FUTURE MATHEMATICS PROJECT: ENHANCING LEARNING AND TEACHING OF ENGINEERING MATHEMATICS WITH TECHNOLOGY

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Abstract
This paper introduces the ongoing (2015-2018) EU funded project Future Mathematics (FutureMath). The project aims to enhance learning and teaching of engineering mathematics by exploiting educational technology. The objectives of the project are to explore and develop methods to learn and teach engineering mathematics effectively and innovatively by utilizing educational technology and using digital contents. As an outcome of the project, we will provide a collection of best practices, useful resources and pedagogical practices for web-based learning and teaching of mathematics.

Keywords: mathematics learning, mathematics teaching, technology, research projects.

1 INTRODUCTION
Mathematical skills are a prerequisite in technical studies. In fact, developing proficiency in mathematics is fundamental aspect of different engineering disciplines. However, mathematics is a subject that many students have difficulties. They may even experience that mathematics is not that relevance or importance to their professional studies.

Various studies [1], [2] have also shown that the lack of mathematical proficiency already causes problems in engineering mathematics’ and other courses in globally (high drop-out rates, lower graduation rates, lack of basic knowledge etc.). However, mathematics is one of the cornerstones in building engineering knowledge and understanding that is required in engineering disciplines. Thus, the basic level of mathematical proficiency of engineering students needs urgently to be increased on a large scale.

This paper presents overall the FutureMath project. Furthermore, we will introduce experiences related to usage of educational technology in mathematics learning and teaching. In addition, we will highlight some preliminary project results. Thus, we will

a) shortly introduce the overall project plan,
b) highlight the results of questionnaire for students related to technology enhanced mathematics learning and teaching,
c) introduce the topics of mathematics online pedagogy, and
d) summarize the experiences and best selected practices for mathematics learning and teaching that have been investigated during the project so far.

2 FUTURE MATHEMATICS PROJECT
FutureMath project is a three years project that began in September 2015. It is funded by the EU Erasmus+ Programme. The project consortium consists of four university partners. The partners are Tampere University of Applied Sciences (Finland), Slovak University of Technology in Bratislava (Slovakia), Technical University of Civil Engineering Bucharest (Romania) and Technical University of Madrid (Spain). All the partners have a special responsibility area in the project.

According to the project plan, different development themes vary during the project lifetime. Correspondingly, the project started with the needs analysis phase. In that phase, we explored the students’ expectations and current situation of technology usage in partner institutions. Simultaneously, research on mathematics online pedagogy started and the preliminary version of mathematics’ learning platform (MLP) was planned and built. Mathematics online pedagogy introduces best practices for utilization of technology enhanced contexts in mathematics education. MLP is a...
comprehensive framework for mathematics education with the respect of the 21st century skills and it hosts various teaching and learning activities that will be produced in the project.

After the needs analysis, project's planning phase started followed by production phase. At this stage of the project, the production phase is in progress. In autumn 2017 project's testing phase will begin and the materials and outcomes produced in the project will be tested.

3 PROJECT OUTCOMES AND EXPERIENCES

Even the project working is going on, we have gained useful experiences and results during the project lifetime this far. In this chapter, we will present the key outcomes and experiences.

3.1 Online survey

In order to ensure the best starting point for the designing and implementing work for the project main outputs, an online survey was conducted in autumn 2015 and again in spring 2016. The main idea was to explore students’ expectations about modern mathematics teaching methods. Data was collected through the online questionnaire submitted to students in all partner institutions. Additionally, the questionnaire was open to other people through the project’s blog. A total of 97 students responded to the survey in which 69 % were male and 31 % female. Students were in the age bracket of 18 - 30 years with an average age of 21 years.

We can perceive from the Fig. 1 that nowadays students own several devices. Thus, they have a possibility to use these common devices also in educational purposes.

![Distribution of devices own by students](image)

Figure 1. Devices that students own.

In the questionnaire, we wanted to explore, which teaching methods they perceive as modern in mathematics context. From the Fig. 2, we can see the most modern teaching and learning methods as well as methods that are currently in use. According to responses, students seem that the most modern ways to teach and learn mathematics are 1) utilizing devices in learning purposes and, 2) using short videos/screencasts for learning and 3) teaching with computer presentations.

