E-LEARNING AND COMPREHENSIVE SYSTEM OF AUTOMATIC ASSESSMENT IN MATHEMATICS IN WROCLAW UNIVERSITY OF TECHNOLOGY

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1. EXECUTIVE SUMMARY

The paper presents the origins, the development and the present state of a system for online study of mathematics and for automatic assessment of student's progress. The project origins go back to 2005, when first online math courses were created and implemented. The original idea to provide student with extensive self-study and self-testing opportunities has grown, over past 5 years, into a sophisticated system for math instruction enhancement. As the system was growing, administrative assessment procedures increasingly employed technology solutions. One of the most innovative features of the system is its striking ability to motivate students to systematic and active study. The authors know of no other solution where self-study opportunities would be so strictly combined with effectively managed frequent testing.

1.1. Background

The material of math e-courses is delivered in the form of Web pages richly equipped with interactive simulators and exercises. Up to now, over 500 hundred math problem types are covered by Java-driven tests, the number continuously growing. Each test applet is capable of repeatedly generating problems with randomly selected data. A teacher can flexibly configure a test to meet specific needs (such as the difficulty level, the method of grading, the time constraint for the solution etc). The student has access to a step-by-step presentation of the correct solution. Individual exercises can be combined into comprehensive exams that in turn are used both for practice and as an element of the administrative grading system.

The university has been employing math e-courses in everyday teaching for 8 semesters now. Besides attending traditional class meetings, the student is supposed to independently study online materials and to develop math skills by working electronic math problems. Grading procedures heavily rely on the sophisticated system of midterm and final exams that are carried out in dedicated computer labs. Administrative measures have been developed to ensure that the system is functioning reliably and securely. As of this writing, the number of students covered by the automatic assessment system in a single semester exceeded 4000 and is growing from academic year to academic year.

1.2. Conclusions

The combination of traditional instruction with highly automated control of the learners' progress has been giving results that by far outgrew the authors' original expectations. Thanks to practically unlimited possibilities to practice, with a large number of problem types, the student is offered highly innovative learning environment. This has strikingly positive impact on students' own motivation to study. The final grades together with the students' feedback, gathered at the end of each semester, leave no doubt as to the effectiveness and the popularity of the new system. The automation of many standard exercises enables the teacher to make a better use of the classroom meetings as more time is available for the discussion of more difficult problems and for applications.

2. INTRODUCTION

The authors present an e-learning project that successfully supports math instruction in Wroclaw University of Technology. The project's origins go back to 2005. At that time, the university was facing both growing demand for math instruction (fast-increasing number of students) and a visible decline of the math skills on the part of secondary school graduates. Additional limitations (e.g., the time assigned for instruction and the number of faculty) led to the situation where the university had to increase the number of student groups, the number of students in a single group, and additionally to cope with the necessity of covering larger material in existing teaching schedules.

An idea then emerged to supplement traditional teaching of mathematics with effective online environment for students' systematic study and practice. The primary objective was to provide a student with as much opportunity to study, practice and self-testing as possible. That was accomplished by creating a comprehensive set of illustrative and interactive lecture notes on the one hand, and a large collection of dynamically generated tests on the other. Electronic tests quickly became an element of grading procedures, as well.

The implementation of the above-described ideas turned out to pave the way to a completely new teaching style and to have essential impact on the effectiveness of teaching. As of this writing, several math e-courses have been created and are used on the blended-learning basis in everyday teaching. Moreover, a comprehensive system of automatic testing, including both technology solutions and the involved logistics has been developed and put into effect. The results (both in terms of final grades and of students' feedback) definitely show that the combination of well-designed content, accordingly adjusted in-class teaching and frequent testing can lead to amazing results as far as teaching effectiveness is concerned.

3. DEVELOPMENT AND PRESENT STATE

The first math e-course was the course in algebra with analytical geometry (see [2] for details). During the first 6 months of 2005, the materials were being simultaneously created and applied in instruction. A relatively small group of 55 students was chosen for the first experiments with automatic assessment.

The results of that pilot testing were so promising that it was decided to enlarge the scale of automatic assessment and make electronic exams standard element of grading procedures.

