prepare for GMAT Tests

As the preparation for a professional certification might be quite time consuming for an individual engaged in economic activities, the Romanian Association of Project Management offers an e-assessment tool for simulation purposes. This practice complies with the effort of digital economy to raise the accessibility level of information systems: individuals don't have to go the association's office and take a simulation test there; they can do that from anywhere, even from their office. The assessment mechanism offered by the Romanian Association of Project Management benefits from a web service to interrogate the questions' database. The algorithm of building the simulation tests respects some knowledge constraints, bounded to the certification level and a stop criterion, bounded to the questions number in a test. The e-assessment, "CertExam", is available at: http://www.pm.org.ro/certexam/ (see Figure 4).

For e-assessment to be more efficient in the professional training activities, it has to be enriched with formative attributes. Shavelson identifies the following practices in formative assessment: on-the-fly or spontaneous assessment, planned-for-interaction assessment, embedded assessment (Shavelson, 2006). The challenge is to include these formative assessment techniques into information systems. Black and William (2009) pointed a set of activities to be mandatory in order to build a formative e-assessment system: providing feedback that moves learners forward, clarifying and sharing learning intentions and criteria for success, activating students as owners of their own learning or as instructional resources for one another (Black & William, 2009). Wang (2008) completes the list by adding the possibility of repeating the test (correct answers are not immediately given, so that the test can be repeated till all the answers are correct), the possibility of seeing query scores (users

are given other users' scores, so that they can compare themselves), applying "all pass and then reward" strategy.

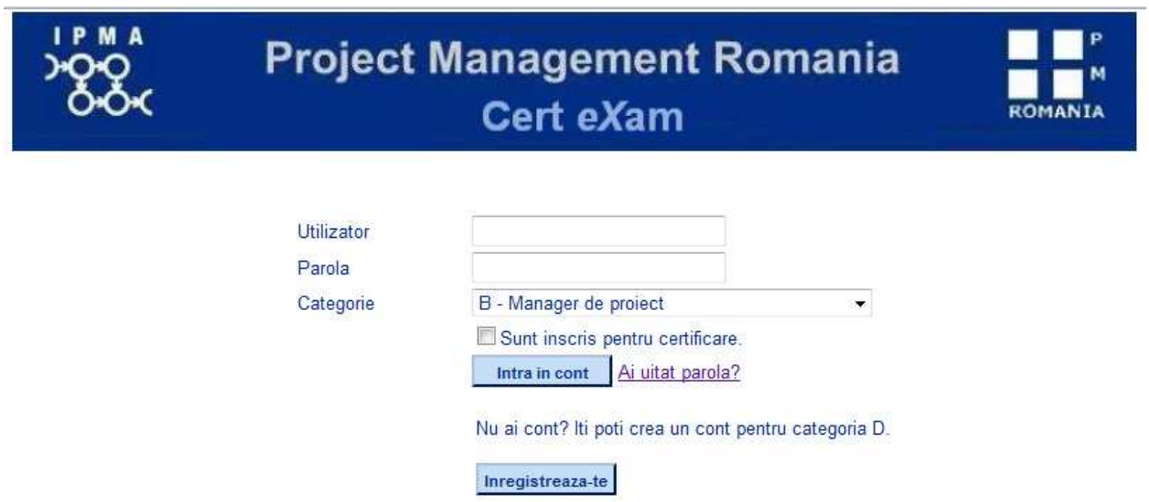


Fig. 4. "CertExam" Application used by the Romanian Association of Project Management

The primary challenge in building a formative assessment application is to really find out what students know, to detect cognitive models used by the students during the representation of the test concepts and apply those models to build computer adaptive tests. Assessment applications have to be tailored not only for students but for teachers and trainers, who use them to create test: each has different priorities, different constraints and different capacity to compromise (for example, some teachers will prefer the test construction to be less flexible, but easier to achieve).

3. Theoretical considerations in building formative e-assessment tasks

According to AL-Smadi & Gütl (2008), the reasons for using e-assessment instead of pen-and-pencil tests are both practical and pedagogical. The practical ones are given by the increase of students' number and, implicitly, of teachers' quantity of work. The e-assessment is meant to resolve the problem of the evaluation of a large number of students in a short period of time. The pedagogical reasons come from the need of systems which evaluate students' knowledge correctly and efficiently. In the past, the purpose of the e-assessment applications was to shorten the time spent by the teachers for evaluation process, but now, the e-assessment applications have new challenges to overcome: the efficient management of questions, the building of intelligent tests, adapted to each user.

The questions' management depends on the type of questions. Open questions are scarcely used in e-assessment, that is why the future discussions will target only the closed questions. The most spread type of question is the multiple-choice question, which is built-up from:

- question root (the question's body);
- pre-built answers, which contain:
  - the key(the correct answers);

- the distractor (the wrong answers).

In order to manage this type of questions, the relation between question and answers has to be treated: each answer has to have a binary value (for example, 1 for correct answers and 0, for the wrong ones). An issue which has to be taken into consideration when building multiple-choice answers is the fact that the correct answer can be guessed. To reduce this risk, Roșca & Cristescu (2004) propose the method of correlated items or the method of inserting a negative value in the scoring algorithm, as a penalty for choosing the wrong answers. The method of correlated items was successfully applied in large-scale experiments, in Taiwan, too (Tam & Lu, 2011).

