2014 International Conference on Advances in ICT for Emerging Regions (ICTer): 043 - 048

E-Assessment in High-Level Cognitive Courses: Improving Student Engagement and Results

Enosha Hettiarachchi[#1], M. Antonia Huertas[*2], Enric Mor[*3]

[#] *Internet Interdisciplinary Institute (IN3), Universitat Oberta de Catalunya, Barcelona, Spain*
[1]khettiarachchi@uoc.edu

[*] *Computer Science, Multimedia and Telecommunication Studies, Universitat Oberta de Catalunya, Barcelona, Spain*
[2]mhuertass@uoc.edu
[3]emor@uoc.edu

***Abstract*- Introducing e-assessment in high-level cognitive courses is still a difficult issue, especially when adapting theoretical models and systems to real courses. One of the challenges is that most of the e-assessment tools offer simple types of questions such as Multiple Choice Questions (MCQ), which does not allow proper assessment for skills. Another challenge is to find an appropriate way to offer formative assessment in this type of courses through both practice and assessment facilities with personalized feedback. In this paper, a general e-assessment system and a formative e-assessment model for high-level cognitive courses are presented. They allow going beyond MCQ type of questions, and an easy adaptation to different learning scenarios. The model and the system are applied into an actual high-level cognitive course, a Logic course of a Computer Science degree program in a fully online learning environment. As a result, it showed that students' participation in the continuous assessment has increased. Overall when comparing students' results before and after the introduction of the e-assessment system, it shows that with the introduction of the system, students' performance, in terms of students' marks had improved.**

***Keywords*- formative e-assessment; high-level cognitive course; e-learning; virtual learning environments; e-assessment tools**

I. INTRODUCTION

Assessment is central to learning and teaching. What is assessed defines what is taught and how it is learned. The process of assessment, in turn, shapes institutional practice and affects a learner's view of the value of engaging in learning [1]. Technology can play a significant role in this process, if used appropriately; it can add value to any of the activities associated with assessment. Generally, e-assessment, commonly known as online assessment or technology-enhanced assessment, can be defined as the end-to-end electronic assessment process where Information and Communication Technology (ICT) is used for the management of the end-to-end assessment process from the perspective of learners, tutors, educational institutions, awarding bodies and regulators, and the general public [1],[2].

E-assessment, have traditionally been used for tasks that focus on testing the acquisition of declarative knowledge. Such tasks have required students to select a predetermined response based on factual recall like, for example, the simple MCQ and short answer question types [3]. Such questions have been popular because they are quick to write and are easily constructed in common Learning Management Systems (LMS) used in higher education institutions [4]. However, cognitive skills where students have to apply their analytic, creative, and constructive skills cannot be assessed via MCQ and equivalent forms of basic assessment items [5], [6]. As the current change in education is to transform learning and assessment from the memorized facts to a broad, well-rounded model that reflects the learner-centered outcomes, academic programmes should work on building and assessing student's critical thinking skills [7]. As G. Crisp [4], [8] stated, in order to test higher order capabilities, it is needed to design authentic assessment activities, but the workload in designing such tasks is considerable. Also, it is possible to minimize opportunities for copying and cheating by allowing the assessment software to randomly select items from an item bank and also by shuffling the order of items and the order in which the options are presented to the students [9]. Considering the above, one of the motivations was to go beyond tools which offer MCQ types of questions and investigate the introduction of an interactive, dynamic environment for both skill and knowledge assessment in an online educational environment while minimizing the level of copying and cheating by students.

Practice is an important aspect of assessment as it allows students the opportunity to act on the feedback [10]. Also, timely and constructive feedback motivates students to learn more efficiently [10]. By considering the above, to improve students' performance, as the second motivation, it was needed to examine a formative e-assessment model that can be used to offer both practice and assessment facilities.

Advances in computer hardware and software, interactive technologies, and more importantly, advances in e-learning and e-assessment standards and specifications made it possible to address the aim of this research. Therefore, the motivations mentioned were achieved through a design and development of an e-assessment system that is compatible with the current standards and specifications. Assessment is provided through a formative e-assessment model which is comprised of both practice and assessment facilities. After completion of testing and evaluations, the e-assessment system together with formative e-assessment model was applied in the actual classroom of a fully online university. In this paper, we present the effects of introducing e-assessment in a high-level cognitive course through student engagement and results.

In this article, section 2 presents a review of the central concepts related to e-assessment. Section 3 provides a detailed explanation about the design, development and evaluation of the formative e-assessment model and the e-assessment system. Section 4 presents the analysis and results after the introduction of the system in the actual classroom with a focus on students' satisfaction and improvement of students' marks. Finally, section 5 presents the discussions and conclusions.

