Knowledge Assessment at the Faculty of Electrical Engineering and Computing

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Abstract. *The article deals with the problem of assessing student knowledge in programming courses at the Department of Applied Computing of Faculty of Electrical Engineering and Computing, University of Zagreb, Croatia. It discusses the evolution of an assessment system from a simple midterm and homework based model to a more complex and better organized model in order to eliminate a negative backwash effect and to stimulate an active approach to learning. Various types of employed assessments are presented, their theoretical background discussed and the success of their implementation evaluated.*

Keywords. Assessing knowledge, e-learning, technology supported assessments

1. Introduction

To assess means to determine the value of something. This simple definition leaves many questions unanswered when education is concerned: who will determine the value of one's knowledge? How will it be measured? Is the knowledge value objectively determined?

Assessments represent a daily task to teaching staff and are generally not given the required attention. Teaching and learning are considered the most important elements of the educational process without looking into their relation to assessing knowledge. Nevertheless, assessments influence learners' motivation deeply, shape their perspective on learning and therefore take an important role in the educational process [7].

During the past ten years the Department of Applied Computing of Faculty of Electrical Engineering and Computing was continuously enhancing student assessment methods, especially for courses with high number of enrolled students (more than 700) in the 1st year of study: "Programming and Software Engineering" and "Algorithms and Data Structures". The old assessment system, which was based on two mid-term exams or a classic written exam as an option, had to be upgraded. Due to the lack of teaching staff, improvements would hardly be possible without the introduction of a technology supported assessment system. Therefore, to support continuous student assessment, quizzes were introduced as a supplement to classic, paper-written exams.

The system evolved from a simple multiple choice assessment tool to a more complex technology supported assessment and e-learning system and was named Adaptive Hypermedia Courseware (in further text AHyCo) [9].

A Web-based Learning Management System (in further text LMS) AHyCo was created at the Faculty of Electrical Engineering and Computing, University of Zagreb. Theoretical background of AHyCo and implementation are described in [5] and [6].

AHyCo provides numerous functionalities included in most today's LMSs such as the delivery of learning content, assessment, discussion forums, administration of classes and groups of students, anonymous student surveying, mid-exam administration, schedule planning etc.

Further paragraphs describe the evolution of the system and discuss advantages and disadvantages of technology supported assessment with AHyCo.

2. Current trends in assessing knowledge

When judging on how much one has learned, a learner's performance can be compared to his or her own prior achievements, with the achievements of the other people and with some predefined criteria [7]. Although traditionalists see assessors as fully objective and experts in the field being assessed, modern theories say that learners primarily have to assess themselves.

This revolutionary thought comes from the belief that a learner has to decide on his or her own notion of learning. In a scenario such as this teachers are seen as facilitators and have to be the ones to direct learners towards their own goals or to facilitate the accumulation of knowledge [7] [5] [6].

3. The evolution of assessment methods at the Faculty of Electrical Engineering and Computing

3.1. The first attempts – midterms and quizzes

In the year 2000, quizzes (multiple choice tests) were introduced to the course "Programming" (the course was later replaced by "Programming and software engineering"). The final student mark was calculated out of the results of six quizzes (40% of the total grade; 1% for each correct answer, -0.3% for each wrong answer) and the results of the two mid-term exams (60% of the total grade). It is important to note that this type of grading was optional, because regardless of the results students achieved, they could take classic written exam(s) at the end of the semester. Nevertheless, this was a solid base for significant changes few years later.

Although quizzes provided a new way of assessment in order to retain the initial quality new questions had to be added every year to enlarge the questions database. Nevertheless, an internal evaluation showed that students who wrote quizzes at the end of the week had much better results than ones who wrote it in the beginning of the week. That was dealt with by reducing the time span between the assessments.

Today it is obvious that quizzes and midterms represent a classical form of assessing knowledge. Not being changed for decades, they come with questionable validity measurement and reliability problems.