An interesting approach in questions' management is given by the use of taxonomies, ontologies and semantic graphs. These advanced knowledge structures allow the implementation of advanced techniques for e-assessment. In fact, the competences and concepts from a domain which has to be evaluated through tests are structured in ontologies (Vasconcelos et al., 2009; Schmidt & Kunzmann, 2006; Bodea et al., 2010). Intelligent structures used in questions' management facilitated the development of advanced e-assessment algorithms. The creators of e-assessment applications used, besides the classical linear or dynamic tests, evolutionary algorithms (EAs), rules-based algorithms (RBA), algorithms based on computer adaptive testing (CAT) principle or recommender mechanisms to improve the feedback parts of an e-test.

3.1 Application of evolutionary algorithms

EAs are used in creating pedagogical paths, based on the learners' profile and their learning objectives. Azough, Bellafkih and Bouyakhf (2010) used genetic algorithms to resolve the problem of searching the most optimal path from a starting point, represented by learners' profile, to a final point, represented by learning objectives, while passing through intermediate points, represented by courses. Huang, Huang and Chen (2007) use genetic algorithms for curriculum sequencing, but they don't treat only the content problems, as Azough, Bellafkih and Bouyakhf (2010) do: they also search for the most optimal teaching operation (presentation, example, question or problem). Huang, Huang and Chen (2007) argue that learners' ability should also be studied, when choosing the curriculum, besides considering learners' interests and browsing behaviors.

Particle swarm optimization (PSO) is a very useful EA related technique, with a wide range of applications. Dheeban, Deepak, Dhamodharan and Elias (2010) show that PSO with inertia-coefficient is suitable for improving e-learning courses composition. They also underline that their PSO variant is better than the Basic particle swarm optimization algorithm (BPSO) and experimental results come to strengthen their hypothesis. Wong and Looi (2010) published a detailed study about the application of PSO in the content planning and e-assessment domain. They identified the work of Cheng, Lin and Huang (2009) to be the only known study about a PSO used in an adaptive dynamic question generation system for web-based testing: the key element of their work is the fitness function, which selects a different question on each step in the online test. The fitness function has three parameters: the difficulty level of the question (which has to be as closed as possible to the knowledge level of the user), the question item's relevance (as close as possible to the course content that the instructor wishes to assess the learner on) and the number of times a question is

chosen (as low as possible). Cheng, Ling and Huang (2009) compare the PSO search to the exhaustive search and conclude that the first one is more suitable for the large-scale item banks. Chen and Jiang (2007) apply PSO to an assessment paper generation system. According to Wong and Looi (2010), the main difference between an assessment paper generation system and an adaptive dynamic generation system for knowledge assessment is the step in which the PSO is applied: for the first system, the PSO is applied only once, at the beginning of the test, when all the questions are selected; for the second system, the PSO is applied at each test item selection. The PSO fitness function developed by Chen and Jiang (2007) has three sets of control variables: the learning points to cover, the ratios of the questions with different difficulty levels and the total marks of the paper. All these variables are pre-defined by the instructors. Yin, Chang, Hwang, Hwang and Chan (2006) use the same fitness function, but with different variables. Huang (2006) only uses the question difficulty as a function parameter. Wang and Chu (2008) combine a genetic algorithm with their PSO approach. Ho, Yin, Hwang, Shyn and Yean (2009) also use enhanced multi-objective PSO to improve the e-assessment services: they try to solve the problems of multiple assessment criteria and parallel test sheets' composition from large item banks. Their proposed algorithm was compared to a competing genetic algorithm and they proved the superiority of PSO over classical genetic algorithm.

The current study shows another application of PSO to the e-assessment domain. The main purpose of the application is to enhance the formative features of e-assessment, which is not regarded only as a knowledge evaluation instrument, but a knowledge creation one. In order to illustrate the suitability of PSO for resolving the formative e-assessment problem, the applied PSO algorithm is further described. The variables used in the fitness function construction are suitable for a project management certification process. PSO algorithm is a robust stochastic optimization technique, which is inspired from the movement and intelligence of swarms. It uses a number of particles that constitute a group moving around in the search space looking for the best solution. It imitates the bird from a flock which is nearest to the food. All particles have fitness values, evaluated through the fitness function and velocities. The fitness function used for the PSO algorithm applied to project management e-assessment is the following one:

$$Minimize\ f(q) = \begin{cases} |d_q - A| + |d_q - D| + \\ \frac{Exp_q \times CA_q}{ExpMax^2} + \frac{1}{CO_q}, if\ CO_q > 0 \\ |d_q - A| + |d_q - D| + \\ \frac{Exp_q \times CA_q}{ExpMax^2}, if\ CO_q \leq 0 \end{cases} \quad (1)$$

Where

q: the question id
A: ability level of the user, where, $0 \leq A \leq 1$
D: desired difficulty of the e-test, where $D \in \{0, 25;0.50;0.75;1\}$, according to the four certification levels awarded by the International Project Management Association (2006);

d_q: difficulty of the question q, where, where $0 \leq d_q \leq 1$;
ExpMax: the maximum exposure number of a question from the questions pool;

Exp_q: the exposure number for question q, where where $0 \leq Exp_q \leq$ ExpMax;
CA_q: the number of times in which question q has been correctly answered;
CO_q: number of concepts which are verified by the question q, contained by the competences established to be checked by the e-assessment session; the knowledge domain to be checked is divided in competences, which contain concepts;

The PSO algorithm is applied every time a new question is selected. The ability level of the user is updated after each given answer. The parameters from the third term of the fitness function from formula 1 are also changing each step on the way. The test difficulty and the number of concept are established by the trainee (if the session is part of one's preparation process) or by the trainer (if the session is an official step from the certification process). The other elements besides the fitness function are the ones usually used in PSO approaches (Schutte & Groenwold, 2005).

