International Journal of Engineering Education Vol. 33, No. 2(B), pp. 898–907, 2017
Printed in Great Britain

0949-149X/91 $3.00+0.00

BeA Add-ons to Support On-line Assessment and to Improve Review Communications*

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During the last years, ICTs (Information and Communication Technologies) have been used extensively for supporting teaching and learning processes for both distance and in-person scenarios. In case of in-person scenarios, a key part of these processes involves the assessment of the students using written exams. BeA (Blended e-Assessment) has been developed for addressing this kind of assessments with ICTs. This platform supports the streamlining of the whole cycle required for assessing traditional written exams from preparation to print in paper, to grade and review on-line. This paper introduces new developments in BeA to support also on-line assessment and automatic grading of written multiple-choice tests, and communication facilities to allow student-professor communication during the reviewing stage. Using these facilities professors have more options to prepare exams and tests, and different assessment processes, including self-assessment, are facilitated in a more comprehensive way.

Keywords: e-assessment; e-marking; on-line grading

1. Introduction

Information and Communication Technologies (ICTs) are used to provide technical support to assessment tasks in different ways. Within assessment tasks, we can find tests, automatic assessment, delivery of answers to the students, or making score reports. The use of tools that offer this kind of services, for instance as a part of a Learning Management System (LMS) (e.g., Moodle, Ilias), is more and more usual nowadays [1]. On-line learning platforms provide support for the assessment of the students, and often, this support includes the automatic assessment of test exams. A good example is the multiple-choice question test, where the students have to choose one answer among several ones.

In many cases, professors prefer to assess their students using questions in a more open way. Students are required to answer questions with whole freedom, using their own words and completing the answers using graphics, formulae, and other kind of elements [2]. In this case, professors can assess even the expressivity, organization, originality, skills for summarize ideas, etc. Another benefit about this kind of assessment is that professors, during the exam, do not have to be worried about technical failures that can disturb the exam (for instance, computer or networks failures). Some attempts have been carried out trying to automatize the assessment of these open answers. Nevertheless, it is not easy for the most popular assessment tools to support the automatic assessment of this kind of assessments, because it would imply to combine techniques of Natural Language Processing and Artificial Intelligence. For this reason, traditional written exams become more a need than an option supported by ICTs.

BeA (Blended e-Assessment) [3] is a tool designed to support the whole life cycle of written exams by ICTs. It does not deal with on-line tests (mainly those automatically graded) because a lot of tools devoted to support this kind of on-line assessment in existing LMSs (e.g. Moodle, Claroline, Ilias) are already available [1]. During the last years, while the implantation of the EHEA (European Higher Education Area) model, we have been using this kind of on-line assessment tools as a self-assessment for students, and BeA to manage written exams. The use of these two different tools has been confusing for students (and also for professors), and has been an extra work for everybody. A single system to support all the assessment exercises was considered as a better solution. Therefore, we decided to extend BeA including new on-line assessment functionalities in order to simplify all the assessment phases both to students and to professors. Among these new on-line functionalities, it is included the usual and popular multiple-choice test, where a new function for automatic grading of written multiple-choice test was included in BeA. Furthermore, with the proliferation of the continuous assessment proposed by the EHEA model, the students have to attend exams and lectures at the same period. To support the reviewing of these continuous assessments along the term in a better way, BeA has been extended with new communication facilities.

The rest of the paper is structured as follows. The

* Accepted 13 December 2016.

next section describes similar tools to BeA. Section 3 addresses BeA: its history and the motivation for designing it, and its basic functionalities. Section 4 introduces the new types of exams supported in BeA. Next section focuses on the facilities that BeA provides to improve the communication with the students during the whole life cycle of an assessment process. Finally, section 7 presents the conclusions and the future work.

2. Related work

Computers have been around to support assessment for many years. PLATO (Programmed Logic for Automatic Teaching Operations) and TICCIT (Time-shared, Interactive, Computer-Controlled, Information Television) [10], are two of the first attempts of using computers for these processes in the 1960's. As a main part of the instructional design and media, assessment was affected by the revolution of microcomputers in the 1980's, and something similar happened in the 1990's with the introduction of the World Wide Web when assessment systems started to become web-based systems.