978-1-4799-7732-1/14/$31.00 ©2014 IEEE

II. E-ASSESSMENT

E-assessment has the potential to offer new forms of assessment with immediate feedback to students and is, therefore, one of the major challenges for both schools and higher educational institutions today. As a result, It is becoming increasingly important to construct a pedagogically driven model for e-assessment that can incorporate assessment and feedback into a holistic dialogic learning framework, which recognises the importance of students reflecting upon and taking control of their own learning [11].

Formative e-assessment is predominantly about improving student learning. Formative e-assessment tasks with timely and appropriate feedback should be used throughout a course; these tasks are primarily intended to have an impact on the current learning of students and most often use feedback to connect the formative task to potential improvements in student performance in subsequent summative tasks [12]. As mentioned in [13], formative e-assessment is a means of promoting self-reflection and students taking control of their own learning.

Five key strategies for formative e-assessment can be noted as: engineering effective classroom discussion, questions, and learning tasks that elicit evidence of learning; providing feedback that moves learners; clarifying and sharing learning intentions and criteria for success forward; activating students as owners of their own learning; and activating students as instructional resources for one another [14].

Through the above five strategies, it shows the importance of student engagement with e-assessment systems for improving their learning process through practice and self-assessment. Practice is an important aspect of formative e-assessment as it gives students the opportunities to act on the feedback [10]. Therefore, immediate constructive feedback is particularly useful as it helps students to monitor their own progress and motivates students to learn more effectively [3]. In this case, practice, immediate feedback and monitoring of progress can be identified as the main elements of formative e-assessment, which is the main focus of this study.

In recent years there has been a rapid increase in demand for e-learning and e-assessment systems. Through the use of these systems, the knowledge and skills are transferred electronically through different communication mediums and devices. There are some interesting and well-known tools available for e-assessment in online education [15]. Some of them can be noted as SCHOLAR [16], ExamOnline [17], TOIA [18], Moodle Quizzes [19], Moodle Assignments [19], Turnitin [20], Hot Potatoes [21] and Maple T.A. [22]. Typically, they focus on MCQs, which are not suited for examining creative tasks and particularly they are not able to assess mathematical calculations or proofs [5]. Therefore, when it comes to formative assessment, for evaluating cognitive skills of students, it is needed to go beyond MCQs and provide a more dynamic and complex type of assessment activities.

Both in e-learning and e-assessment, sharing of learning resources as well as communicating with similar systems has become a major challenge. Several standards and specifications have been defined to design and build the e-learning systems and components. In order to have a high quality e-assessment system, one of the main requirements is standard conformation while designing and implementing the systems. Standards help to ensure five abilities such as interoperability, reusability, manageability, accessibility and durability [23]. When communicating between different systems, it is needed to use appropriate standards to maintain security and interoperability while carrying out a seamless communication. Therefore, standards and specifications such as IMS LTI (Learning Tools Interoperability) [24], IMS LIP (Learner Information Package) [25], IEEE PAPI (Public and Private Information) [26] and O.K.I (Open Knowledge Initiative) [27] can be used. The use of appropriate e-assessment tools together with standards and specifications offers a high quality assessment experience for both students and teachers.

III. TECHNOLOGY-ENHANCED ASSESSMENT (TEA) SYSTEM

A. Formative E-Assessment Model

An appropriate formative e-assessment model is essential to enhance students learning experience by providing facilities to assess their own learning process by means of feedback. Several formative e-assessment models were analysed [1], [23], [28], [29] and out of them, the one proposed by JISC [1] was selected as the starting point because it clearly explains the relationship between e-assessment and effective learning. This model suggests a seamless integration between learning and e-assessment. Learning modules can be provided either as e-learning or blended learning through an LMS. Once the learning module is completed, students are provided with assessment activities either as formative or summative depending on the course. Later, once the assessment activity is completed, if students have successfully completed it, they are provided with feedback together with the final qualification. If not, students are also provided with a constructive feedback and directed to a revision module, allowing them to practice and take the assessment at a later stage.

The main purpose of introducing this model was to provide more benefits for students to improve their learning process through practice. Personalized feedback plays an important role when introducing practice. According to [30], personalized feedback has to be offered in a way that encourages the students to actively change their ideas and ways of organizing their answers and discourse within a given subject domain. This was considered when defining our formative e-assessment model. Also, this model is designed in a general way to make it easily applicable to any subject domain. In our formative e-assessment model, once the learning module is completed, students are provided with a new type of test called practice test, in addition to the assessment test, presented in the JISC model.

Each practice test consists of an unlimited number of attempts with no time restriction. For each attempt, students are provided with a personalized feedback, both in the cases of being successful and unsuccessful. If successful, students are provided with a feedback and also directed to the assessment test. In this case, to be successful, students need to obtain a pass mark specified by the course. The reason for having a restriction of a pass mark was to motivate students to practice more before attempting the assessment test [11]. If unsuccessful, based on the marks obtained, students are provided with a constructive feedback and also directed to the revision module.