In the PSO algorithm, the goal at each iteration is to find the question having the difficulty level closest to the trainee's ability level and closest to the targeted test difficulty level, being the least exposed so far and checking a large number of concepts from the established learning objectives. The initial ability level of the trainee is established via self-evaluation, a pre-test or uses a default value (taken from a database), as shown in Figure 5.

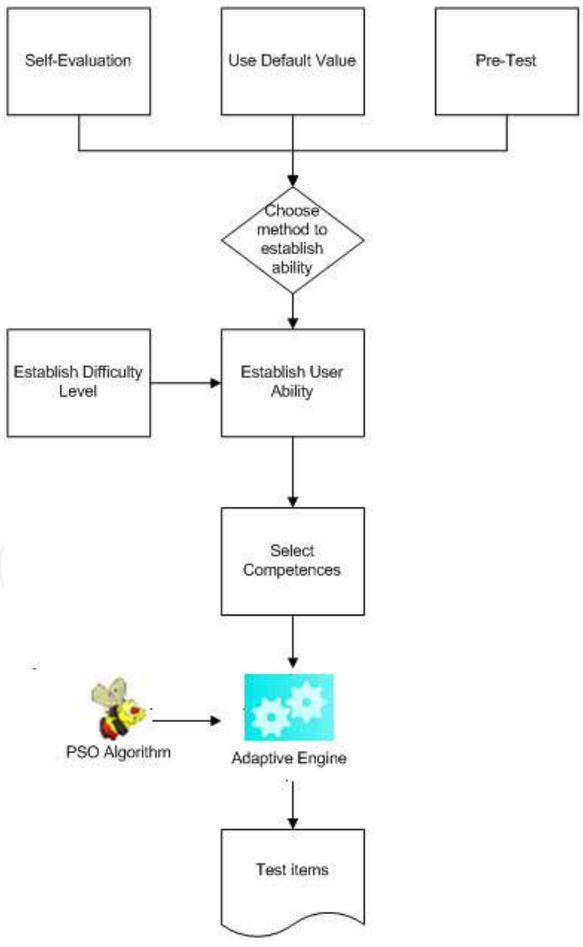


Fig. 5. Workflow of Building Tests with the aid of PSO Algorithm

The prerequisites to access the PSO algorithm are:

- establish difficulty level of the test (for each level, a difficulty value is available: the values are taken by parameter D from formula 1);
- establish the ability level of the user; if the user chooses to self-evaluate himself (inserts his own level), the number is projected to the interval [0,1], to ensure compatibility with the values of the parameter A from formula 1;
- establish the knowledge to be checked by the test; whether the user chooses to step over this stage, all the concepts will be checked; the maximum exposure number of a question from the questions pool: this operation is made by calling the database and it is not visible to the user.

3.2 Application of rules-based algorithms

To allow the creation of electronic formative tests, many researchers have used personalized rules (Lazarinis, Green, & Pearson, 2010; De Bra, Aroyo & Cristea, 2004). Test creators can enter information about assessments. Conditional rules applied in specific points of the e-tests force a new stage progress or a regress to the incorrectly answered questions (Lazarinis, Green, & Pearson, 2010). The application of rule-based tests requires the adoption of an adaptive-test prototype consisting of four parts, according to De Bra, Aroyo & Cristea (2004): the domain model, the user model, the adaptive model and the adaptive engine. Improving formative testing by applying rule-based algorithms further supports the idea that educators, trainers and teachers should be actively involved in improving the students' results, in optimizing the benefits of using e-assessments. National Research Center of assessment, standards and testing students in the U.S. proposes an application so that the teachers can engage in formative testing, in setting the attributes, the context and the type of electronic test answers (Vendlinski, Niemi, Wang, & Monempour, 2008). Although not strictly complying with the four parts proposed by De Bra, Aroyo & Cristea (2004), the application architecture addresses the same principle of separation between questions' management, tests' management or students' management. The application has four modules: Designer, Assembler, Scheduler and Gradebook (Vendlinski, Niemi, Wang, & Monempour, 2008).

The current chapter proposes an RBA (rules-based algorithm) model, where the set of rules for building a test are established by the trainers. Each rule has an initiation point (whether the rule is applied at the beginning of the test or after a certain question), an action (for example, the rule consists in showing only the question of level D) and a set of conditions (for example, the rule is applied if the trainee has previous project management education). The obvious advantage of using rules-based tests is the flexibility offered both to the trainers and the trainees of the system. The tests are adapted to trainees' educational objectives, previous knowledge or courses. In the same time, the trainers gain the possibilities of reflecting on the assessment experiences and offering personalized tests for each student, thus motivating the students and helping them in the learning process.

3.3 Using adaptive feedback and recommendation engines

In the last years, numerous repositories of educational digital resources have been created. These repositories are added to the unclassified resources provided by Internet itself. In this

overcrowded space of online educational resources, the e-learning users feel the need of services which can help them identify the proper learning objects. Recommender systems (RS) serve this purpose (Manouselis et al., 2010). A RS guides the user to interesting objects (concepts) in a large space of possible options. In educational area, RS started to spread more and more: some assist students to plan their semester schedule, by checking courses that comply with constraint regulation and with students' preferences (Hsu, 2009), others are used at course ranking (Farzan & Brusilovsky, 2011) or to give proper knowledge to proper members in collaborative team contexts, by respecting role, tasks, members' level of knowledge (Zhen, Huang & Jiang, 2010).

In e-assessment, recommender engines can be used to improve the selection of the tests, taking into account the educational objectives or to optimize the feedback mechanism: each student can receive bibliographical recommendations, according to one's mistakes. RS can be also used by teachers and trainers in selecting the proper questions from a database, like in Cadmus case (Hage & Aimeur, 2005).