Notable is that teaching with the transparencies and making notes were seen as the least modern ways to teach and learn mathematics. In the question about the teaching methods that are currently used in the mathematics’ courses, the responses were upside-down to that what students think are modern teaching methods (Fig. 2).
Questionnaire contained also a question where students were asked to select five methods, which are the most important in terms of learning. The most important ways of learning was very teacher centered as the top one was “Making exercises during classroom sessions”, followed by “Personal guidance of lecturer during classroom sessions” and “Teaching with whiteboard”.

Based on the survey results, 85 % of respondents agreed that “Using the modern technology in mathematics’ learning purposes, increases my motivation towards course concerned”. In addition, the most of the students (over 70 %) preferred to have more alternative teaching and learning methods as well as more online content in university mathematics courses.

### 3.2 Mathematics online pedagogy

Based on research work carried out at the beginning of the project, we selected trends such as flipped classroom, learning analytics, short videos/screencast, gamification and online assessment to be more investigated during the project. So-called mathematics’ online pedagogy discusses about these trends. At this stage, we have already some experiences about utilization of such methods in university teaching. In this paper, we will shortly introduce these trends.

Mathematics online pedagogy encapsulates pedagogical resources for engineering mathematics' online learning, teaching and assessment by providing effective teaching and learning methods for ICT-supported mathematics learning. In this project, flipped classroom, learning analytics, short videos/screencast, gamification and online assessment will be shortly introduced under the online pedagogy theme.

#### 3.2.1 Flipped classroom

The main idea of flipped classroom is that students study theory before the in-class sessions at home. During the lessons, the core issues of the topic can be discussed, but the in-class sessions concentrate more on collaborative practicing of exercises, for example. However, flipped classroom is a quite flexible method and lecturers apply it differently.

During the FutureMath project, flipped classroom method has been tested for first year engineering mathematics courses. Practically, students have studied theory from videos, books, pdfs etc. Thus, during the classes, students have had much more time than usually for calculating exercises. The experiences have been very positive.
3.2.2 Learning analytics

According to International Conference on Learning Analytics and Knowledge, learning analytics is “the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs [3].” Thus, it concentrates on improving learning outcomes on a large scale.

FutureMath project uses a Moodle as learning management system (LMS). Moodle records students’ log events that can be analyzed. With this data, it is possible to investigate for example students’ overall learning activity or amount of views per resource. Different possibilities for utilizing learning analytics through Moodle are being reviewed.

3.2.3 Short educational videos

Different kinds of educational videos have been used for years. In mathematics context, term short video can refer to a short educational video that is pedagogically planned and produced with high quality. Short videos can be produced with screencast technique utilizing tablet or PC, for example. Typically, mathematics screencast videos last less than 10 minutes and each videos have special educational purpose. Usually mathematics’ short videos contain e.g. examples, theory or combination of them or hints and solutions for the exercises.

During FutureMath project, applications such as ShowMe and Explain Everything have been utilized for recording short educational videos with tablet computers.

3.2.4 Online assessment

Online assessment can have various forms depending e.g. on LMS that is used by institution. One option to carry out mathematical online assessment is Moodle LMS. Moodle enables different kind of quizzes that can contain i.e. mathematical questions (STACK) including algebraic responses. In Moodle, mathematics online assessment can be carried out with the other question types as well. In FutureMath project, different kinds of STACK questions have been planned and produced. The experiences have been positive.

Currently, the research on gamification is going on.

3.3 Mathematics learning platform and learning resources

The project’s learning platform (mathematics learning platform, MLP) bases on Moodle LMS (see Fig. 3). During the project, different kind of resources for technology enhanced mathematics teaching and learning will be placed on MLP. After the project lifetime, MLP will contain versatile set of resources for improving mathematics’ students learning outcomes especially in engineering studies. The intention is to make learning resources that are motivational and interesting. The focus is on accessibility. Furthermore, through the MLP, the aim is to provide more possibilities for personalized learning of mathematics.

During FutureMath project, versatile set of learning resources have already been planned. At this stage, the production of learning resources is going on. In autumn 2017, pilot courses will be organized to test the learning resources. All the learning resources and materials developed in the project will be freely available under the idea of Open Educational Resource (OER).
ACKNOWLEDGEMENTS

The authors thank the EU for supporting this project funded under the ERASMUS+ Program, with reference 2015-1-FI01-KA203-009044.

REFERENCES