Each assessment test consists of a limited number of attempts with a time restriction. The time allocated for each

assessment test, depends on the difficulty level of the assessment and the course curriculum. Even in tests, for each attempt, students are provided with a personalized feedback. Limited number of attempts was provided to allow students the possibility to obtain the required marks within given attempts. At the same time, it gives a bit of pressure to students and motivates them to think carefully about the answers. It also motivates students to practice in order to improve their mark by paying more attention to their errors or mistakes [31]. To discourage guessing the answers, minus marks are given. The questions offered within a particular attempt are selected randomly from a bank of questions. For questions where students have to select the correct answer, the answers are also shuffled within each attempt. These measures were taken to minimize the cheating and copying of answers by students [9]. As the final mark, the highest marks out of the given attempts are taken. This is also another way to facilitate more practice, as students tend to attempt several times in order to obtain a higher mark. Once the assessment test is completed, students can access the next learning module. The formative e-assessment model is shown in Fig. 1.

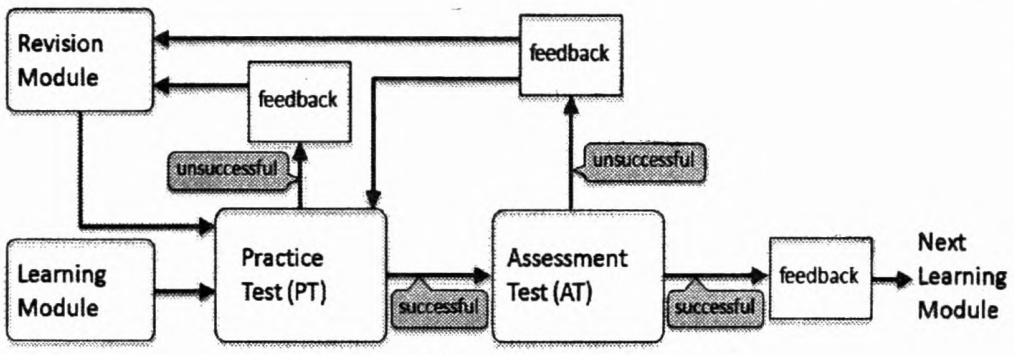

Fig. 1 Formative e-assessment model

B. *Modular Structure of the Technology-Enhanced Assessment (TEA) System*

The "Technology-Enhanced Assessment (TEA) system" was developed following a modular structure and consists of five interconnected main modules: knowledge assessment module, skill assessment module, progress bar, competencies and gradebook. Out of these modules, the progress bar, competencies and gradebook are taken as the standard modules of any TEA system, which provides teachers with the facility to track students skill and knowledge learning process throughout the whole learning process. Knowledge assessment module and skill assessment module are domain dependent and therefore, according to the subject context, these modules can be changed. In order to make the system general enough to be used for any subject and context it was designed following a modular architecture.

The TEA system was developed on top of Moodle [19]. One of the reasons is that Moodle provided user management facilities, one of the main considerations needed for the system. Another reason is that Moodle is one of the most commonly used LMS and any educational institution who doesn't have their own LMS can use it as their own. Finally, Moodle is a standardized tool and its modules should also be developed according to standards. Therefore, by developing the system as modules with the Moodle LMS, it was possible to maintain the required technological requirements such as security and interoperability.

Knowledge assessment module provides both practice and assessment tests with simple type of questions such as MCQ with feedback for each step performed by the student. Skill assessment module also provides both practice and assessment tests with dynamic, interactive questions which allows students to construct the answers with the guidance of feedback, errors and hints. As the skill assessment module, an intelligent tutoring system for learning logic, developed by the Universitat Oberta de Catalunya (UOC), known as AELL [32] was selected. It assists students in the process of practice and self-assessment. Basically, the system automatically evaluates each step of the realization of an exercise, and assigns the value correct, wrong or incomplete. The AELL system was enhanced into a skill e-assessment module by including the added functionalities such as inclusion of a database of questions categorized into different difficulty levels, random generation of questions and personalized feedback for each step of the answer.

Progress bar provides visual guidance to aid students to understand their progress with respect to the course. For each student, it provides a graphical representation of total progress, activities completed, to be completed and not completed. Teachers also have the facility to view the progress of all the students as a graphical report.

Competencies provide both a graphical and a textual display for both teachers and students. Teachers have the facility to assign competencies to students based on the marks they have obtained for a particular test. Students can assess their own competencies both in the form of graphical and textual as a progress bar and a table.

Gradebook provides grades and outcomes obtained by students for each test.

