

# ECMS.-Educational Contest Management System for Selecting Elite Students

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**Abstract:** Selecting elite students out of a huge collective is a difficult task. The main problem is to provide automated processes to reduce human work. ECMS (Educational Contest Management System) is an online tool approach to help - fully or partly automated - with the task of selecting such elite students out of a mass of candidates. International tests like the PISA study revealed the need for such new methods in extracting better students out of collectives and to offer new online based tools for knowledge gaining processes.

**Keywords:** ECMS; Educational Contest Management System; Elite Students; PISA Study; LMS (Learning Management System); e-Learning; Test & Assessment Tools

## 1. Introduction

The problem of selecting elite students out of a collective is the need of massive human resources to organize and operate such a process. Automating these processes is an essential task to reduce time and human efforts. The need for such tool applications increased after several statistical studies and publications like the PISA Study (Stanat 2000; OECD 2004a). Since the national results of the PISA Study (OECD 2004b) have been a shocking event, a wide spread discussion broke out about how to solve such educational problems and what tools would be necessary to teach and test scholars and students more efficient.

Unlike many existing test and assessment tools (TA) or LMS (Learning Management Systems) - like the Blackboard Learning System (Blackboard 2004), ILIAS (ILIAS 2004), Moodle (Moodle 2004), Claroline (Claroline 2004), .LRN (Bartle 2002; MIT Sloan 2002) or the Whiteboard Courseware System (Whiteboard 2004) - the introduced ECMS (Educational Contest Management System) provides not only an e-Learning platform. It also gives opportunities to offer simple multi-choice tests and homework problems (Schneider 2004a). An essential part of ECMS is the semester-based structure of exams to be sat by the students. This allows for the scenario that not all students will pass

each semester (exam) and join the next semester (exam). ECMS is now developed as version 2.0 and is integrated into the Universitas Virtualis (Virtual University Environment) project (Schneider 2004b). A previous version of ECMS 1.0 ("The Reverse-Engineering-Academy (REA)") (REA 2002; Schneider 2004b) - with focus on software-protection (SP) and Reverse Code Engineering (RCE) - shows the success of the ECMS sieving process in the time range of a long time survey of 2 1/2 years using very hard problems increasing in difficulty (see section (III)). The ECMS has it's own connection to the Universitas Virtualis Bibliotheca Server (Schneider 2004c) which uses GDL 4.0 (Ganesh Digital Library Project) (Fahmi 2004) as its core platform and provides additional access to learning material and ECMS related publications.

## 2. System description

ECMS is based on MySQL 4.0 and PHP 4.3.0. It is not dependent on third-party packages and can be installed easily on local machines or any servers using the Apache Webserver System (Behlendorf 2004). The ECMS can be accessed via standard web-browsers (See figure (2)). Figure (1) shows the UML layout of the database scheme.

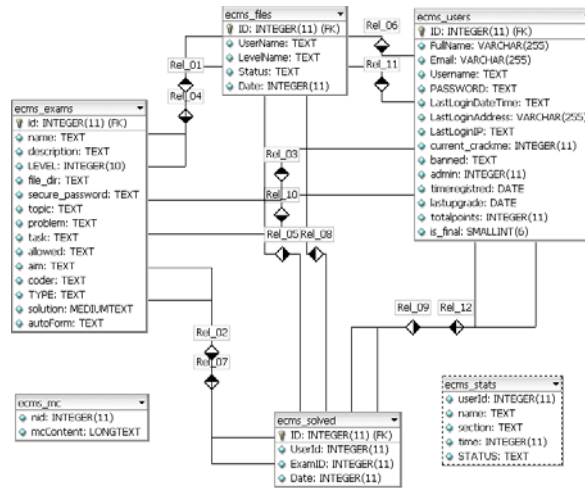


Figure 1: UML Diagram of the ECMS database scheme

As a basic principle ECMS is capable of offering an unlimited mixture of multiple choice tests and homework. It is therefore open for any type of exam content. ECMS 2.0 currently offers a free and anonymous registration process for students, which is capable of extension and cross-link to third-party authorisation systems. Students have access to multiple provided course material which can be attached as original file (e.g. .doc or .pdf) or as a package file (e.g. .zip or .tar.gz) by the exam moderator. To prevent students from being non-active after the registration process, ECMS automatically bans all students not finishing the first exam after 30 days and deactivates the account to prevent re-

registration with the same user data. The current grading and ranking table can be viewed by every registered student. The ECMS can only be used by registered students using a self-set password. Extending ECMS to accept additional user registration data or using a different password system is made easy and there is an option to adapt the system for individual needs.