In the present century, several companies and institutions have been introducing in their agendas assessment aided by computers. The regulatory authorities in England, Wales and Northern Ireland [11], The Joint Information Systems Committee (JISC) [12], and even the IMS Global Learning Consortium [13], are producing standards, principles, and guidance for e-assessment to transform educational assessment.

Most of these proposed models and techniques try to achieve automatic assessment, with a minimum involvement by professors. They often use methods based on tests involving several types of questions, created by the professors or generated by the tool itself. Also, we can find tools which focus on offering a system to support professors' assessment and grading instead of automatizing all these tasks. But it is quite difficult to find systems that combine these two methods of assessment, i.e., systems that allow to create both test exams capable to be automatic assessed by the system, and traditional written exams which need the professors to assess them.

Following, we present some works related to the assessment process to make a big picture about this matter over the last years.

Plone [14] is a content management system that incorporates a tool for supporting computer science education with software components. It supports the creation, management, submission, and assessment of assignments and tests, including the automatic assessment of programming exercises, as we can see in [15].

In [16] a case study is presented, where an instructor uses a pen input device and a microphone to record audio comments while marking up an electronic copy of a student's homework assignment. The student can then view the resulting animation using any web browser, for an experience similar to that of sitting beside an instructor who personally explains the strong and weak points of the student's work.

TestWeb [17] is an e-assessment environment with dynamic generation of tests based on parameterized tasks with different solution forms, simulation of test conditions, automated verification and rating of tests, and customized statistical summaries. This tool can be used for rated on-line tests as well as for individual self-assessments.

Penmarked [18] is a software solution to fully support the marking and annotating of students' assignments with free-form ink annotations and associated marking tasks, like gathering and returning assignments, and recording grades.

The design and development of an eMarking tool (designed as a plugin for Moodle) is presented in [19]. This tool supports the printing, digitalization and marking of paper-based evaluations based on open source software.

Eyegrade, a system for automatic grading of multiple-choice exams, is presented in [20]. It offers a truly low-cost solution requiring only a regular off-the-shelf webcam. Eyegrade performs both mark recognition as well as optical character recognition of handwritten student identification numbers.

The authors of [21] propose an exam digitization four-step pipeline: (i) Given a video of a student flipping through an exam, frames that contain exam pages are identified; (ii) the page from each frame is extracted out and post-processed to improve readability; (iii) then it is determined which questions are answered on which pages (an on-line grading system can allow an instructor to quickly navigate to a particular question); and (iv) the exam is assessed.

In a system for automated grading of multiple-choice exams using simple answer sheets that are annotated by the students, the authors of [22] propose a simple and effective computer vision algorithm which enables automated reading of a limited set of handwritten answers and minimizes the need for a human intervention in a scanning process.

A tool for the automatic management of paper tests has been developed by the e-learning laboratory of the University of Valladolid [23]. This tool allows professors to make paper tests from those one previously designed in Moodle. Students can answer the tests in a classroom without a computer, using the exam sheets and pen. When these tests were answered, they can be assessed through a

system based on commodity scanners, and the results are loaded into Moodle.

The Xerox Ignite™ Educator Support System [24] is a data collection, analysis, and visualization workflow and software solution to assist educators. When students' homework and/or exams are scanned into the Ignite system, it reads, interprets, and analyzes the students' work. Then the professor can select how to view the data by choosing from numerous reports.

In [25] it is presented a framework of an Automatic Assessment System for learning object oriented programming language which consists of five modules: (i) teaching module to help students learn and submit program code; (ii) real time detector module to show existing error and supply hints to solve problem; (iii) marking module to compile, mark, execute, and pre-set evaluation criteria; (iv) analysis and reporting module to give instant feedback; and (v) social module for interactions between the users.