The TEA system was mainly developed using PHP and MySQL and this allowed the system to be easily connected with any LMS while maintaining security and interoperability. For this purpose, the IMS LTI specification [24] together with OAuth [33] protocol was used. Users of any institutional LMS can automatically access the TEA system with the single sign-on facility provided by the IMS LTI specification. To establish a standard integration between rich learning applications (often remotely hosted and provided through third-party services) and platforms like LMSs, portals or other educational environments, IMS LTI specification can be used. This provides a seamless learning experience for students by allowing them to access to rich applications that appear to take place inside the learning environment. All the modules and the system are also linked together using the IMS LTI specification and for transferring data between these modules, and to the LMS, OAuth protocol is used together with the IMS LTI specification. OAuth protocol is used to secure its message interactions between the tools. To carry-out both connections and communications between tools, both message-based and service-based connections were used. The modular structure of the TEA system is shown in Fig. 2.

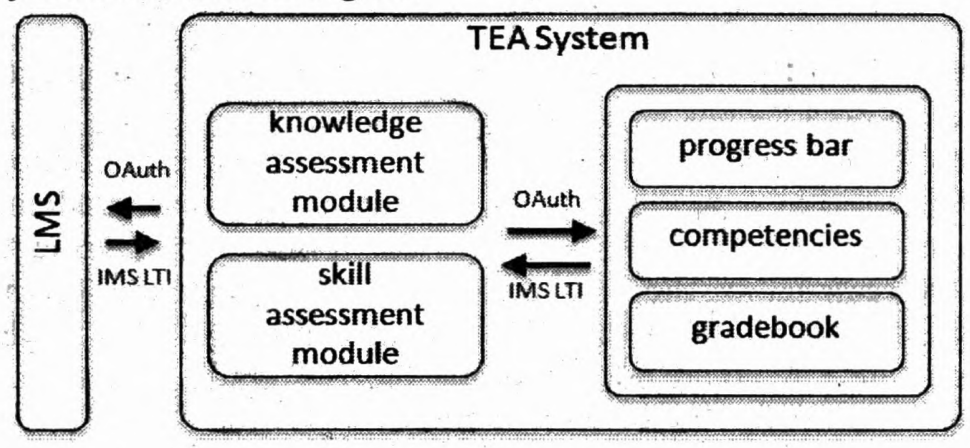

Fig. 2 Modular Structure of the TEA System

After completion of the development, the evaluation of the TEA system was carried-out under two stages such as testing and validation. For testing, a methodology comprised of unit, integration, system and usability testing was deployed in parallel with the system design and development process. Validation was defined with respect to a validation plan to verify the quality, performance of the system and the model and whether it satisfies expected educational requirements and user needs. In other words, the objective of validation is to show 'proof of demonstration' in the real life and show that the system and the overall process fulfil its intended purpose [34]. For validation, a mixed-mode evaluation technique comprised of both quantitative and qualitative techniques was used [35]. This was carried-out in a high-level cognitive course of a real online environment.

Evaluation of the TEA system yielded some interesting results: the system supported student learning process in terms of students performance, using the system and the formative e-assessment model to perform continuous formative assessment helped in the final examination marks, using formative e-assessment model helped students to improve their learning process through practice and immediate constructive feedback, teachers could track student learning process throughout the whole course, and as a result of the TEA system, students were more engaged in the classroom. Detailed description of the evaluation and the results are explained in [36].

IV. Application of the TEA System

After completion of the evaluation, the system and the model were adapted to a concrete course. In this section, we present this process and the analysis and results in terms of students' engagement and improvement in the final qualifications. As the real scenario, an introductory Logic course in the Computer Science Degree programme of a fully online university, Universitat Oberta de Catalunya (UOC; www.uoc.edu) was selected. The traditional Logic course is an overview of propositional and predicate logic and special attention is given to formalization and reasoning procedures. Thus, it is a high level cognitive course, where students must acquire higher order problem solving skills in addition to knowledge. In the Logic course, the AELL system mentioned in the previous section was used for learning purposes.

A. Adapting the general TEA system

Before the introduction of the TEA system, the Logic course had Continuous Assessment (CA), which students had to complete using the AELL system in order to facilitate automatic assessment to the teachers. These CA were the same for all the students, with approximately two weeks to be accomplished, after studying the relevant teaching units and therefore, they had the possibility to copy answers from each other. In addition to that, at the end of the course, students had to do a 2-hour face-to-face final examination (EX). Both continuous assessment and face-to-face final examination were used as a summative assessment. In this case, students were not provided with facilities for formative assessment. When calculating the final mark, the EX had twice the weight as the CA, provided the EX exceeds a minimum grade. In fact, the CA could only improve the EX grade, due to the high risk of copying between students.