Yet further expansion of automatic assessment had encountered natural barriers, such as the lack of a sufficient number of computer labs in the first place. Up to the fall semester of 2007, partially-proctored assessment was therefore applied; students were taking mid-term electronic exams remotely (one can consider those as homework assignments). The results of those exams were then combined with the results of traditional "paper" tests in grading procedures. However, the final exams were always given in a computer lab under the supervision of teachers.

The system was expanding twofold. First, grading procedures based on automatic assessment were increasingly applied to more and more student groups. Secondly, new e-courses were being developed and immediately put to work. Those were: Mathematical Analysis (developed and implemented partially, under further development), Linear Algebra with Elements of Abstract Algebra (complete), and Remedial Mathematics (developed and implemented partially, under further development). Starting the fall semester of 2007, the university has been using a number of dedicated computer terminal labs that are assigned exclusively to automatic assessment. In contrast to general-purpose labs, those new labs are cut off from the Internet, thus ensuring security. The local database connectivity is supported, of course, yet no unnecessary software is present. In addition to traditional proctoring, the introduction of electronic surveillance is planned in 2009, to enhance anti-cheating measures.

The table below presents the numbers of students of Wroclaw University of Technology who took part in courses with automatic assessment in respective semesters. Evidently higher numbers of students in fall semesters reflect the distribution of math courses delivery between the fall and the spring semester in each academic year.

Semester	Number of courses	Number of students	Labs: **G**eneral/ **D**edicated	Tests: **D**istant/ **P**roctored
Spring 2005	1	55	G	P
Fall 2005	3	380	G	D (final: P)
Spring 2006	2	95	G	D (final: P)
Fall 2006	8	950	G	D (final: P)
Spring 2007	3	200	G	D (final: P)
Fall 2007	7	900	D (1 lab)	P
Spring 2008	4	300	D (2 labs)	P
Fall 2008	26	4000	D (4 labs)	P

Table 1. Numbers of students in automatic assessment

3.1. How automatic assessment works in practice

From a single student's perspective, automatic assessment is carried out through a series of 4 or 5 electronic mid-term exams (depending on the individual department), followed by an electronic final exam. Each mid-term exam covers a portion of a given course curriculum. The exam sessions, distributed evenly throughout the semester and the student groups, are held in dedicated computer labs. Every student is assigned the dates and the times of his/her exams at the beginning of the semester. Missed exams are handled in a special way, due to organizational and technical constraints.

In that way, each student in the system takes 4 to 5 electronic exams in the semester, followed by the comprehensive final e-exam.

A huge number of students that are in the system involves a large amount of organizational and technical effort. This will now be discussed in greater detail.

At the beginning of each semester, data is gathered concerning the demand for e-exams. Precise exam schedules are created. The communication channels are defined and established so that proper information flow among designers, teachers, departments and students is ensured. Technical preparations (labs, network, importing students and exam data into a database) are accordingly made.

Each e-exam is given in a computer lab. (The technical details of the exam preparation are discussed in the Section 6). Respective student groups arrive at the lab at predefined times. Exam supervision is ensured from the side of specially trained staff. The students undergo identity verification and logging procedures. Once a student launches his/her exam, the time countdown begins. The student solves the exam problems by hand and/or through dedicated user interface tools. The answers are entered either in edit fields (if numeric) or through dedicated user interface elements (e.g. in graphing problems). As soon as the student finishes the exam, his/her work is being automatically graded and the exam results are recorded in the database. Steps are presently being taken to equip the computer terminals with student I.D.'s scanners, so that the authorization and logging into e-exams be further improved.

Safety measures are taken to prevent the students from technology-related cheating. The computer terminals have access to a dedicated small local network only.

Both the students and the teachers have immediate access to all the results of the exams already given. Filtering is supported, allowing the teacher to do required statistics. The possibility of detailed analysis of students' results (refined even to a single problem type) enables the teacher to make adjustments of the in-class instruction process, to the benefit of teaching effectiveness. Access from mobile phones is also supported (http://156.17.73.112:8080/db/kw.jsp?album=172367 is a sample link), in which case the presentation is adjusted to a limited area of a mobile phone display. However, the authors abandoned the idea to pursue what is called m-learning in mathematics, due to the fact that learning mathematics is so different from learning other disciplines.

The teacher has also access to what is called “students’ claims”. If a student suspects that his/her solution has been graded unfairly (e.g. the credit for the solution is too low) then he/she can export all necessary information regarding the problem and the solution to an external file. The student later informs the teacher about the claim. The teacher accesses the file, reads the details of student’s solution and resolves the claim.