By having up to 15 assessors correcting midterms in parallel, the validity of the assessment suffers. In addition to that, both midterms and quizzes suffer from well known backwash effect [7]. Students tend to study the matter needed to pass the course, not the matter representing the core knowledge being thought. Aligning the two in order to neutralize the backwash problems is time consuming and requires an additional effort in restructuring the courses themselves.

3.2. Homework as a possible assessment enhancement

All these issues showed that the used approach to teaching and course organization had to be radically changed. The first attempt included students answering one randomly chosen question from a previously completed assessment in the presence of the department staff and handing in homework assignments to be checked during the quizzes session. As the number of department staff in year 2004 (due to the department reorganization) significantly decreased, especially the number of teaching assistants that dealt with the student assessment, this approach been abandoned and the further development of the AHyCo system became a priority.

3.3. A better organized approach to assessment

Today, assessment of knowledge at the programming courses at the Faculty of Electrical Engineering and Computing consists of several parts: in-class assessments, midterms, homework and quizzes. Performance assessment [7] of knowledge is realized as homework in the form of programming assignment. Students upload homework and get immediate feedback from the system on the achieved results.

3.3.1 The automatic evaluation of programming assignments

In the year 2005 assessments with the automatic evaluation of programming assignments have been introduced as a replacement for classical homework. Students were given either whole programs or individual functions as programming assignments (Figure 1). On upload, students' code is joined with the code previously defined by the teachers and compiled. Upon the successful compilation, program is run against the predefined tests and its output compared with the expected results. Tests can be defined either as fixed set data or can be generated randomly according to a specific built-in mechanisms [3].

Although this approach might seem fully behaviourist, programming assignments promote

an active demonstration of the learned matter [5] [6] and are as close as our system of performance assessment gets to the contextual knowledge assessment and constructivist principles. These advise an active approach to learning so that existing metal representations can be joined to create the new ones therefore promoting cumulative knowledge acquisition [7].

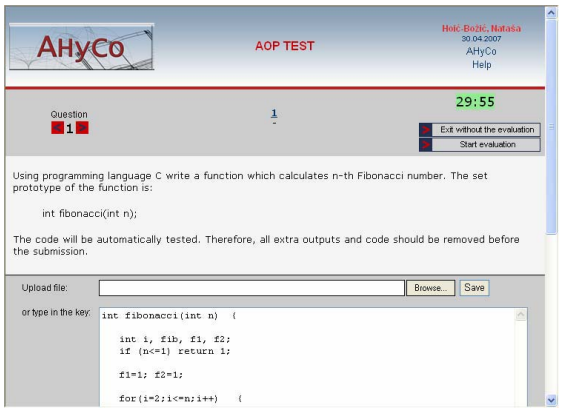

Figure 1: Student user interface for programming assignments upload

Nevertheless, the system for the automatic evaluation of programming assignments can sometimes be quite rigorous. Since student programs are tested with predefined tests, creating more tests usually leads to the better precision of the evaluation. In contrast, minor errors in student programs may result in the failure of all tests. This is the main reasons why mid-term and final exams are still being reviewed manually.

3.3.2 The support for manual exam reviewing

Traditional paper written exams used to assess students' programming skills are subject to many controversies. The advantage of a paper written exam is that student can concentrate more on the logical problem and less on the pure syntax. In addition to that, even if student does not know how to solve the whole program he or she can write just a part knowing that it will be evaluated by a person and not by machine therefore earning some points in case that there are good fragments in the answer.

The disadvantage is quite obvious: when writing a program on a computer, student can test and modify it until it starts working correctly. This is a good thing in case it contained minor errors, but is a principle that should generally be avoided. Modifying a program until it starts working correctly can produce unreadable code that is difficult to maintain and is not a part of good, structured programming practice [8].

As a compromise to these two approaches, AHyCo supports a simple mechanism for the evaluation of written exams (Figure 3) with the feedback to students as soon as the exams get corrected. Students upload their answers in a similar manner as they upload their automatically evaluated homework. The main difference comparing to homework is that in this case uploaded code will not be compiled (even does not need to have the proper program structure) and the whole exam must be written in the presence of teaching staff. When the exam is finished, teacher will see the list of the students and their answers (Figure 2).