To give granted access to the administration and moderation area, ECMS uses a simple but effective security concept using .htaccess and .htpasswd files. Adapting the administration authentication process to database driven variants can be done quickly and easily.

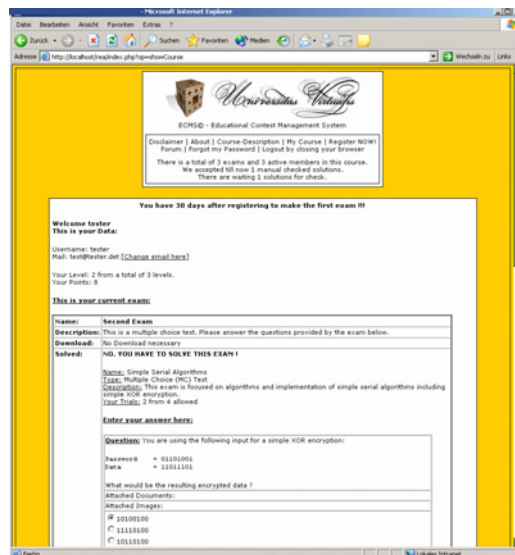


Figure 2: The ECMS Web-Frontend offering a multiple choice test.

### 2.1 Multiple choice exam layout

The core of each Multiple Choice Exam is the XML based template which definition can be seen in figure (3). The template defines the

name and a description for each given exam to add additional information about the topic or similar. <MINCORRECT> defines the minimum number of correct answers to pass the exam. Failing the exam will result in an overview page

showing which answers had been wrong but without any information about what was wrong. ECMS protects itself against cheating via history- back-button brute force attacks. <TRIALS> defines the maximum tries which are allowed for the student. Exceeding the maximum number will lead into automated failure and results in automated banning from ECMS. After the general exam information each multiple-choice question is defined by <TESTITEM and a unique identifying id. Using these id's ECMS can build dynamic forms for the web front-end. Each test item consists of several node informations. <QUESTION> contains the question the student will be

asked. <ITEM defines over unique id's the possible pre-set answers of the student. To identify the correct answer the <CORRECT> tag connects to the corresponding <ITEM id. The XML structure gives the possibility to add unlimited questions to each exam. The XML is stored in the database and will be loaded dynamically with each form called by the student. <ATTACHEDFILE defines using id an unlimited number of attached files of non-restricted formats (.pdf, .zip, .doc,) which can for example contain files with courseware or lectures. To offer additional information the <ATTACHEDIMAGE tag contains a link to attached images related to the exam.

```

</TEST>
<NAME>File Knowledge Exam</NAME>
<DESCRIPTION>
  This exam contains questions about...
</DESCRIPTION>
<MINCORRECT>8</MINCORRECT>
<TRIALS>6</TRIALS>
<TESTITEM id="1">
  <Q>
    <QUESTION>
      How many sections can...
    </QUESTION>
    <ATTACHEDFILE id="1">
      courseware1.zip
    </ATTACHEDFILE>
    <ATTACHEDIMAGE id="1">
      question1.gif
    </ATTACHEDIMAGE>
    <CORRECT>2</CORRECT>
    <ITEM id="1">4.294.967.295</ITEM>
    <ITEM id="2">65.535</ITEM>
  </Q>
</TESTITEM>
...
</TEST>

```

Figure 3: XML template for multiple choice exams.

## 2.2 Homework system

The homework feature consists of giving the student the problem and needed material which may be needed to solve the problem. The solution will be uploaded by the student and can be accessed by the administrators and moderators in the administration area of ECMS. Homework will be checked manually by any moderator registered. Since each homework is correlated to one exam constructor (moderator) an automated mail information will be send to the moderator about the new incoming homework. If the homework fails, the moderator marks the homework as failed and uses the ECMS mail functionality to tell the student why the solution had been

denied. To accept the solution the moderator clicks the hyperlink "upgrade" and the student will be automatically set one exam higher including an automated mail about the accepted status of the solution. Denying a homework will activate the same process with difference that the moderator can enter the reason of the negative answer. Since students can not be banned automated within the homework process, the moderator has the option to ban and unban the student from ECMS directly. The number of failures is stored in the database and is shown to the moderator.