After the presentation of the previous systems as examples of the work carried out over the last years in the field, we can make a comparison among them and ours. We find systems addressing online assessments, for instance through multiple-choice exams, both based on automatic [14, 17, 25] or non-automatic assessment [18]. The new characteristics of BeA related to test exams cover these functionalities (although not all the possible formats). By the contrary, these systems do not have the option of paper exams. Also, we can see systems that work with paper exams [16, 20–23], which are subsequently digitalized for assessing (just like our system). Nevertheless, they do not have the option of managing test exams within the same tool (including assisted or automatic assessment). Besides, within the set of system managing paper exams, we have two special cases: (i) [19] is a plugin for Moodle, and so, it is possible to make test exams supported by this LMS; and (ii) [24] allows the automatic assessment of short-answer questions (so BeA does), but it does not support the assessment of paper exams.

Finally, for the best of our knowledge, we have to mention that none of the revised works (except [25]) offer a tool for maintaining a discussion between students and professors after the results of the assessment were presented to the students. This is also an important feature of our system, as we can see in the next sections.

3. BeA (Blended e-Assessment)

3.1 History and motivation

Our first work on this topic was carried out in 2007 [4], where we designed an on-line platform for answering exams not only on a computer and everywhere, but focusing on official exams in a classroom or laboratory. This platform addressed the more common types of automatic assessment questions and free text questions too. This kind of questions is very useful in any exam, and especially in engineering degrees, where the students have to solve several types of questions or problems with fully freedom and using their own words [2]. This type of questions does not have an automatic assessment, and the objectives of this first version of our platform were to help the professors in these cases.

This first tool allowed the assessment through an atomistic model [5]. Initially, all the questions are considered as right and the professor gives them the maximum score by default. Then, this score is decreased if errors are found. The tool allowed the definition of errors by the professors that can be assigned to any question. The definition of an error is made up of an explanation and a penalty over the score of the question. During the assessment of exams, professors can select specific portions of text in the answers of the students, and assign them some of the predefined errors. When a student checks his/her answers, he/she will see a red mark linked to the errors. When he/she clicks on it, an information window with the definition, explanation and penalty is shown.

This first system had several services to manage on-line laboratory exams, checking the computers involved in the exam, and the possibility of having different exams in different computers to minimize the risk of cheating (because a student would be surrounded by students answering different exams). Nevertheless, this idea of assessing on computers turned out to be inconvenient. For instance, to assess students in a laboratory with 20–24 computers in courses with over 200 students was unfeasible.

Therefore, we focus on supporting traditional written exams answered on a piece of paper. We adapted the tool to an environment where the exams were answered in a traditional way, i.e., with pen and paper, and through the use of a scanner they were stored in a computer to follow the rest of the stages in the life cycle of an exam [3]. This allowed us to maintain the facilities presented in [4] to assess open answer questions. Lately, we added functionalities related to: annotations, surveys, assessment interfaces, and scores. In addition, the system began to use QR-codes [6] and was named as BeA (Blended e-Assessment), because it is exactly what the tool makes. If e-assessment is [7] "*the end-to-end electronic assessment processes where ICT is used for the presentation of assessment activity and the recording of the responses*", then blended e-assessment [3] "*will take place when exams are performed using pen and paper*".

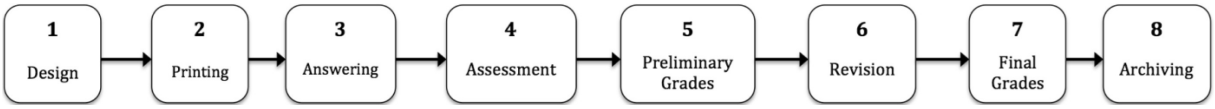

Fig. 1. Stages of the exam.

Fig. 2. Header with data to be filled by student (Top) and personalized header for every student (Bottom).

3.2 Functionalities

BeA can manage the three typical modes of assessment (holistic, atomistic, and analytical) [5]. Although we use the atomistic one because is the more appropriated for the course of engineering where we are using BeA. As we said before, in this atomistic mode all the questions are considered as correct in the beginning, and we assign them the maximum score by default. This score is decreased depending on the errors that the professors find during the assessment.