In order to adapt the general TEA system, we have implemented both the formative e-assessment model and the modular structure. All the modules were connected to the UOC LMS using the IMS LTI following the general model of Fig. 2. As with a normal online classroom, students login to the LMS of the UOC, supporting administration, documentation, tracking, reporting and delivering of educational courses. After login into the system, they move to the Logic classroom where they are provided with necessary information, schedule and guidelines. From there, students are automatically logged into two modules which they can use for practice and evaluation purposes.

For knowledge assessment, MCQ questions are used and the data such as grades and statistics are stored within the module itself. Using the AELL system, students are provided with questions of skill type, where they have to build the answers in a step-by-step manner. The screen captures of the questions provided for both skill and knowledge assessment are shown in Fig. 3 and Fig. 4. Grades and statistics are stored within the module. For both modules feedback is provided. Finally, the grades are passed to the UOC LMS.

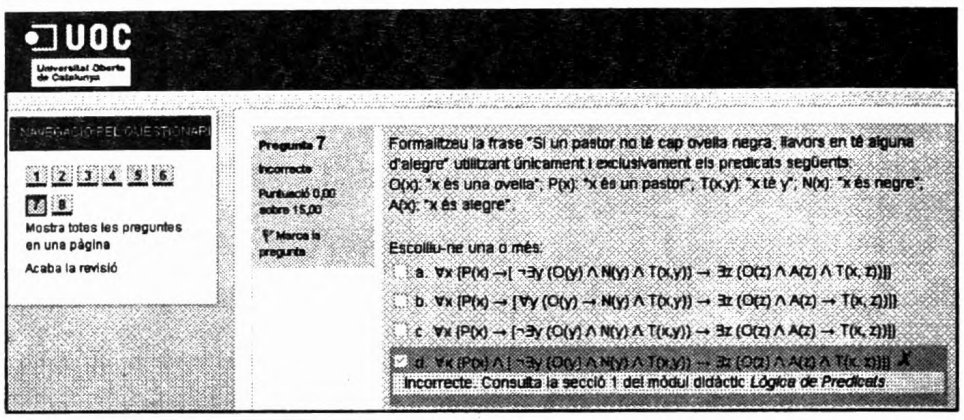

Fig. 1. MCQ question with feedback and marks

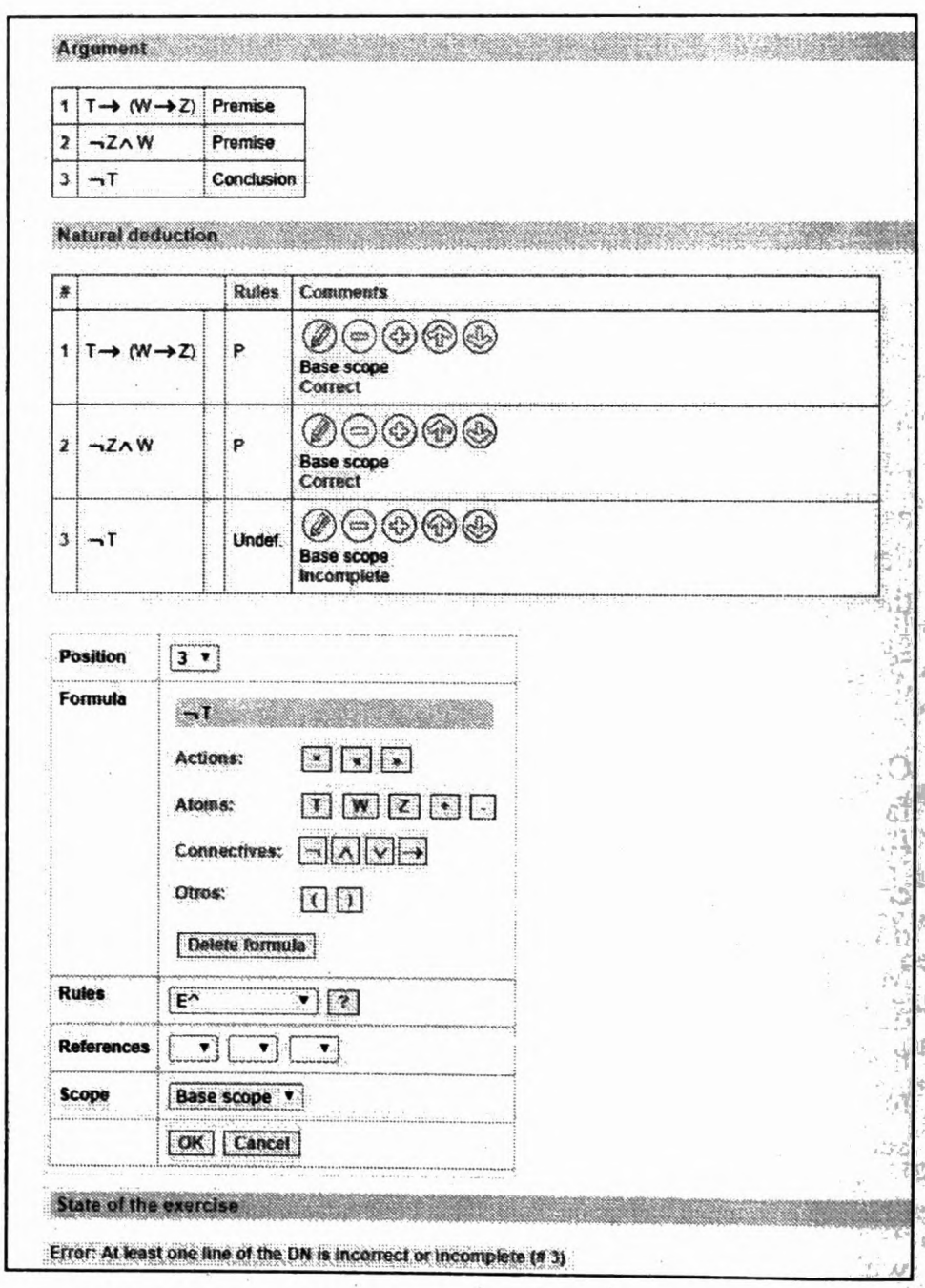

Fig. 4 Skill question with hints, feedback and error messages

After the introduction of the TEA system, the Logic course is able to offer formative assessment through Continuous Assessment (CA). Here, the CA consisted of both practice tests and assessment tests for both skill and knowledge assessment according to the formative e-assessment model in Fig. 1. Students have to pass the practice test (with a minimum mark) within an unlimited number of times to be able to attempt the assessment test. As practice tests were used only for practice purposes, the questions were the same for all the students and when calculating the final CA marks, only assessment test marks were counted. For the assessment test, students were given only 3 attempts. The questions provided within the assessment test, were selected randomly from a large database of different difficulty level, therefore the questions offered were different for each student. Sometimes, students got the same questions as in the practice test, but the probability was less, as the course consisted of a large question bank. In addition to this, a 2-hour face-to-face final examination was offered. The introduction of formative assessment through the TEA system has increased the difficulty of cheating and, therefore, the confidence in the CA grades. As a result, and to promote formative assessment, a change in the final course evaluation model has been possible. Based on another type of assessment model of the UOC, now, when calculating the final mark, based on students participation and performance on the continuous assessment, students had the possibility to obtain a higher weight for CA. Therefore, if students' performance is higher in the CA, they are given a double weight than for the EX. If students do not pass the CA minimum grade, they can go for the traditional evaluation method (EX) where they have to pass the final face-to-face examination. This was done to promote CA as well to offer equal benefits to students who spend time on completing CA online.