The current chapter proposes the use of RS in the feedback module of an e-assessment application. After an e-test is finished, the incorrectly answered questions are analyzed and the concepts which were not understood by the students are extracted. These concepts are mapped to a domain ontology. By using that ontology, a set of lexical instances for each misunderstood concept is obtained and used for internet search. Thus, bibliographical recommendations from the web search are offered to the students.

4. A formative e-assessment system for project management

Taking into account the theoretical considerations in building formative e-assessment tasks, the authors propose a modularized e-assessment system for project management, which uses the Competences Standard of the International Project Management Association (International Project Management Association, 2006). The main purpose of the system was its use in the preparation process for the certification.

4.1 The system architecture and technical details

The architecture of the system is available in Figure 6.

The system has several components, which ensures its flexibility:

- the admin module (offers the possibility to accomplish operations on levels, competences, trainers, users or questions);
- the trainer module (allows the creation of rules-based tests, visualization of previously created tests and visualization of students' information);
- the student module (contains the web application used by the students to resolve online tests, which are created with various adaptation models);
- the web service;
- the business services, which use a domain model, created with nHibernate technology;
- the database, which contains information about questions, tests, simulations, users; the database is relational and is constructed using the IPMA Competences Baseline (International Project Management Association, 2006).

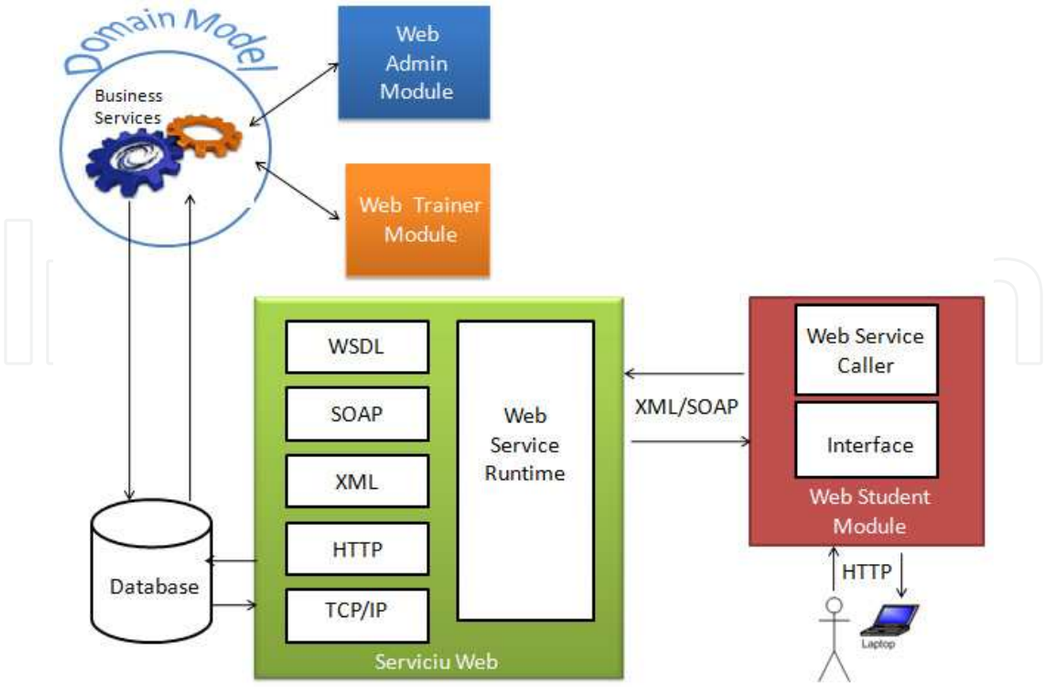


Fig. 6. General Architecture of the Project Management E-assessment System

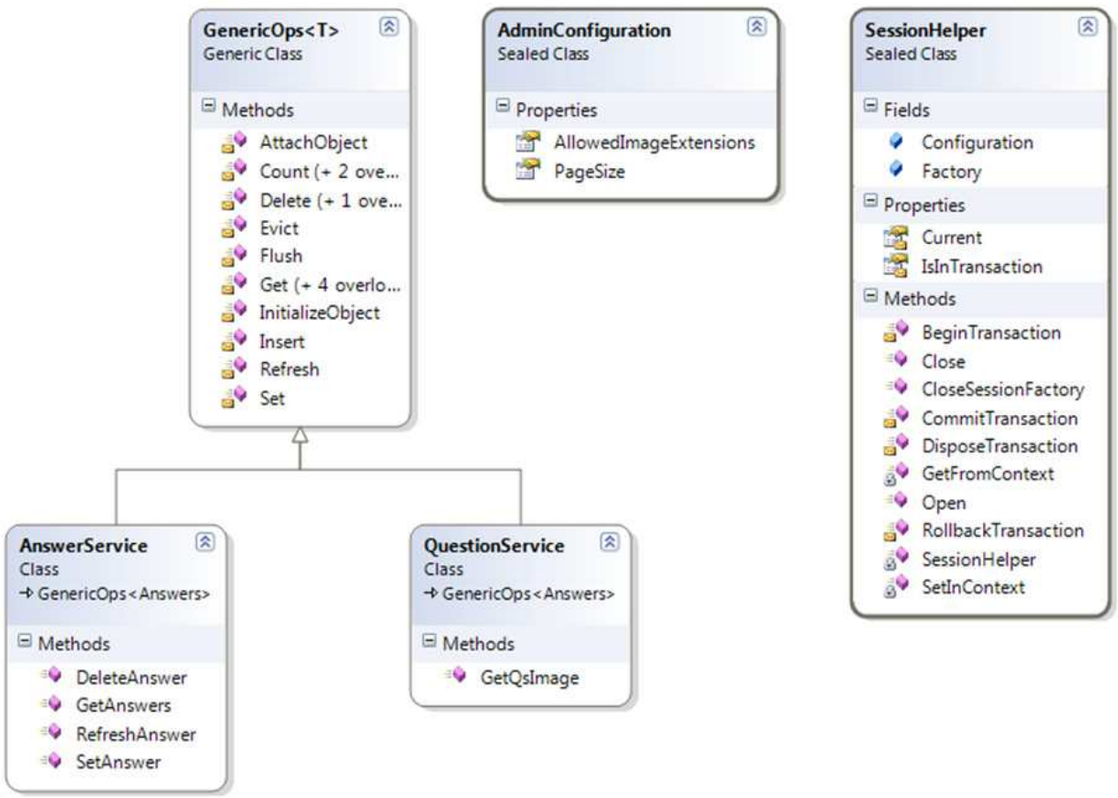


Fig. 7. Excerpt from the Class Diagram of the Business Services

The communication with the database is made in a formal manner:

- the admin and the trainer module communicate with the database via a set of business services (an excerpt from the class diagram of the business services is available Figure 7);
- the student module communicates with the database via the web service, which receives Ajax calls (from Dojo library) (see Figure 8).

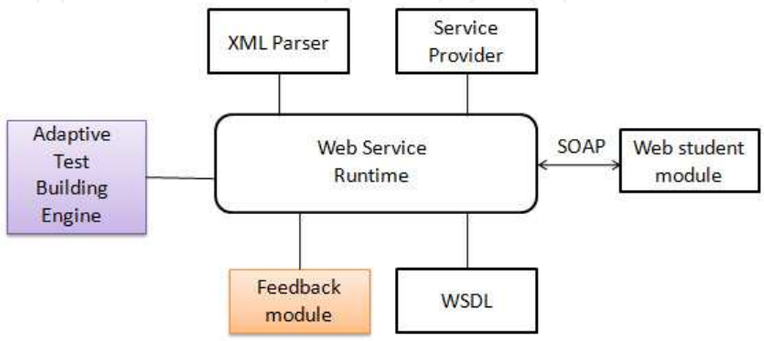


Fig. 8. Web Service Architecture

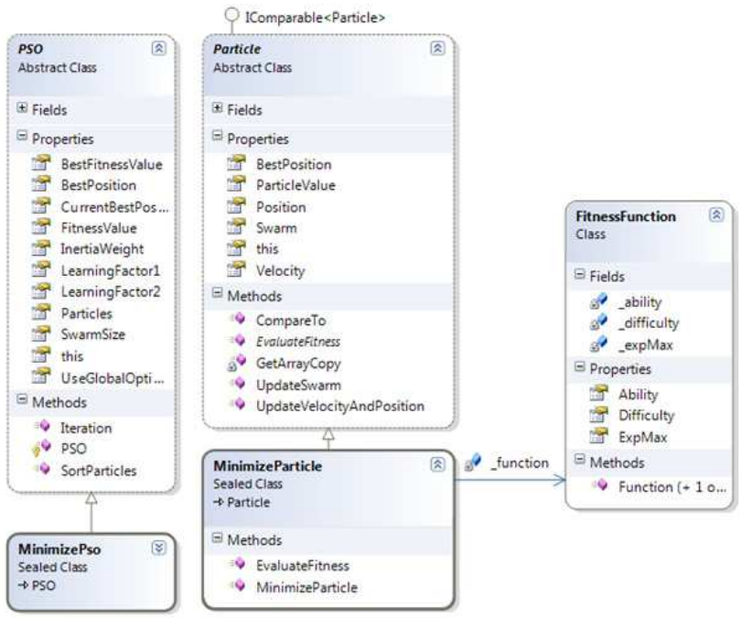


Fig. 9. The Class Diagram of the PSO Algorithm

The solution was developed in C#, the exception being made by the web student module, which was developed in Javascript. The calls to the web service were implemented using the Dojo library. The domain model was created with nHibernate. The formative character of the e-assessment system is given by the adaptive test building engine and the feedback module, from Figure 8. The feedback engine offers the trainees the possibility of revising their mistakes and consulting further web bibliography recommendations, to fill their knowledge gaps. Thus, future learning directions are offered. The adaptive engine contains

the PSO algorithm applied to test construction and a rules-based algorithm, where a set of rules for building a test are established via the trainer module. The classes diagram used by the PSO algorithm is shown in Figure 9. Thanks to the use of abstract classes (see class PSO and Particle), the minimizing function can be easily changed. All the parameters which have to be set as prerequisites are fields in FitnessFunction (presented theoretically in formula 1): they are seen as constants by the FitnessFunction.

4.2 The system functionalities

Each module of the e-assessment system has several functionalities. Through the admin module (see the left side of the Figure 10), one can make statistics, edit information about levels, competences, concepts, questions and answers, rules applied in tests, students or simulations. An example of screens form the admin module is available in the right side of the Figure 10: the editing of questions and answers. Each question has attached several multiple-choice answers and one can edit the answers only using a specific question's screen.