BeA addressed practically all the stages of the life cycle of an exam (see Fig. 1), especially all related to the communication with the students:

1. Any text editor can be used to design the exam. Some rules have to be adopted related to the margins of the document (a header of 5 cm., and 1 cm. of separation between questions), to avoid possible scanning mistakes. Once the exam was edited following these rules, a PDF file containing it has to be uploaded to BeA, where the header data will be added to every page of the exam. The header (see Fig. 2) has the following elements: (i) a QR code for identifying the specific page of the exam (located on its left side); (ii) several fields that the student has to fill (with his/her first name, last name, identifying number, and e-mail); and (iii) on the right side, an identifying QR code of the specific student, or a space where the student has to set an identifying QR code sticker (that the professor previously gave to the student). Considering the version in which the student has to set the QR code sticker, BeA provides a PDF file with all the pages of the exam; otherwise, BeA provides a PDF file with personalized pages of the exam for every student.
2. Once the PDF file of the exam is ready, the professor has to print as many copies as needed. Although some institutions can implement exams through smartphones, tablets and computers, and therefore this stage could be unnecessary, most institutions (universities and colleges) in our environment use paper for exams.
3. The professor delivers the exam paper to the students in the classroom. Once the exam is finished, all the pages with the answers of the students are scanned, converted to PDF format, and uploaded to BeA for assessing. Before to proceed with the assessment, the professor has to mark out the area occupied by every question/answer, and so, BeA is able to know the area that has to assign to every question. This process can be carried out before or after the scanning, but always before the assessment. Besides, at this point, the professor can upload the solved exam. Therefore, after these steps and before the assessment, a student gains access to both his/her answered exam and to the solved one.
4. In the assessment stage, BeA provides a view based on the questions instead of the students. For instance, if the exam has 4 questions and it was answered by 20 students, BeA is designed to show to the professor the answers of all the students to one specific questions at a time (i.e., the 20 answers of the question 1, the 20 answers of the question 2, and so on). In this way, the professor can assess all the answers of one specific question at the same time. As we have

said before, from the beginning BeA was designed to provide atomistic assessment, where the professor considers that the answer is right, and he/she adds penalties to the score when he/she finds errors. To do that, the professor can define a list of errors, everyone with its specific penalty score and description, and if he/she finds some of these errors in a question, he/she can assign it to that question with a single mouse click. Therefore, a specific error is always described and scored alike. Besides, we do not have to forget that all the exams are stored in BeA, and they are accessible through any web-enabled device. So, the assessment can be carried out from everywhere, and the professors do not have to take the paper exams wherever they go to assess them.

5. The preliminary grades are the sum of the scores in every single question. Although the professor has corrected by focusing on questions, when observing the preliminary grades, he/she has the option to see the full exam of a student with all the questions and to add the comments and adjustments to the grade he/she considers appropriate. From our experience, it is very useful for the professor to have a global vision of the student's exam, especially when the score is in the limits of passing the exam and making decisions in consequence. Once the exam is completely assessed, the professor can give access to the students to see their marks and results and advance to the reviewing stage.
6. In the revision stage the students can dialogue with the professor about the assessment of every single question. We will go further into this functionality in the next section.
7. After the review, the grades turn into permanent without any chance to modify them. BeA permits to export the grades as a csv file so that it is easy to transfer this information to other tools such as the LMSs.
8. Once the grades are permanent, the exams and assessments are saved. As the tool saves scanned exams and also their assessments and comments by the professor and the student, the exam can be reconstructed as the original one submitted by the student, or with the assessment and comments. Similarly, it can be stored in PDF format, independently of the format used by BeA.

4. New types of exams

The initial goal of BeA was to facilitate the management of processes involved in classical exams (pen and paper) in the digital world [3]. Such initial goal has already been achieved, but new functionalities were required. A key issue came from the use of two different systems related to assessment processes. BeA has been used to support pen and paper written exams, while third-party on-line assessment tools (e.g. questionnaires in Moodle) were used to support self-assessment assignments. The use of these two systems creates some confusion to users and difficulties to integrate data. Therefore, it was decided to include new question types of on-line assessment similar to the existing ones in on-line assessment platforms:

- Open answer: The student enters a text as an answer. This kind of question needs the intervention of the professor to grade it.
- Number: The statement contains empty areas where the student enters a number. During the edition of the question the right answer must be set by the professor.
- Short answer: The statement has empty areas where the student enters a short text. The professor is required to provide the right answer.
- Multiple-choice: The student can choose between several possible answers, and one answer (or several) is (are) correct.