At the end of the semester, the results of e-exams are combined with other credit (in-class activity and additional “paper” tests given by the teacher). The final grade can be based on the above elements only, or an extra final “paper” exam can be administered. This varies from department to department. In some departments, the automatic assessment continues to be partially-proctored, in which case students take their e-exams remotely, as a form of homework assignments. This is accompanied by traditional “paper” mid-term exams carried out in class. In general, many details of grading procedures are left to the teacher’s discretion.

The combination of in-class instruction with e-learning content and with regular, frequent testing yields variety of mutually interweaving learning threads. The predefined schedule of e-exams for example, forces the instructors to strictly conform to time requirements as far as going over particular parts of material is concerned. In-class meetings, preparation of question sets, handling students’ claims, replying to students’ emails – all those activities make up a unique rhythm, in which face-to-face teaching is supplemented by e-learning-related events and tasks.

4. Innovation

We will now give a detailed discussion of those functional solutions of the system that we believe played a fundamental role in making it innovative.

As mentioned before, two major objectives were set: to provide the student with an attractive online environment that would enable active study, and to considerably increase the frequency and the amount of testing while keeping workload increases at a minimum.

In order to meet the first objective, the system creators had to develop well-designed, user-friendly and highly interactive content. The content is intended to “work” in such a way that the student is continuously kept busy by being strongly encouraged to experiment and (even more important) to continually practice while studying. The second objective was met by including automatic exams in administrative grading procedures.

The math content of a typical math e-course is organized into SCORM/IMS modules. An individual module corresponds to a chapter of material. Resulting SCORM/IMS packages can be easily placed in any SCORM or IMS – compliant e-learning platforms (LMS). Each module consists of:

1. Lecture notes in the form of HTML or XHTML pages (with math formulae in GIF or MathML format). Those notes feature high interactivity, including dedicated simulators (for illustration of respective math concepts), drop-down proofs of theorems, drop-down solutions of examples and interactive animations.
2. E-exercises in the form of Java applets. A single exercise is actually an unlimited collection of single-problem tests addressing a specific math concept or method. The applet is capable of repeatedly offering the student a (theoretically) unbounded sequence of problems of a given type. The student is required to solve the problem by hand and then enter the result(s) in the applet window through specially designed user interface elements: edit fields, spin controls, check boxes or radio buttons. Applets are created in such a way that the content designer can control various parameters of a test, such as the time constraint, the difficulty level, the grading scheme (e.g., two-state grading or scored grading with partial credit whenever applicable – see [3] for details), the number of student’s trials to provide the correct answer, and so on. Controlling those parameters does not require any intervention in the source code, the designer only modifies appropriate external configuration files. The functionality of a single exercise includes immediate grading, the correct step-by-step solution presentation, completeness check (so that the student is warned that his/her input is incomplete), and initial correctness check (so that the student can be given one or more chances to correct the erroneous result). The supported problem

types are not limited to the situation where the solution is a numerical value or a set of numerical values. In many problems, the solution is supposed to be provided as a drawing (e.g. the graph of an equation), in which case the student is provided with dedicated graphing tools in the applet window. Many math problems have didactic value at the cost of a considerable amount of computation (e.g. problems in matrix theory and the theory of systems of linear equations). In automatic exercises of that type, a student is given special tools for designing the desired matrix operations, the computational part being left to the program. As of now, over 500 math problem types in linear algebra, analysis and elementary mathematics have been supported as electronic exercises.

3. A practice e-exam at the end of the module. An exam addresses the material contained in the module, thus giving the student an opportunity of self-testing.

E-exercises and practice e-exams are truly innovative. Their functionality mimics a real-life math problem-solving lesson.

In addition to the above, supplementary content is added to interactive lecture and exercises materials. Each chapter is followed by problem sets (in PDF form) addressing the chapter material. The problems can be used by the student for self-study or by the teacher in class, as needed. Those problem sets typically contain the problems that can not or need not be made into e-exercises (e.g. proofs of certain facts, or more advanced application problems). Also, the list of recommended literature and recommended Internet resources are given. Finally, glossaries of terms, with appropriate links to respective pages are included.

Of all elements described above, probably most helpful are numerous dynamically-generated, varying-data e-exercises that assist the student in the study (this has been strongly confirmed by student surveys). Since an e-exercise addresses a single math concept or method, the learner can self-test his/her understanding of a very small portion of material.

