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Technology enhanced e-assessments in Calculus courses with application of CAS

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1. About the changing face of engineering education

As long as education can change, the world can change.

The technological development in the twenty-first century naturally and inevitably leads to the introduction of new tools into the university education. The experience in e-learning at the Technical University of Sofia (TUS) can be traced back to 1998. Numerous technology enhanced lectures, tutorials, laboratory classes and related textbooks have been created by lecturers in engineering, informatics and mathematics courses. Students and PhD students have been also involved through the development of theses on applications of Virtual Learning Environments (VLE) such as Moodle and ILIAS for design and implementation of effective didactic models. The outcomes of their research contribute to the changing face of engineering education.

Mathematics education has undergone a transformation based on applications of Computer Algebra Systems (CAS) [2], [3] and VLE. Though their simultaneous application is a challenge, it is a good opportunity for digitalizing mathematics education. Actually, there is "no way back", i.e. no education, progress and development without technology. Digital mathematics exists and digital resistance is not appropriate.

The focus of a dynamic unity of VLE and CAS in mathematics courses at TUS was on students' motivated, active, conscious and emotional participation in the teaching-learning-assessment (TLA) process. Assessment was an integral part of the TLA process and the three components were equally considered and mutually interrelated. But something was missing in the digital environment ... It was e-assessments (diagnostic, continuous, formative, summative) provided with tools for authentication & authorship analysis in online and blended environments assuming the student would take the assessment at a distance. And, finally, a brave but necessary project TeSLA has arrived [5].

2. Re-design of Calculus courses within the framework of TeSLA project

Ne varietatem timeamus. /Do not be afraid of diversity./

Since January 2016 TUS is a partner university in the TeSLA project which conception /philosophy/ is built on a "general trust" that knows no time limits or national boundaries and could fit to any system of higher education. The project aims to support and assure e-assessment processes in order to improve the trust level across students, teachers and institutions. According to TeSLA LOGO this system provides continuous and modular trust-based authentication & authorship analysis for e-assessments.

Concerning the educational aspects of TeSLA system it has to be mentioned that its implementation could give a significant added value as well: highly qualified and experienced teachers can design and develop a great diversity of e-assessment activities with purposeful

and balanced application of the potential of the VLE and course related software [1], [4]. And these cannot be achieved in a face-to-face educational mode. Of course, teachers have to be aware of possible abuse of technology: they have to make what is important technology supported, rather than what is technology-supported important.

The undergraduate course Calculus 1 (Calculus of One Variable) was one of the piloted courses in TeSLA project. It is taught to students first year of study. The latter could be a reason they to prefer performing the activities in university computer labs, not at home, i.e. not at a distance. Within the framework of TeSLA project six tools for authentication & authorship analysis have been developed and tested in seven partner universities. Understandably, *Face Recognition* (*FR*) and *Keystroke Dynamics* (*KD*) were recommended to be tested as suitable for mathematics courses. Another two named *Voice Recognition* and *Plagiarism* are also useful for assessing students' capability to defense their individual and collaborative courseworks or to explain multi-step solutions. In the presentation a real (follow up) assessment activity monitored by TeSLa system will be demonstrated.

The students performed three activities: enrolment and two follow-up assessment activities. It was both challenging and exciting to re-design the TLA process, modify existing in-class tests and re-formulate questions. On one hand, in order to enhance the quality of assessment activities, we took advantage of the wide range of types of questions available in VLE Moodle and used the potential of a CAS-environment to create questions as well as to facilitate students in selection of approaches to find, interpret and check up answers/solutions. On the other hand, appropriate support materials were provided online and students could use also external resources.

Almost all the types of questions available in VLE Moodle were included in the assessment activities: True/False, Numerical, Multiple choice, Matching, Drag and drop into text, Drag and drop onto image, Select missing words, Essay /open answer questions/. A didactic system of questions/problems has been created. This diversity of questions and flexibility in answering them considerably contributed to enrichment and enhancement of assessment activities. They could serve as innovative assessment practices in mathematics education. During the assessment process students are allowed/required to use CAS and submit the produced CAS-protocol with solutions, explanations, interpretations and reflection on the results. In the presentation illustrative examples will be shown.

3. The synergies between VLE, CAS and TeSLA tools for enhancing university mathematics

Some things can't be explained, only experienced.

All the three components of the triad teaching-learning-assessment are to be considered in tandem and not focus on any one of them. Through a balanced integration of VLE and CAS in the design and development of assessment activities and related learning and support materials we aimed at helping students built up habits for Lower Order Learning and Higher Order Learning in accordance with the improved Bloom's taxonomy.

The follow up activities were performed by students for the purpose of formative e-assessment. They were used for both summative purposes in that 20% of the overall mark was allocated to these activities and formatively in that detailed feedback was provided. The latter appeared to be a motivation for students to better prepare themselves and avoid attempts for "helping" classmates or using illegal ways far achieving higher results. Universities have a mission to create a good sense of fairness and honesty for students as an important element of culture and to ensure action. And here TeSLA tools come to the rescue.

An e-assessment tool provides data to teachers about students. Having information per student, and also per "classroom", teachers could propose changes in courses and curriculum in order to help students acquire sustainable knowledge and develop required competencies. Independent individual/collaborative learning with self-assessment can also be monitored by TeSLA tools. On time provided feedback both online and offline, based on the individual learning trajectory, allows students make a desired progress in their own pace anytime and anywhere.

4. Conclusion

***Challenge is energy of life*.**

Technology can "replace" hundreds of teachers but a powerful methodology and highly qualified teachers can give thousands of technologies vitality. Training of teachers should be the key concern of universities: in creation of e-assessment activities interrelated with the teaching and learning activities and according to the principle "What gets assessed is what gets taught". Like any other technological tool TeSLA system need a professional attitude to be taken to. Converting tools into effectively integrable instruments is a real question in education. In this sense there is still much to be done in order to assure trust-based e-assessments.

Educational technology (ET) is to be considered as

ET=Technology OF Education+Technology IN Education.

A proper utilization of technology in education requires a policy of support for research in the field of educational science, high quality software and teacher training. Together we need to go further to 4C = Challenging Changes in Curricula and Courses.

Keywords: mathematics education, e-assessment, CAS, VLE, TeSLA system

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