BeA was extended to deal with on-line and written exams. From these four types of questions in the case of on-line exams, just Open Answer questions need to be graded by the professor, in the same way that it is graded in written exams. The other three types (Number, Short Answer and Multiple-Choice) are graded automatically by BeA. These three types of questions can also be used in written exams, and in this case, they will be graded as the rest of questions: by hand and not automatically, but with the facilities provided by BeA. Nevertheless, in this case usually the grade options for each question are binary: right or wrong. To facilitate the grading of this type of questions in written exams a facility has been included. In case a certain mistake is found in the most part of student answers, the same mark can be assigned and replicated for all the students' answers. Then, the professor only needs to review those students' answers that didn't contain the specific mistake and change the mark.

In case just the multiple-choice question type is used, BeA can grade the written exam automatically. The Number and Short Answer question types could be graded automatically, but text recognition software needs to be developed and tested, and currently it is out of the scope of BeA. As it is simpler to recognize answers in multiple-choice question type we decided to focus on this type and support its automatic grading. Now, it is possible to automatic grade written exams including just this question type automatically without the direct

intervention of a professor. This grading is done as soon as the answered written exams are scanned and uploaded to the platform, which immediately shows the results of the assessment. This feature makes use of OpenCV, a powerful open source library which implements computer vision and machine learning algorithms.

Test templates, which may vary depending on the number of questions and possible answers, are generated by BeA. The correct answers are introduced by the professor at the moment the template is created and saved in the platform database. Both single and multiple correct answers for each question are supported. The question titles of the exam are printed on a separate sheet. Each row in the test template represents a question of the exam, and contains a certain number of circles, one for each possible answer. In order to answer each question, students must fill the circle or circles, which correspond to their chosen answer or answers. When the exam is scanned, BeA detects the circles on the template and decides whether each answer is selected or not depending on the covered surface percentage inside the circle. In order to avoid possible ambiguities, we ask the students to fill the whole circle in order to select an answer, although our tests also showed good performance when using other symbols like an X or a tick. If an ambiguous answer is still found, it is marked with a special type of error, which indicates the professor that the question needs manual correction; this is not a common situation.

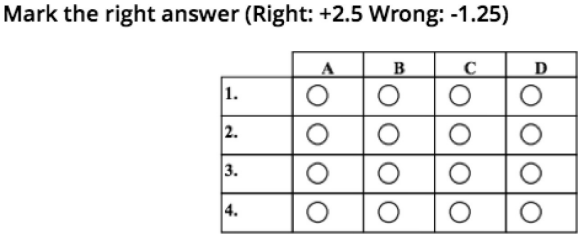

Fig. 3. Template generated by BeA for a 4-questions with 4-options exam.

The algorithm used to detect circles is the Hough transform, originally used for detecting lines and curves but that can also be used to detect arbitrary shapes, most notably ellipses and circles, in its generalized form [8]. In the circle case, OpenCV directly implements this algorithm through the method HoughCircles, which returns a matrix containing the coordinates and radius of each detected circle. After applying a binary threshold to the scanned exam and blurring it to reduce noise, we use circle Hough transform. Then BeA sorts the resulting list knowing that circles detected on a single row represent options of the same question. As this method does not usually detect every single circle, we take advantage of the fact that all the questions are vertically aligned and we add any option that has been missed by the Hough transform by comparing with the positions of the same options in different questions.

When the detection ends, BeA determines the answers chosen by each student, as previously stated. For each question, the picked options are compared with the correct answers in the database, assigning an error marker to the question if necessary. Wrong questions can be penalized with negative scores if the professor decides it. When multiple choices are correct, the question may be partially right, in which case a proportional fraction of the score is given. BeA calculates the total score using these error markers in an atomistic mode of assessment.

In Fig. 3 we can see the template generated (to be printed) by BeA for a four multiple-choice questionnaire (four possible answers too). And in Fig. 4 we can see the screen seen by the student to the answer of the question 1. In this case, BeA scanned the statement of each question for a better visualization of the exam.