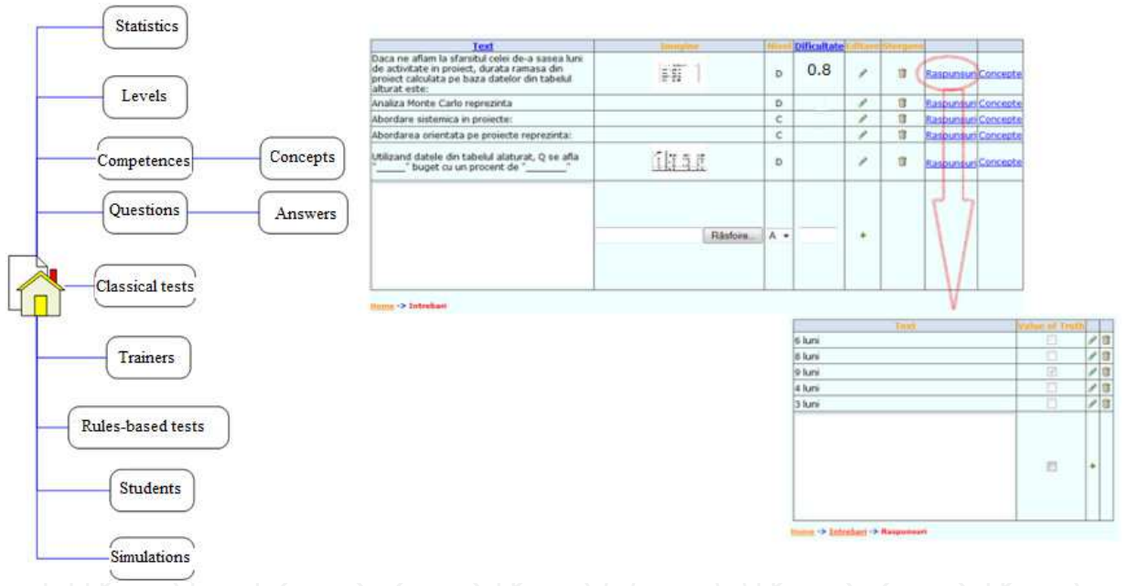


Fig. 10. Functionalities in the Admin Module

The trainer module has the following functionalities: one can view the students (without editing or deleting their information), one can see the rules created by other trainers and create his/her own rules. The trainer's functionalities are available in the upper side of Figure 11 and the rules creation screen in the bottom side of Figure 11.

The web student module has several functionalities (see Figure 12):

- a demo variant of the e-assessment: the same five questions are always offered;
- create new account page: only level D accounts can be created online; the other more featured types of accounts can be obtained only after official registration into the project management certification process, at the Romanian Association of Project Management;
- recover password page: the password is resent via e-mail to the users;