Equally important are e-exams. An e-exam can be viewed as a collection of single e-exercises, each addressing a specified math problem type. The application of e-exams is twofold. First of all, they serve as practice utilities. Secondly, e-exams are used in the administrative process of progress assessment. Each exam incorporates such features as time constraint, variability in selecting the problem set (so that no two students get identical problem sets), security and storing the student's results in a secure database. A virtual scientific calculator is available in the exam window. Flexible grading systems can be set up without the intervention in the source code.

Dedicated software has been designed and created to facilitate the process of e-exam creation, so that no technical or computer-science knowledge is required to set it up. An exam designer has control over such parameters as

- The number of exam problems on the exam and the scores for each problem.
- The exam time.
- Specific problem types from which to select a given exam problem. The designer can either predefine the exact type of each problem on the exam, or to specify the probability with which problems of given types will appear. In that way, the distribution of problem types within an exam is further diversified.
- The completeness check. The designer can decide that the student is warned if incomplete input is detected on submitting the exam for grading. In such case, the student is prompted to complete the input or to proceed with the exam submission.
- The number of trials that the student is given for correcting possible errors. This is called "initial correctness check" and was introduced after repeated students' complaints that the system does not allow for correcting simple misspellings while transferring the answer from paper into the exam window.

During an e-exam in a computer lab, the student solves the exam problems by hand and/or through dedicated user interface tools. The answers are entered either in edit fields (if numeric) or through dedicated user interface elements (e.g. in graphing problems). Once the student finishes the exam, his/her solutions are automatically graded and the exam results are stored in the database. Steps are being taken to equip the computer terminals with student I.D.'s scanners, so that the authorization and logging be further improved.

The above-described features of the system have proven to have a huge impact both on students' attitudes toward learning math, and on the overall effectiveness. The authors know of no existing e-e-learning implementations of comparable functionality.

5. Pedagogy

It is every math teacher's pedagogical dream to convince his learners that skills in mathematics mean skills in solving math problems, rather than merely memorizing concept definitions and theorems.

When a math course is delivered to students whose future job is not mathematics itself, the instructional process is often disturbed by the fact that the required pace of exposition to the material is not in line with the amount of time that the student can (or is willing to) spend on practicing. The only solution able to put students to systematic work is frequent testing. With large groups of students, on the other hand, this means additional workload on the teacher's side related to arranging a large number of exams that later have to be graded by hand.

The described system has turned out to have huge impact both on students' attitudes and on the teaching style. Below are the most obvious pedagogical benefits of the system.

- A student has access to study materials any time he/she wishes and from any Internet-supported location. This is a powerful time-saving factor for a student.
- Thanks to the presence of hundreds of dynamically generated e-exercises of varying difficulty and with varying data, the student has practically unbounded self-assessment opportunities. The student is additionally motivated by the fact that he/she has immediate access to the correct answer and the detailed step-by-step solution of each exercise. In that way, the student can study and practice at their own pace. Additional online practice exams enable the student to better identify their preparedness for the actual exam.
- Frequent testing motivates students to systematic work. Arrangement of e-exams outside of classroom teaching schedules means additional saving of the instruction time.
- During lecture classroom meetings, the instructor needs to spend much less time on introducing standard notions. In traditional chalk-and-board only instruction, the pace of lectures is always considerably slowed down by the necessity to give students time to take detailed notes of all definitions, theorems and examples that the teacher presents. With the material independently available online, the teacher can go over individual portions of material much faster. The instructor has thus more time for discussing various subtleties of math notions and methods, and can adjust the pace of exposition more freely according to the audience needs. The time pressure being considerably decreased, lectures gain in value and can be delivered in a more appealing way.
- The above equally applies to classroom recitations. Standard skill-developing math problems are now rarely worked in the classroom. Instead, students are encouraged to discuss and work more advanced parts of the material.
- The results of automatic exams are automatically stored in a database that can be later accessed by students and instructors. This makes the process of gathering data on students' progress effective and paperwork-free. Another important benefit is that a teacher can carry out detailed analysis of the exam results practically as soon as the exam is over. Thanks to that, necessary adjustments of in-class teaching are very easy to identify.
- Over past years, a considerable decline in the level of math skills has been noted among first year students (see Section 2). As a result, a growing number or first year students are unable pass even in basic math courses. Including portions of elementary mathematics in the curriculum was successful remedy to the problem (at the price of tightening in-class time that could be allotted to university level mathematics). However, the required improvement was not seen until remedial mathematics e-course was created and made available to students.