While on-line automatic assessments are used to support self-assessment, our previous experiences show that if students are required to answer this type of assessments during classroom time and not online as homework, the results obtained are more correlated to the actual learning [9].

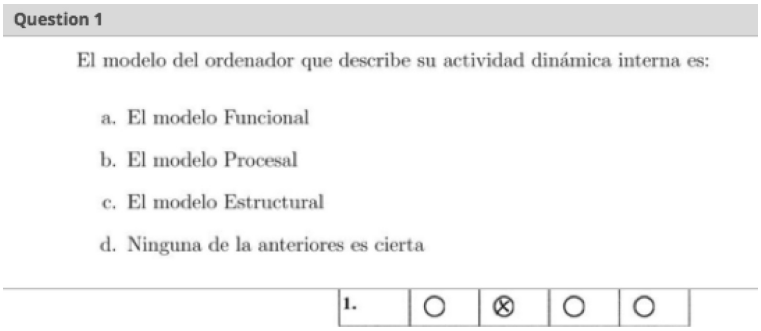

Fig. 4. Screen viewed by student of the answer of question 1.

5. Communication between professor and students

During the exam lifecycle, from the steps 3 to 8 described in section 3.2, students can maintain some communications with the professor related to the assessment process. Few seconds after the professor has uploaded the scanned answer sheets to BeA, students have access to them. This involves just the time needed to process the scans by BeA (to divide the contents of the answer sheets in groups of questions/answers). The time needed to perform this task depends on the number of exam sheets, the number of students and, of course, the speed of the scanner. In our case, we have used a 2006 Ricoh Aficio 1515 scanner. This task takes between 3,8 and 4,8 seconds per page in the scanner, and only 0,5 seconds per page by BeA to process the information. As a result, an exam of 3 pages administered to 30 students, which provides 90 pages to be scanned, takes around 7 minutes of scanning and just 45 seconds of processing time by BeA. Of course, the professor does not need to pay too much attention because the scanner-feeding tray is used to provide the sheets. In addition, as explained previously, the professor can also scan and upload to BeA a solved version of the exam including the right answers and give permission to the students. Therefore, in a very short time after the exam is finished students can access both their exams and a solved version of it.

The next step of the process involves the assessment performed by the professor. Once this step is finished the assessed exams are visible for every student through the BeA platform. Students can view all the answer sheets of the exam, the assessment performed by the professor, including possible mistakes, scores and professor comments, and the right answers. BeA doesn't show to a certain student the grades obtained by other students directly. Instead, BeA shows the position of his grade in relation to grades achieved by other students, particularly in accordance to quartile and polar representations. Fig. 5 shows these representations. On the left side, it is included a table with the exam questions, the grades of the student and the average grades of the classroom. On the right, this info is shown in a polar graphical representation. Each vertex represents a question in the exam. When the mouse is situated over any of the vertexes of this figure it is shown the student grade and the average grade for the corresponding question. The center side of the figure shows a quartile representation of the exam grades, where the point is used to represent the grade obtained by the student. When the grade of the student is passed, then the color of the point in the quartile representation and of the lines of the polar graphic for the student is green; in other case (not passed) the color of both is red. In the upper side of the figure it is included the rank of the grade among all the classroom students (14 out of 45).

As it is shown in Fig. 6, mistakes are shown as "bubble comments" with an X letter inside. When the student places the cursor over this element, a pop-up notice shows the description and penalty of the error provided by the professor. In this way students can see their mistakes, compare their own exam and assessment with their peer ones, and verify that all the occurrences of the same mistake receive the same penalties (same assessment criteria). Therefore, the assessment is performed in a transparent and fair way. Nevertheless, in case the professor performs some error during the assessment task and some learner disagrees with the result, a reviewing stage is included (stage 6, Fig. 1), to enable students to make comments or complaints to every single issue. A communication