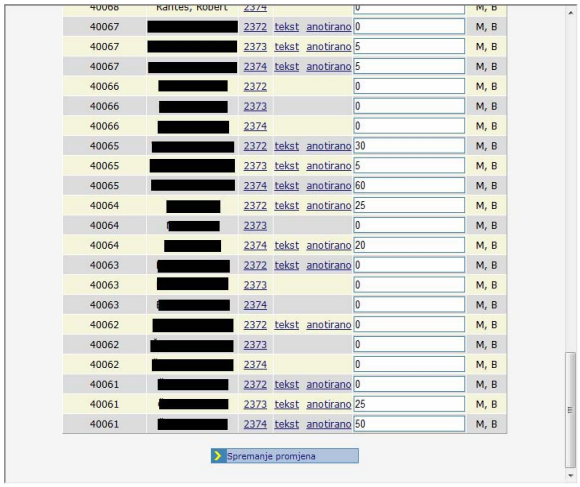

Figure 2: Teacher user interface displaying the list of uploaded students' exam answers

Through the AHyCo's web user interface, the teacher can review students' answers and write comments (Figure 3) that will be later displayed to students.

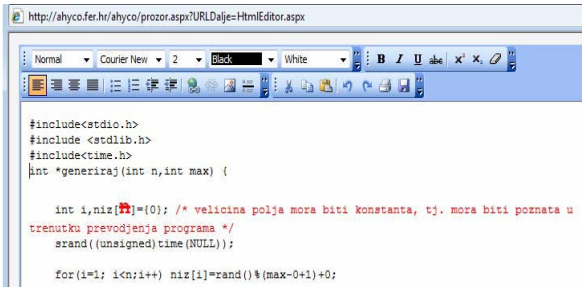

Figure 3: Teacher user interface for the review of students' exam answers

Unfortunately, this way of reviewing was used only few times because it takes significantly more time when compared to the traditional manual correction and because it is limited only to textual comments.

In order to better emulate traditional manual correction, a support for graphical assessment reviewing was implemented. Students' answers can be scanned and reviewed not only by writing textual comments but by using more complex annotations (Figure 4). In order to support this type of exam reviewing graphics tablets are needed.

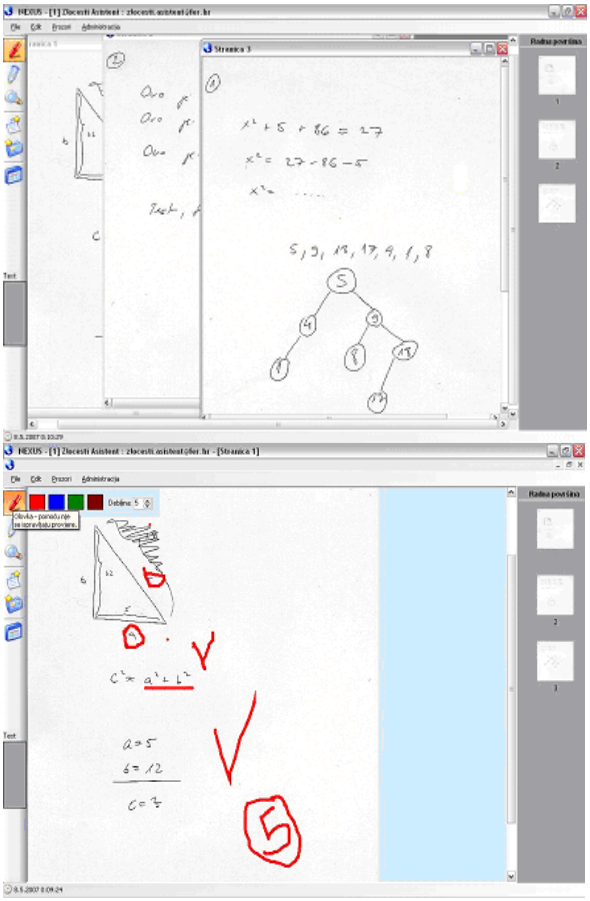

Figure 4: Graphical exam reviewing using graphics tablets [4]

Unfortunately, as long as the reviewers are not equipped with Tablet PCs, the process of reviewing is not as useful as it should be. The main problems are the difficult coordination when drawing on simple graphics tablets and watching the exam on the monitor in the same time and the disproportion between the tablet size and monitor screen resolution.