6. TECHNOLOGY

The project makes use of these main technologies:

- HTML/XHMTL with interactive elements in the form of Java applets

- SQL database
- SCORM

Below is the discussion of how those technologies are used and why they have been chosen.

It was assumed from the very beginning that the electronic materials should work in any e-learning environment (LMS). Existing online-quiz utilities that can be seen in many LMS's, are of very limited value when it comes to math problems. It is well-known that studying mathematics is not memorizing facts but rather developing unique skills in associating various ideas, notions and methods, and applying them in problem-solving. Very often, the answer to a math problem is not numeric. It can be an algebraic expression, a graph or the set of properties of a math object that the student is supposed to identify.

In view of the above, each individual e-exercise requires separate programming (in terms of encoding). Generally, to encode a math problem is a complicated task, especially if one needs to get all the features described in the "Innovation" section above (e.g., the correct solution presentation that includes currently selected problem data). Thus the "successful candidate" for the optimal programming language for that purpose should have features that both facilitate the programming of math functions and provide tools for other kinds of functionality. The language should also enable easy creation of Web applications.

After considering all those factors, Java has been chosen as the primary programming language.

Over 500 math problem types have been supported in the form of highly flexible Java-driven tests.

6.1. How and why Java was employed

These are main reasons why Java has been reached for.

- Java is object-oriented – it stimulates efficient programming and has mechanisms that assist the programmer with avoiding programming errors;
- Java is architecture-neutral and portable – programs written in Java run and behave the same way on different operating systems;
- Java programs are known to work very well in web applications;
- The language construction allows the programmer to create programs that are safe (no harm can be done to a client's system);
- Even in its basic version, Java comes with an abundant library of math functions;
- Many additional Java libraries and Java development tools are available free of charge;
- Java supports assistive technologies (with people with disabilities in mind) – this is not used in the present version of the system but is considered in future).

All interactive elements, such as simulators, calculators, interactive animations, e-exercises and e-exams are all based on the Java SE 5 libraries. Some elements of e-courses require 3-dimensional graphics. Java 3D 1.5.1 library was used to meet that requirement.

To support symbolic calculations, necessary in math analysis, some applets make use of Wolfram's webMathematica server, purchased by the university for the sole purpose of math e-learning (see [4] for details).

Mathematical expressions in Java applets are presented in one of the two forms: GIF images (Java SE library is used here) or MathML expressions (JEuclid 3.1.x (http://jeuclid.sourceforge.net).

6.2. Databases

Every LMS puts access restrictions on its built-in database, so the authors decided that the data management in automatic assessment should be entrusted to a database that would be totally LMS-independent. One of the two professional popular databases: SQL DB Oracle XE or PostgreSQL is used. The database communication is programmed in J2EE technology, with Apache Tomcat as a servlet container. In combination with existing Java database connectivity solutions, that approach enabled a safe and reliable 3-layer implementation. (See Section 6.4 for more details on database communication).

6.3. SCORM packaging

The content is organized into SCORM modules (see [1] for more on SCORM]. The main reasons for that solution are the following:

- SCORM is a widely known standard for packaging electronic content. Its logic encourages a content designer to follow good content creation practices.
- SCORM modules can be easily placed in every learning environment (LMS) that supports that standard. In Wroclaw University of Technology Moodle is used as the learning platform but other LMS's (like Blackboard or WebCT) are equally acceptable.
- SCORM-compliant content is portable between learning platforms. This yields the possibility of easy implementations in other institutions.

Reload Editor (www.reload.ac.uk) is typically used to aggregate the materials in the form of SCORM or IMS packages. The editor is very simple to use and is a very effective tool for those authors of math materials who wish to create SCORM packages from existing resources (regardless of an authoring tool that was originally used for writing the content).