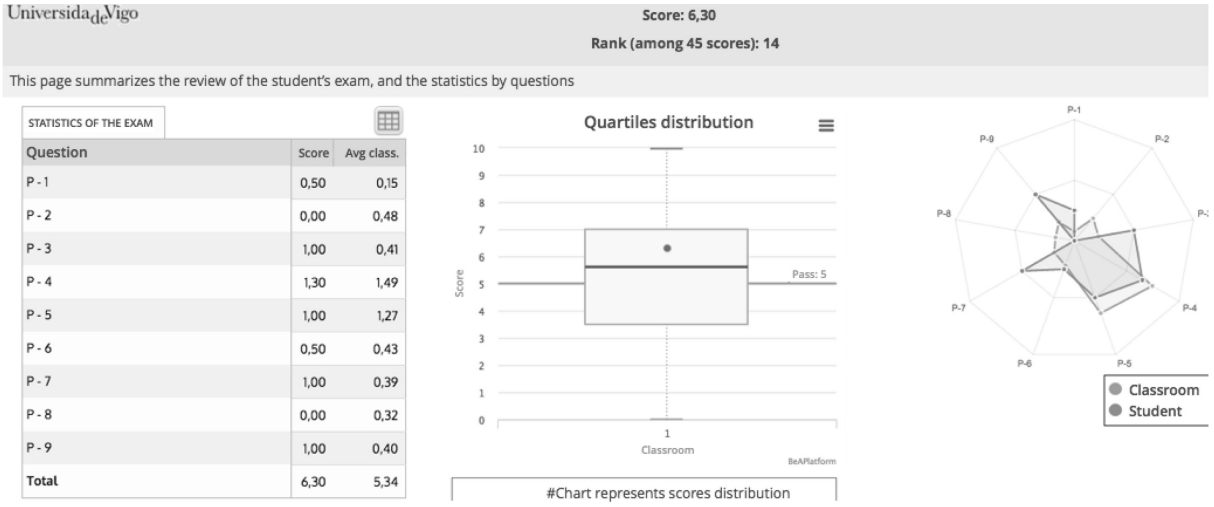

Fig. 5. Screen describing the grades of a student.

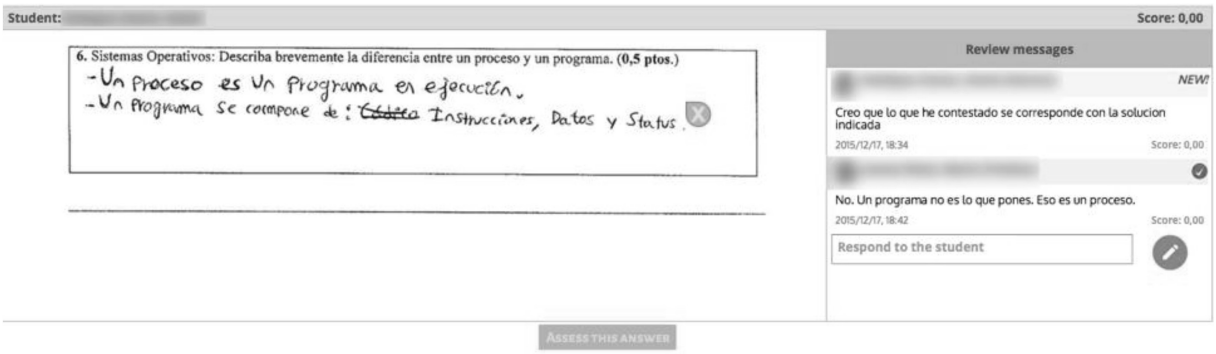

Fig. 6. Review screen in BeA (some data is blurred to save privacy).

facility similar to a chat, which is very familiar to the students, is provided to support this communication between the student and the professor.

The options provided to perform the review through the BeA platform facilitates the reviewing stage to a long extend, making it more simple and direct. In previous versions of the BeA development, the review stage was done through the e-mail. Although it was a more flexible option than the in-person review, it also had serious problems when referring exactly to a specific question and message description. The professor had to deal in one hand with the e-mail and on the other hand with the manual assessment of the question of the student. With this new functionality, the review message is appended in the question itself, and the professor can go directly to the assessment of that question if needed while maintaining a dialogue with the student about the review, all of it managed and saved by BeA.