3.3.3 Stimulating in-class assessment

In-class assessments are delivered traditionally in an oral or written manner and represent an opportunity for the direct contact with the teacher. Although certainly not being the most efficient method of assessment, they put student in the centre of the educational process providing an opportunity for the direct communication with the teacher. As an informal form of assessment, the use of mobile devices and text messaging is being employed. Using their mobile devices students submit an answer to the predefined question and receive immediate feedback from their lecturer together with a more elaborate version of the answer. Currently, a system called MILE [2] is being developed in order to provide a systematic support to mobile learners and to enhance discursive and social elements of an in-class learning environment [1] (Figure 5).

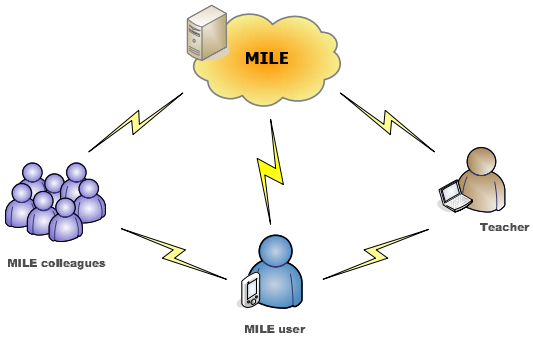

Figure 5: The main components of MILE system

3.3.4. The results of the enhanced course assessment mechanism

The outcome of the very first homework with automatic evaluation of programming assignments, held in the year 2005, was quite disappointing. Due to the lack of experience and due to ambiguities in test definitions, average student result was 71.49% with about 40% of complains (The authors of the article received more than 300 e-mails in three days) temporarily leading to the cancellation of the automatic evaluation of programming assignments. The semester was completed with classical homework that was manually reviewed and had average student results of 94.28%, 90.2% and 94%, that was slightly above expectations. After thorough preparation, in the next year the assessments with the automatic evaluation of

programming assignments were successful with results being: 89.25%, 84.56% and 79.74% (The decrease was expected since the first assessments are usually simpler). At the point of writing this article, the automatic evaluation of programming assignments is still in use.

With the automatic evaluation of programming assignments, the grading scheme for "Programming and Software Engineering" course has changed. To calculate the final grade, a mixture of the normal referenced approach and criterion – referenced approach to assessment is used.

The final score is composed out of 70% gained from mid-term exams and final exam, 6% from homework, 18% from quizzes and 6% from classroom activity. Students have to collect a minimum of 50% to pass the course. The ones above the 50% are given the grades based on the normal distribution.

4. Conclusion

The article presented an effort in enhancing assessment mechanisms in programming courses at the Faculty of Electrical Engineering and Computing and discussed the new ways of student assessment that should entice a more active approach to learning.

The first attempts included introducing short homework and quizzes in addition to standard midterm exams. Although being an innovation, these have not turned out to be a complete success due to the negative backwash effect. In order to neutralize it and to introduce constructivistic elements to learning other types of assessment, such as the automatically evaluated programming assignments and in–class assessments were introduced. These had upgraded the assessment system and students have become aware of the importance of constant and active learning.

Nevertheless, the implementation of new assessments mechanisms, although attractive, has many hidden traps and can cause difficulties both to teachers and to students. An obvious example of such difficulties was the introduction of automatic evaluation of programming assignments.

In the future, numerous attempts to further enhance the system are planned: mobile devices are to be used in order to provide a more active learning environment, new ways of stimulating in-class assessments are planned, more problem oriented activities are to become a part of the curriculum etc.

To sum up, in our opinion, organizational and technological enhancements of assessment systems are necessary to support an active approach to learning thus eliminating the negative backwash effect and preparing students for real working environments and lifelong learning efforts.

5. Acknowledgements

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