6.4. Technology behind the e-exams preparation and work

Electronic exams are prepared in an easy and yet sophisticated way. Before each e-exam, problem sets are designed through special configuration files. As of now, this is being done by system designers in cooperation with individual teachers. From the very beginning, however, the system creators kept in mind that in the long run, the technical side of e-exam preparation from existing e-exercises should be easy to learn by "ordinary" math instructors, obviously after some training. Therefore a special software tool has been developed that enables the user to select problem types and to specify all necessary exam parameters (such as the scores, time allotted for solutions, available calculators etc.). The output is an electronically signed SCORM package with the resulting e-exam. The package can then be sent directly to the LMS administrator. The database system is designed in such a way that an exam is visible and available within a specified period of time and for a specified group of students.

After a student submits the exam, the system writes the exam results to a database. The following diagram presents the communication details.

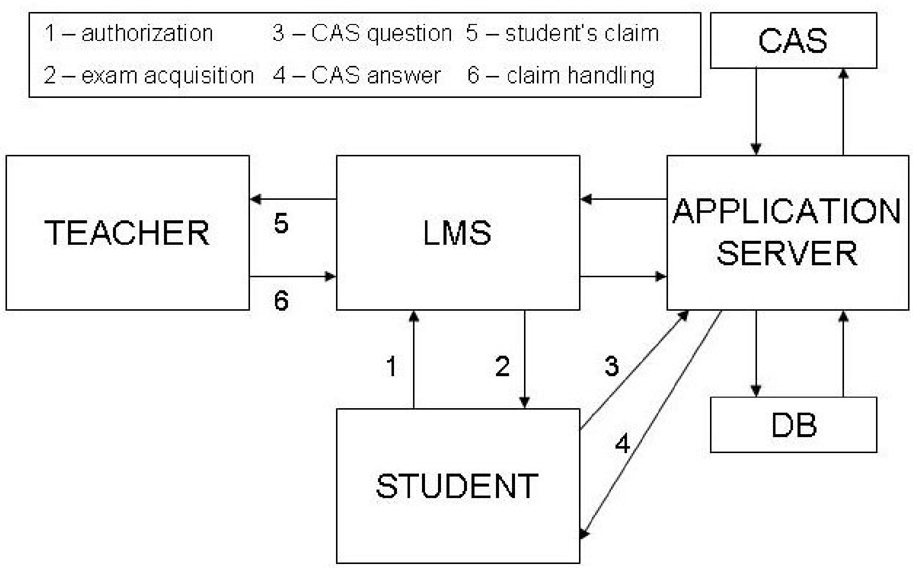

Fig. 1. Automatic assessment - communication flow

It should be noted that with the exception of webMathematica all the software is open source, thus free of charge.

7. Usefulness and benefits of the system

- The system, in which the student's progress is primarily measured through a series of automatic exams, with convenient online learning environment available, resulted in essentially better final grades. The diagram below shows the distribution of final grades for the whole population of the so-called Basic Study Program (first-year students who are not yet assigned to specific engineering department). Similar results are repeatedly obtained for other groups and other semesters. The results are in clear positive contrast with failure rates over 50% in the traditional teaching.

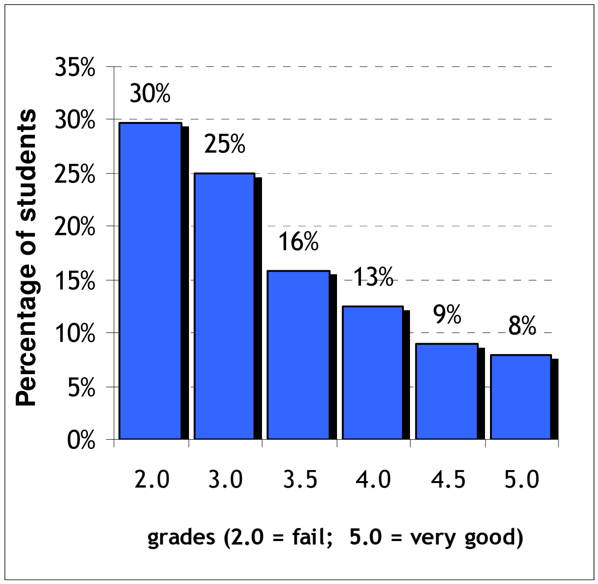

Fig. 2. Final grades (Fall 2007, 480 students)

- After each semester, student evaluations are carried out through anonymous surveys. Among other survey questions, two are of special interest: the effectiveness of study and the fairness of automatic assessment. Two diagrams below depict students' opinions on those two elements. The students are also given the opportunity to express any written comments in their surveys. Those comments often contain invaluable suggestions for further enhancements of the system functionality.