B. Analysis and Results

In this paper, we have analyzed, whether the students' marks have improved with the use of the TEA system in the actual Logic classroom. Also, students' perceptions after using the system were also considered.

First, we analyzed the students final marks in both Continuous Assessment (CA) and final face-to-face examination (EX) in the Logic course. Accordingly, overall 88% of students completing the continuous assessments and 76% of students attending the final examination have passed it. Then, we analyzed the students passing the course after taking the final face-to-face examination, before and after using the TEA system. To evaluate whether student engagement in the classroom has improved with the use of the TEA system, the percentage of students who were present for the final examination was analyzed. Then the effect of completing the CA and then doing the EX was also evaluated. The data for the above, before and after the use of TEA system is displayed in the Table1.

TABLE I
DATA BEFORE AND AFTER APPLYING THE TEA SYSTEM

	Before TEA system Sep. 2011 – Jan. 2012 No. of Students =130	**After TEA system** March - June 2014 No. of Students =185
Completion of CA	66.9%	80.25%
Present to the EX	57.7%	71.0%
Passing the course	39.06 %	55.4%

According to Table1, it shows that the percentage of students who passed the course had improved after using the TEA system. Also, the number of students who attended the final examination had improved. It can be taken as a reason due to the use of formative e-assessment through CA in the course, students were more interested and engaged in the course. When looking at the percentage of students who have passed the final examination after completing the CA, it also shows a considerable improvement. On the one hand, with the introduction of the new formula to pass the course taking the CA and EX results, students had a higher motivation to pass the CA. On the other hand, with the introduction of the TEA system that incorporated the formative e-assessment model, the cheating and copying were eliminated. Also, as a consequence of the formative assessment, student had to practice more in order to pass the tests given under the CA. This made students more active and engaged in the system and as a result, they were able to pass the final examination. Overall, the use of the TEA system together with the formative e-assessment model that comprised of both practice and assessment tests had improved students' results in the final examination.