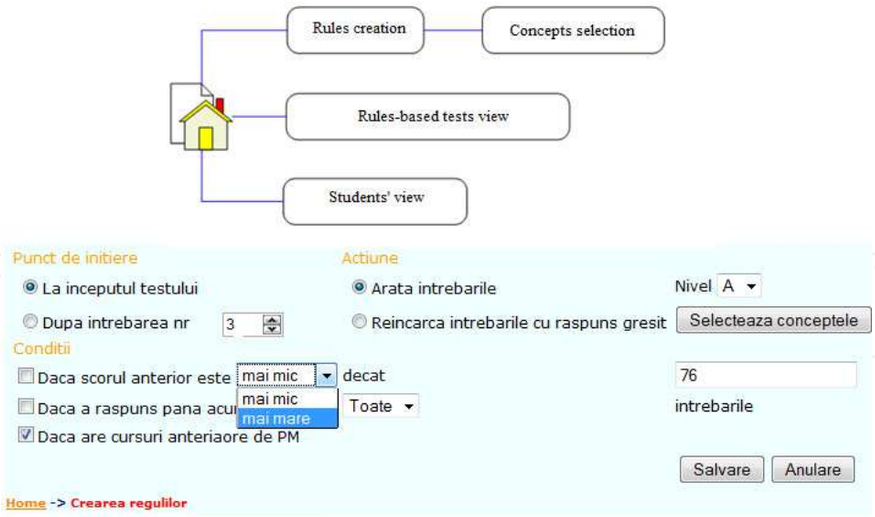


Fig. 11. Functionalities in the Trainer Module

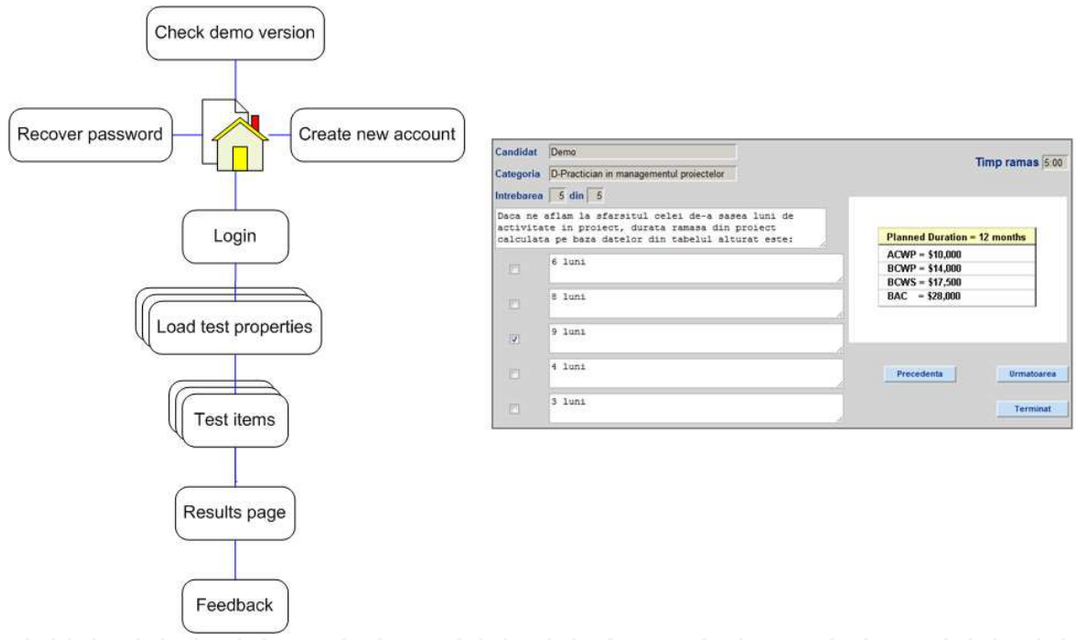


Fig. 12. Functionalities in the Web Student Module

- login page: after inserting the username and password, the trainees have to check whether they are officially registered or not to the certification process (for each case, they have different rights; another important information provided by the trainee is the certification level: A (project director), B (senior project manager), C (project manager) and D (project management associate) (International Project Management Association, 2006); after completing the first step in the login page, the trainee has to provide other useful information (choosing test model, providing necessary information for the chosen test model and so on and so forth): these set of pages help at loading test properties;

- the test item pages contain several graphic elements: the question text, an image (optionally), possible answers, the time frame , navigation buttons (see the right side of Figure 12);
- the results page can be accessed once the test session is over; it contains the final grade, the number of correctly answered questions, the duration of the test and it gives the possibility to access the feedback module;
- the feedback module accesses an educational recommender system engine to provide the trainee further web bibliography for improving one's knowledge.

5. Evaluation of a formative e-assessment system for project management

The e-assessment system was evaluated from two points of view: its performance and its utility. In order to evaluate system performance, the adaptive e-testing was compared to the dynamic e-testing (the questions are randomly selected from the item pool). The utility of the application was evaluated via a short controlled experiment and a questionnaire-based survey.

5.1 Performance evaluation

For evaluating the performance of the e-assessment system, the authors compared the average execution time for selecting one question, in various forms of e-assessment, using item banks of variable dimensions: of 100, 200, 800 and 1600 questions. Also, the number of iterations and the number of particles used by the PSO algorithm was changed. The bigger the size of the item bank is, the more performing the adaptive e-assessment is (see Figure 13). For small item banks, the execution time of an adaptive e-assessment algorithm (PSO for our case) is big, but for large item banks, the execution time is small enough, comparing to other types of algorithms. Also, the execution time for PSO with a lot of iterations and particles is big, but the accuracy of the algorithm is increased.

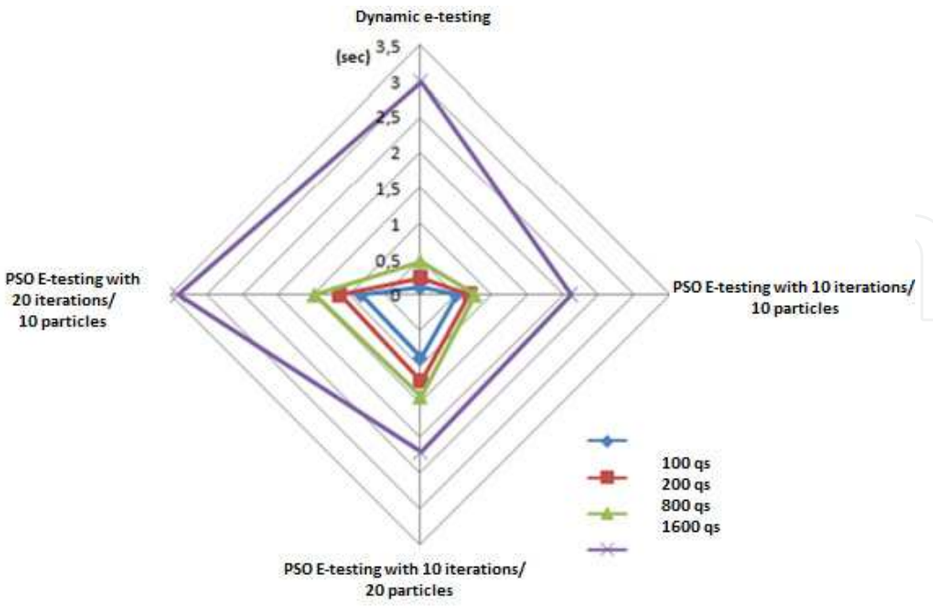


Fig. 13. Average Execution Times for the Selection of One Question, in Various Forms of e-assessment, using Item Banks of Variable Dimensions

5.2 A controlled experiment

The controlled experiment compares the effects of using the proposed e-testing application and the effects of using a classical e-testing application. Two groups of students are used for this purpose, each group having 75 master students. These students were asked to prepare themselves for the certification exam in project management, level D, offered by the Romanian Association of Project Management. Information about the participants to our evaluation study is available in Table 1.

Criterion	Students who used CAT to prepare themselves	Students who didn't use CAT to prepare themselves
Age	under 25: 48 between 25 and 35: 23 over 35: 4	under 25: 44 between 25 and 35: 24 over 35: 7
Previous studies (graduated college)	Technology: 35 Business administration & economics: 32 Other: 8	Technology: 29 Business administration & economics: 30 Other: 16
Hours spent daily in front of a computer	Less than 1 h: 0 Between 1 h and 4 h: 27 Between 4 h and 8 h: 42 Over 8 h: 6	Less than 1 h: 1 Between 1 h and 4 h: 33 Between 4 h and 8 h: 40 Over 8 h: 1

Table 1. Information about the Participants to the Controlled Experiment

All the students passed a diagnostic test, with the same set of questions. The test was a pen-and-pencil test. Then, preparation process for the certification exam started: it has lasted for three months. The first group used the formative e-assessment system three times, during the preparation process. The second group (the control group) used a non-formative system, which had no feedback, adaptive features or recommendation mechanisms. The students from the control group had the possibility to use the non-formative e-assessment system for the same number of times: three times. The two groups didn't know they were using different e-assessment systems. Their results in the preparation process were registered and analyzed. The failure rate was bigger in the controlled group, so the students using the adaptive e-testing were better prepared. Also the progress curve was sharper for the students using the adaptive e-assessment system.