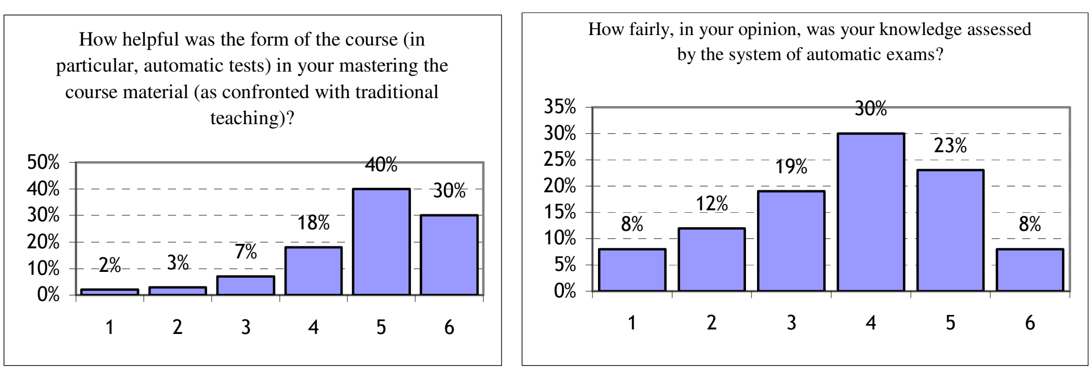

Fig. 3. Student evaluations – effectiveness (left) and fairness (right)

- Thanks to the possibility of unlimited practice, math problems generated from the electronic system posed considerably less trouble to students who studied with e-support than to those studying in a traditional way. This has been confirmed by statistical research.

- Obviously, as the system was being implemented on a larger scale, automatic assessment was subject to criticism from many math instructors in the university. The teachers mainly resented the fact that automatic exercises and tests are limited to those types of math problems whose solutions rely on an algorithm of some kind. Yet when a closer look was taken at traditional exams, it soon turned out that overwhelming majority of traditionally-given math questions address the same standard issues that electronic exams do. There was often misunderstanding among teachers as to what automatic assessment is and what it is not. The teachers had to learn that automatic assessment is not an obligatory replacement but rather the supplement to existing assessment activities; the results of e-exams in grading procedures can (but not have to) count in grading procedures at a teacher's own discretion. The evolution of teachers' attitudes is slow but clear: those who join the system rather than just looking at it from outside soon get convinced of its benefits.
- The system is easily portable and can be implemented in other institutions at practically no extra costs. One piece of evidence for that is the experience of making a portion of the remedial math e-course available to the University of Economy in Wroclaw. The amount of work needed to accomplish this was limited to selecting necessary SCORM modules from existing resources and then aggregating it into ready-for-use tailored content.
- The usefulness of the solutions presented in this paper was noted by international e-learning community as early as in 2005. The e-course in algebra and analytical geometry was the winner of EUNIS prize in The Best-Designed Course/Lesson competition at 6^{th} International Conference Virtual University in Bratislava, Slovakia (the certificate can be found at http://www.im.pwr.wroc.pl/~kajetano/ba/dyplom_BA_2005.jpg).
- The success of the first e-course in algebra with analytical geometry drew the attention of Polish Scientific Publishers, the well-known Polish scientific publishing house. In August 2008, the publisher initiated a new series called "e-Mathematics", and the textbook in algebra (ISBN 978-83-01-15493-6) was published (in 1000 copies), based on the electronic content of the e-course. The book is accompanied by a code that gives the buyer access to online materials with e-exercises and practice e-exams. The online service is maintained by the publisher's partner software company. As of this writing, the book is almost sold out. The publisher is strongly interested in publishing other books based on the existing math e-courses content.

The reader is referred to http://www.im.pwr.wroc.pl/~wierzeje/e-learning.htm for detailed reports (in Polish) that contain, in particular, both statistical data concerning the results and the student evaluations of e-courses. In particular, the reports provide the complete sets of students' written comments.

The URL to the project is http://eportal-skp.pwr.wroc.pl with **eunis** as login and **EuNis.2009** as the password.

On the grounds of experience gained so far, the authors strongly believe that as complex as the above-described system can seem, its portability and ease of implementation makes it an appealing solution to use in any interested educational institutions.

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