To obtain students' perceptions about their learning experience, a questionnaire was introduced which was voluntary and given after the completion of the course. With respect to students' satisfaction, 100% of students agreed that instructions for answering questions were presented in a clear and concise manner. 98% of students were satisfied with the automatic grades offered through the system for both practice and assessment tests. Also, 100% of students were satisfied with the questions provided in both practice and assessment tests.

For formative e-assessment, 69% of students agreed that it was helpful to practice before attempting the assessment tests. When it comes to automatic personalized feedback, 98% of students mentioned that it was satisfactory. Also, 87% of students mentioned that the TEA system was capable of offering correct marks as the marks obtained through the system fit the knowledge and skills developed. When asked about both practice and assessment tests, 84% mentioned that they were helpful to learn skills related to the course and 96% mentioned that they were helpful to understand the topics covered in the materials. On average, students have used 2 attempts to obtain the minimum mark required to pass the course. Also, 87% of students stated that when they pass the tests on the second or third attempt, they were able to identify and understand the mistakes they made in previous attempts. It shows that, they were able to obtain the facilities provided through practice tests and personalized feedback. To evaluate the importance of assessment tests in the learning process, when asked whether they would have learned the same if they did not have assessment tests, 96% of students said no. This shows that they prefer and value the facilities offered through the assessment tests. Overall, students were satisfied with the TEA system and the formative e-assessment process.

V. DISCUSSIONS AND CONCLUSIONS

When it comes to introducing e-assessment in high-level cognitive courses, one of the challenges was that most of the tools offered MCQs. Another was to find an appropriate way to offer formative assessment through both practice and assessment facilities with personalized feedback. At the same time, it was needed to minimize the level of copying and

cheating by students in a fully online learning environment. This was achieved through a design and development of the TEA system and the formative e-assessment model.

After application of the TEA system and the formative e-assessment model in the actual Logic classroom of a fully online environment, it showed that students' participation in the continuous assessment has increased with the use of the formative e-assessment model. Students were more active in the classroom and in turn they have performed well in the final face-to-face examination. Also, the percentage of students who passed the course, after completion of the continuous assessment had increased. Overall when comparing students' results before and after the introduction of the TEA system which incorporated the formative e-assessment model, it shows that students' performance in terms of students' marks had improved. Based on the student's perceptions, they were satisfied with the system and formative e-assessment provided. According to their answers, it highlighted the importance of assessments as students mentioned that they would not have learned the same without having assessment tests. Also, as a result of the system, it was possible to change the examination model by giving more emphasis for continuous assessment. This is one of the interesting results, due to the formative e-assessment model and TEA system with minimized cheating facility.

As future work, it is especially needed to introduce more adaptive assessment facilities with more personalized feedback based on the skill and knowledge level of each student, in order to improve the application of the formative assessment model to a real case.

ACKNOWLEDGMENT

This work has been partially supported by the Spanish Ministry of Science and Innovation funded Project MAVSEL (ref. TIN2010-21715-C02-02), the project TIN2013-45303-P "ICT-FLAG" Enhancing ICT education through Formative assessment, Learning Analytics and Gamication, Department of Computer Science, Multimedia and Telecommunication Studies of the Universitat Oberta de Catalunya (UOC) and the Internet Interdisciplinary Institute (IN3) of the UOC.

REFERENCES

[1] JISC. *Effective Practice with e-Assessment: An overview of technologies, policies and practice in further and higher education.* Joint Information Systems Committee, 2007.

[2] J. Cook and V. Jenkins, *Getting Started with E-Assessment.* 2010

[3] E. de Bruyn, E. Mostert and A. Schoor, "Computer-based Testing-The Ideal Tool to Assess on the Different Levels of Bloom's Taxonomy". In *14th International Conference on Interactive Collaborative Learning (ICL2011)*, pp. 444-449, 2011

[4] G. Crisp, "Interactive E-Assessment - Practical Approaches to Constructing More Sophisticated Online Tasks". *Journal of Learning Design*, 3 (3), pp.1-10. 2010

[5] S. Gruttmann, D. Bohm, and H Kuchen. "E-assessment of mathematical proofs: chances and challenges for students and tutors." In *International Conference on Computer Science and Software Engineering*, vol. 5, pp. 612-615. IEEE, 2008.

[6] T. A. Majchrzak and C. A. Usener, "Evaluating the Synergies of Integrating E-Assessment and Software Testing". In *Proceedings of Information Systems Development Conference (ISD2011)*. Springer, 2011.