5.3 A Questionnaire-based survey

The questionnaire-based survey focuses on trainers' and trainees' opinions about the utility of the system. The questionnaire contained 10 questions, graded using a 5 points - Likert scale (from "I strongly disagree" to "I strongly agree"). 16 users filled up the questionnaire: 5 tutors (who created rules-based tests) and 11 students. The questions are available in Table 2. When designing the questionnaire, the directives of the Australian Flexible Learning Framework were taken into account: they drew the attention to the the tendency of developers and suppliers of e-assessment applications to be concerned only with the technical aspects of the products, neglecting information about the success and usefulness of products in the learning process *per se* (Australian Flexible Learning Framework, 2011).

All participants agreed that the interface is easy to use, because it is intuitive and it applies the same conventions in all screens. The application is considered quite useful, since it fulfills the established educational objectives and verifies the knowledge gained from assimilation of educational materials provided by the International Project Management Association. Most trainers concluded that the application needs more features: existence of predefined tests, more support to create tests, the possibility to add short videos for the students to be able to react to certain work conduits. Most of the participants agreed that the application was stable; the only problem was the duration of the .NET session, which was too short. This shortcoming was solved by increasing the session duration on the server. The security of the application didn't raise any problems. Most participants consider the feedback to be the most useful feature of the application: 7 out of 11 students strongly agreed on the importance of feedback, 2 agreed and 2 were indifferent. Just 2 out of 11 acknowledge the utility of the adaptive tests: students don't realize that the feedback mechanism is well performing thanks to the adaptive algorithms. This finding can be explained by the fact that technical details are hidden to the students. Most trainers are satisfied with the rules creation interfaces. Just one of them said that he would like to build criteria for rules creation.

Id	Question
Qs1	The interface of the e-assessment solution is attractive and easy to use.
Qs2	The e-assessment application was useful and easily integrated in the educational process.
Qs3	The e-assessment application needs more functionalities.
Qs4	The application stability is satisfacatory.
Qs5	The application security is satisfacatory.
Qs6	If I had the chance, I would choose another e-assessment aplication.
Qs7	(If you are a student) The feedback mechanism is the most important feature of the application.
Qs8	(If you are a student) Applying different adaptivity models in building tests is the most important feature of the application.
Qs9	(If you are a trainer) Test creation is easy to accomplish.
Qs10	(If you are a trainer) Adaptive rules creation is good enough.

Table 2. Questions used at Evaluating the E-assessment System

6. Future directions

As future directions, the following activities are to be followed:

- the optimization of the formative e-testing application;
- spreading of the application in organizations, thus facilitating the development of PM skills.

Regarding the optimization of the formative e-testing application, the fitness function of the PSO approach can be changed, by adding a more accurate description for the fourth term, in which the correlation between the concepts checked by the item tests and the ones established in the learning objectives is depicted. Further experiments are needed, with different learning coefficients for the PSO algorithm and more questions available in the items' pool.

7. Conclusion

The chapter aims at a change of perspective on e-assessment, which is seen not only as a way of knowledge evaluation, but also as a learning instrument, proper for the education of the already employed individuals or for the preparation process for attaining professional certifications. In order to validate this hypothesis, that e-assessment has formative effects, the following methodology was applied: after reviewing the application of e-assessment in professional training, theoretical considerations about building e-assessment systems were drawn, from two points of view: how questions are managed and how tests (sequences of questions) are built. Finally, the implementation of the theoretical considerations was presented within a proposed e-assessment system for project management knowledge. The system was validated though a set of methods: through experiments – for performance and utility validation and through a survey – for utility validation. Positive results were obtained, so a set of best practices can be obtained from the evaluation of the system. In order to build an efficient e-assessment application for PM knowledge, the following strategies are to be applied: the implementation of adaptive algorithms, the exploitation of feedback mechanisms, the implication of teachers/ instructors in the creation of test rules. The evaluation of the system proved its efficiency in professional trainings.

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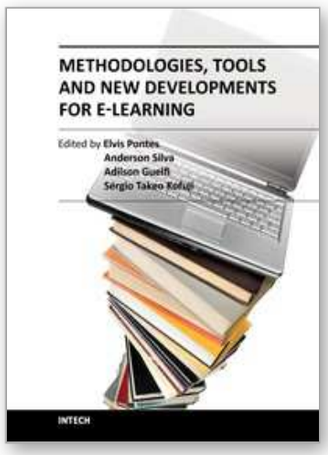
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Methodologies, Tools and New Developments for E-Learning

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With the resources provided by communication technologies, E-learning has been employed in multiple universities, as well as in wide range of training centers and schools. This book presents a structured collection of chapters, dealing with the subject and stressing the importance of E-learning. It shows the evolution of E-learning, with discussion about tools, methodologies, improvements and new possibilities for long-distance learning. The book is divided into three sections and their respective chapters refer to three macro areas. The first section of the book covers methodologies and tools applied for E-learning, considering collaborative methodologies and specific environments. The second section is about E-learning assessment, highlighting studies about E-learning features and evaluations for different methodologies. The last section deals with the new developments in E-learning, emphasizing subjects like knowledge building in virtual environments, new proposals for architectures in tutoring systems, and case studies.

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