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

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

1. About the changing face of mathematics education

Mathematics education undergoes a transformation based on applications of Computer Algebra Systems (CAS) and Virtual Learning Environments (VLE). Their joint use appears very challenging to exploit and is a good opportunity for digitalizing mathematics education. 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 the Technical University of Sofia (TUS) was up to now on students' motivated, active, conscious and emotional participation in the teaching-learning-assessment (TLA) process [1], [2], [3]. 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-assessment (diagnostic, continuous, formative, summative) provided with instruments for authentication & authorship analysis in online and blended environments assuming the student would take the assessment at a distance. And, finally, TeSLA has arrived.

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

Since January 2016 TUS is a partner university in the TeSLA project [4] 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". It has to be mentioned that there is also a significant added value: 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. And these cannot be achieved in a face-to-face educational mode.

The undergraduate course Calculus of One Variable was one of the piloted courses. Within the framework of TeSLA project six instruments for authentication & authorship analysis have been developed and tested in seven partner universities. The TeSLA instruments Face Recognition (FR) Keystroke Dynamics (KD) were understandably recommended to be tested as suitable for mathematics courses. Another two instruments named Voice Recognition and Plagiarism can be also useful for assessing students' capability to defense their individual and collaborative courseworks or to explain multi-step solutions.

The students performed three activities: enrolment and two follow-up assessment activities. It was really 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. 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/. This diversity of questions and flexibility in answering them 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.

The follow up activities were performed by students for the purpose of formative e-assessment. They were used formatively in that detailed feedback was provided, based on the individual learning trajectory as well as for summative purposes in that 20% of the overall mark was allocated to these activities.

We tried to professionally develop the assessment activities and support materials to help students built up habits for Lower Order Learning and Higher Order Learning in accordance with the improved Bloom's taxonomy.

Most students shared the opinion that they prefer blended learning with distance mode of assessment and being provided with online support materials. TeSLA instruments are adapted for students with special educational needs: now they can be assessed in online environments.

3. Conclusion

Technology can "replace" hundreds of teachers but a powerful methodology and highly qualified teachers can give thousands of technologies vitality. In this sense there is still much to be done in order to assure trust-based e-assessments.

Keywords: mathematics education, digitalization, e-assessment, CAS, VLE

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