[7] N. A.Buzzetto-More and A. J. Alade, "Best Practices in E-Assessment". *Journal of Information Technology Education*, 5 (1), pp. 251-269. 2006

[8] G. Crisp, "Interactive e-Assessment: moving beyond multiple-choice questions." *Centre for Learning and Professional Development. Adelaide: University of Adelaide*, 3, pp.12-31, 2009

[9] R. Clariana and P. Wallace, "Paperbased versus Computerbased Assessment: Key Factors Associated with the Test Mode Effect". *British Journal of Educational Technology*, 33 (5), pp.593-602, 2002

[10] D. R. Sadler, "Formative Assessment and the Design of Instructional Systems", *Instructional Science*, 18 (2), pp.119-144, 1989

[11] D. Whitelock, "Editorial: E-Assessment: Developing New Dialogues for the Digital Age". *British Journal of Educational Technology*, 40 (2), pp.199-202, 2009

[12] G. Crisp, "Teacher's Handbook on e-Assessment". *Transforming Assessment -An ALTC Fellowship Activity*, 18, 2011

[13] D. Whitelock, "Computer Assisted Formative Assessment : Supporting Students to Become More Reflective Learners". In *8th International Conference on Computer Based Learning in Science, CBLIS*, pp. 492 - 503, 2007

[14] P. Black and D. Wiliam, "Developing the theory of formative assessment". *Educational Assessment, Evaluation and Accountability* , 21 (1), pp.5-31, 2009

[15] G. Crisp, "*The e-Assessment Handbook*". Continuum International Publishing Group, London, 2007.

[16] Heriot-Watt University (2014). SCHOLAR. [Online]. Available http://scholar.hw.ac.uk/

[17] Intelligent Assessment Technologies (2011). [Online]. Available http://www.intelligentassessment.com/index3.htm

[18] TOIA. (2007). [Online]. Available http://www.toia.ac.uk/

[19] Moodle. (2014). [Online]. Available http://moodle.org/

[20] IParadigms, LLC. (2014). [Online]. Available http://turnitin.com/

[21] Hot Potatoes. (2014).[Online]. Available http://hotpot.uvic.ca/

[22] Maplesoft. (2014). [Online]. Available http://www.maplesoft.com/

[23] M. AL-Smadi, C. Gütl and D. Helic, "Towards a Standardized e-Assessment System: Motivations, Challenges and First Findings". *International Journal of Emerging Technologies in Learning, (iJET)*, 4(2), pp.6 -12, 2009

[24] IMS GLC. (2014a). IMS Learning Tools Interoperability [Online]. Available http://www.imsglobal.org/lti/

[25] IMS GLC. (2014b). IMS Learner Information Package Specification. [Online]. Available http://www.imsglobal.org/profiles/

[26] CEN WS-LT LTSO (2014). LTSC PAPI. [Online]. Available http://www.cen-ltso.net/main.aspx?put=230

[27] MIT. (2003). Open Knowledge Initiative. [Online]. Available http://web.mit.edu/oki/learn/papers.html

[28] R. G. Almond, L. S. Steinberg and R. J. Mislevy, "Enhancing the Design and Delivery of Assessment Systems: A Four-Process Architecture". *Journal of Technology, Learning, and Assessment*, 1 (5), pp.4-64, 2002

[29] University of Southampton. (2006). FREMA [Online]. Available http://www.frema.ecs.soton.ac.uk/

[30] D. Whitelock, "Activating Assessment for Learning: Are We on the Way with WEB 2.0?" In M. J. W. Lee & C. McLoughlin (Eds.), *Web 2.0-Based-E-Learning: Applying Social Informatics for Tertiary Teaching*, pp.319-342, 2010, IGI Global.

[31] A. M. L. Fowler, "Providing effective feedback on whole-phrase input in computer-assisted language learning". In F. Khandia (Ed.), *Proceedings of the 12th International Computer Assisted Assessment Conference*, pp. 137-150, 2008.

[32] A. Huertas, "Ten Years of Computer-based Tutors for Teaching Mathematical Logic 2000 2010: Lessons Learned", In P. Blackburn et al. (Ed.), *Third International Congress on Tools for Teaching Mathematical Logic (TICTTL 2011)*, LNAI 6680, pp. 131-140, 2011, Springer, Heidelberg.

[33] OAuth. (2013). [Online] Available http://oauth.net/

[34] B. Oates, "*Researching Information Systems and Computing*". SAGE publications Ltd. 2006

[35] J. Frechtling and L. Sharp, "*User-Friendly Handbook for Mixed Method Evaluations*". Directorate for Education and Human Resources Division of Research, Evaluation and Communication NSF, pp. 97-153, 1997

[36] E. Hettiarachchi (2013), Technology-Enhanced Assessment for Skill and Knowledge Acquisition in Onlir.e Education (PhD thesis). [Online], Available http://hdl.handle.net/10803/130931