### 2.3 Gathering of elite students via statistical functions

ECMS 2.0 offers an extendable possibility for evaluating the running sieving progress. Since all data is collected in the main ECMS database, statistics can be easily extracted from it. Possible evaluation modules can contain histograms, scatter-plots or other statistical related methods. From such statistical methods the contest manager can gain an overview on how the progress of the contest and the exams is and may react on the problems occurring with the exam contents.

### 3. Evaluation and results of ECMS 1.0

ECMS 1.0 was first introduced in 2002. It's exams were focused on software-protection, cryptography and Reverse Code Engineering (RCE) topics. ECMS 1.0 included 19 main exams which had been all declared as homeworks. Additionally there had been 10 correlated homeworks to improve the student

knowledge. Another 39 exams with topics mathematics and cryptography had been added as fun part to give students more tasks to solve. Solving these 39+10 exams had no influence on the sieving process. ECMS 1.0 gave the possibility to register anonymous via an existing e-mail account and an username. After 2 years of running the system counted 6361 registered students in the ECMS system. The automated sieving process lead via auto-ban functionality in banning 4998 students who had not been able to solve the first main exam within 30 days. Therefore 78.57% of the students failed the first main exam. The rest of 1352 (21.25%) students were capable of solving the first main exam within the 30 days limit. From the remaining 1352 students only 9 students had been able to solve all 19 main exams. This is 0.14% of the registered 6361 students and 0.67% of the 1352 active students. The average solving time of all exams was a 3/4 year. The set of increasing difficulties was well chosen for the contest focus (See figure (4) and table (1)).

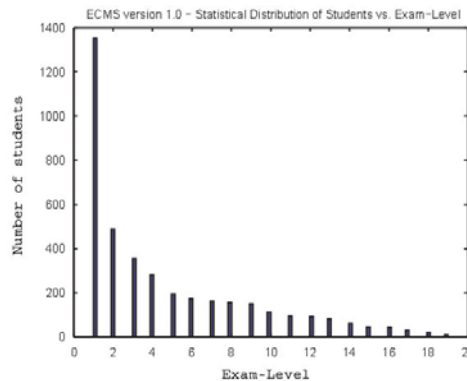


Figure 4: Statistics of the sieving process during 19 exams.

Table 1 shows the statistics of the sieving process during 19 exams including percentage of total registered students and of students passing exam number 1.

Table 1: Sieving process statistics

Exam-Level	No. of Students	% of total	% of after exam 1
19	9	0.14	0.67
18	21	0.33	1.55
17	32	0.50	2.37
16	44	0.69	3.25
15	45	0.71	3.33
14	60	0.94	4.44
13	83	1.30	6.14
12	93	1.46	6.88
11	96	1.51	7.10
10	113	1.78	8.36
9	150	2.36	11.09
8	155	2.44	11.46
7	162	2.55	11.98

Exam-Level	No. of Students	% of total	% of after exam 1
6	174	2.74	12.87
5	193	3.03	14.28
4	282	4.43	20.86
3	355	5.58	26.26
2	488	7.67	36.10
1	1352	21.25	100.00

### 4. Possible Scenarios

There are many scenarios possible for using an ECMS. One field is the company aspect where companies try to evaluate the knowledge of their employees or to offer pre-selection tests for new employees. Another aspect is the university aspect, which offers capabilities to pre-select new tutors or employees. Additionally the ECMS can be used for special educational tasks, like supporting

students in self-testing their knowledge in bioinformatics, medicine, law or economy. ECMS can be used for scholars as well. One example are school-contests containing math-contests or similar.

## 5. Conclusions and future work

ECMS differs from existing e-Learning, test & assessment tools. As difference to common e-Learning solution ECMS is not thought only for educational purposes. It is correlated to a sieving process for the gathering of elite students out of a huge collective. Future Improvements of ECMS will include time limits for each exam. Next there will be support for automated exclusion of students after failing n homework. Additional the support for displaying LATEX2 $\epsilon$ documents including LATEX- and LATEX2 $\epsilon$ -style formulas should be included within future work. Enhanced statistical functionalities for better automated processes is a necessity. Counting wrong given answers will be included. A library containing multiple choice tests and homework with sorted difficulty have to be build. The average solving time for all 19 main exams described in section (III) was fast for the given software-protection, cryptography and Reverse Code Engineering (RCE) topics. For other topics like algorithms in bioinformatics, exams in medicine or math exams there should be a careful preselection of the used exams to prevent long sieving times. To protect the multiple choice tests from brute forcing attacks a randomisation of questions should be implemented.

## 6. Acknowledgments

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