All the modifications done in the grade and committed during the reviewing stage are summarized to the professor. In a similar way, the particular results of his/her review are showed to the student. Therefore, the students mostly choose to review their exams on-line (checking their assessed exams and chatting with their professors), in spite of in-person, because of the friendly communication tools that BeA offers.

In the past, a significant part of the in-person reviews (before the utilization of BeA) were made up by students that wanted to see their exams, to remember what they had done and why, and to see how their exam was assessed. Only a small fraction of the students were confident about its solutions and expected (usually) higher scores. With the use of BeA and its facilities on-line, all the review needs of the professor and students are covered.

It should be noted that the facilities provided by BeA do not have as a purpose to eliminate the in-person review. They simply seek to facilitate the reviewing phase, and what can be resolved through BeA will be faster and easier (avoiding trips to professor's office) than doing in-person. The in-person review is maintained, because there may be cases in which the student or even the professor needs a contact and in-person dialogue that cannot be achieved using ICTs.

6. Discussions

BeA enables other approaches to continuous assessment, which consist in performing exams throughout the course and not only in the periods reserved for this purpose without classes. This implies that the examination is performed during school hours and the student must attend these classes. In such a scenario, the in-person reviews become very complex to plan, as they have to coexist with the attendance to classes. The use of BeA in these scenarios facilitates the revisions without interfering with classes. In this way, new strategies for formative assessment can be developed [26] and not only for summative assessment. Experience in recent years with BeA for viewing and reviewing exams has reduced the attendance to in-person reviews practically to zero. The in-person review of exams is used in exceptional cases.

BeA, in its different versions, has been used since the course 2009/2010 without any breaks in several subjects, especially in the first course of Telecommunications Engineering Technology Degree, with an annual enrollment of more than 220 students, and real users ranging from 130 the first year to more than 220 last year. The inclusion this last course 2015/2016 of the new on-line assessment functionalities has been well accepted by students, avoiding the use of similar tests through the institutional LMS. The perception of the students on the tool maintains the high estimate as shown in [3], with more than 90% considering it useful or very useful, while expressing their preference for written examinations (60%–70%) compared to only computer exams (10%–15%). For example, in this last

course the 94% of students considered very useful or useful the BeA platform, and 68.7% preferred written exams against 8.4% preferred only computer exams.

On the other hand, the opinion of the professors that have used this tool is very good, because the flexibility and facility for grading and reviewing through BeA. As an example, the case of a visiting professor that was able to travel to his country (Venezuela) to meet his new grandson. From Venezuela, he was able to grade the exams of his students through BeA without the need of carrying them. Of course, he could perform the reviewing process fully on-line.

Future work in BeA focuses mainly on incorporating new types of on-line exams, and facilities for surveys and exams using mobile devices as pointed in [27]. We are also interested in integrating BeA with other educational systems, such as LMSs. In this way, we are exploring the IMS LTI specification [28] and other architectures [29] and xAPI [30] as a way to share the events generated in BeA.

7. Conclusions

BeA minimizes time assessment, review and reporting of results to students, maintaining the versatility to use any type of examination, without being restricted to the test type. This makes BeA a more appropriate tool to develop continuous assessment strategies, widely used since the introduction of what is known as Bologne process.

Taking this into account, an on-line assessment functionality has been included in BeA, introducing the Open Answer question and also automatic graded questions, such as Short Answer, Number and Multiple-Choice. These last questions types may be also performed through written exams, introducing a new ''replicate error'' functionality to facilitate the grading of this kind of questions, and introducing the automatic grading of multichoice questions in written exams. This facilitates the performance of short exams in class time.

Acknowledgments—To David Estévez Villaverde, and specially to Juan González Tato, for the work done in the different phases of BeA. This research is founded by European Regional Development Fund (ERDF) and the Galician Regional Government under projects CN2012/260 ''Consolidation of Research Units: AtlantTIC'' and GRC2013-006 ''Consolidation of Research Units'', and by CYTED under RIURE (code 513RT0471) ''Red Iberoamericana para la Usabilidad de Recursos Educativos - Ibero-American Network for the Usability of Educational Resources'' (www.riure.net).

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