Comparative analysis of Engineering math education in EU and Russia

Seppo Pohjolainen
Tuomas Myllykoski
Tampere University of Technology, Finland

MetaMath

MetaMath WP1

- **Case Studies Methodology**

- **Learning European experience**

- **National math curricula workshops**

- **Case Studies, evaluation and recommendations for WP2**

TAMPERE UNIVERSITY OF TECHNOLOGY

Pedagogical reform
SEFI: European Society for Engineering Education

The main message is that although contents are still important, they should be embedded in a broader view of mathematical competencies that the mathematical education of engineers strives to achieve.

"Each tooth of one gear should meet each tooth of the other one for equally distributed abrasion. How does this affect the choice of tooth numbers?"

SEFI: A Framework for Mathematics Curricula in Engineering Education 2013

Engineering Mathematical Competence (SEFI)

"the ability to understand, judge, do, and use mathematics in a variety of intra- and extra-mathematical contexts and situations in which mathematics plays or could play a role"

"A Framework fo Mathematics Curricula in Engineering Education", SEFI 2013.

SEFI: Mathematical Competencies for Engineers

- Thinking mathematically
- Reasoning mathematically
- Posing and solving mathematical problems
- Modelling mathematically
- Representing mathematical entities
- Handling mathematical symbols and formalism
- Communicating in with and about mathematics
- Making use of aids and tools

SEFI: Mathematical Competencies for Engineers

- Content contains five main areas:

    – algebra,

    – analysis and calculus,

    – discrete mathematics,

    – geometry and trigonometry,

    – statistics and probability.

SEFI: Mathematical Competencies for Engineers

- Four levels on areas

  Core 0: High school mathematics

  Core 1: Engineering mathematics essential for most engineering study programs (BSc level)

  Core 2: Electives (Advanced engineering mathematics for some Engineering disciplines)

  Core 3: Specialist Modules (MSc level).

Course comparison

- Courses were compared between the Russian universities and TUT and UCBL.

- The following topics were covered:
  - Engineering Mathematics, Mathematical analysis
  - Discrete Mathematics, Algorithm mathematics
  - Algebra and Geometry
  - Probability Theory and Statistics
  - Optimization
  - Mathematical Modelling.

Course comparison (EU-Russia)

- Selected set of course attributes were collected from each university & compared course.

- **University:** university type, number of students, % engineering students, number of engineering disciplines, degree in credits, % of math in degree.

- **Selected course details:** BSc or MSc level, Preferred year, selective/mandatory, prerequisite courses, outcome courses, department responsible, teacher position, content, learning outcomes, SEFI level, credits,duration, student hours (and their division), avg number of students.

Course comparison

- **Teaching:** Teacher qualifications, delivery method, pedagogy, assessment, SEFI depth aim, modern lecture technology, assignment types, use of third party material, supportive teaching.

- **Use of ICT/TEL:** Tools used, mandatory/extra credit, optional, e-learning/blended/traditional, Math-Bridge, calculators, mobile technology.

- **Resources:** Teaching hours, assistants, computer labs, avg amount of students in lectures/tutorials, use of math software, amount of tutorial groups, access to online material.

Course comparison

- **Quality assurance:** The methods the university/department/teacher uses to ensure the quality of teaching is at the desired level.

- After collecting this information from TUT, UBCL &LETI, KRNTU, UNN,OMSU, TSU and making comparative analysis we may find similarities and differences and and make recommendations.

WP1 Workshops

- The first workshop was organized on 26th & 27th of June 2014 in Tampere, at TUT.

- The second workshop was organized on 11th & 12th of September 2014 in Saarbrucken at DFKI, USAAR.

- The third workshop was organized on 13th & 14th of October 2014 in Lyon at UCBL.

- National workshops related with WP1 were organized in Russia.

Comparative analysis

- Mathematics is understood to be an important subject in Russia and is highly valued.

- BSc 4 year in RU, 3 year in EU (TUT).

- Contents of engineering mathematics courses is very much the same.

- Russian courses cover more topics, may be deeper as well. Amount of exercise hours seems be larger than EU.

- Overall number of credits is comparable, but the credits are different (1 cr = 36 hours (RU) , 1 ECTS=26-27 hours (EU)).

Comparative analysis

- EU engineering mathematics is more applied. Russian students spend more time in learning theorems and proofs, where as European students study mathematics as an engineering tool.

- Changing syllabus (contents and the way of presentation, "theorem-to proof" style could be slightly modified by putting more emphasis on applications).

- Adding topics, applications, examples related to engineering disciplines to improve engineering student's motivation to study mathematics.

Comparative analysis

• Mathematical tool programs (Matlab, Scilab, R-, etc) are common in EU in teaching and and demonstrating how mathematics is put into practice.

• Math tool programs are known in Russia, but their use could be enhanced to solve small scale modelling problems.

• The use of e-learning (Moodle for delivery and communication, Mathbridge for intelligent platform for e-learning), could be increased in the future to to support student's independent work.

Comparative analysis

- In EU, the practices for bridging/remedial courses have been actively developing in the last several decades.

- With the shift to Unified State Exam ("ЕГЭ" - in Russian) and the abolishment of preparatory courses for soon to be school graduates ("Абитуриент" in Russian).

- Russian universities lack the mechanisms to prepare upcoming students to the requirements of university-level math courses.

- Mathbridge system is a valuable tool here.

Comparative analysis

- Most of the EU universities have some kind of pretest for all enrolling students. This makes it possible to detect the weakest students and provide support from the beginning of their studies.

- Selection/recommendation of students for Bridging courses.

Comparative analysis

- Quality assurance is an important part of studies and development of education in the EU.

- Student feedback from courses should be collected and analyzed as well as acceptance rates, distribution of course grades, use of resources in Russian universities.

Comparative analysis

- Results of comparative analysis will be published by Springer as (e)book:

  "Modern Mathematics Education for Engineering Curricula in Europe : A Comparative analysis of the EU engineering mathematics vs. Russia, Georgia and Armenia".

- The book will make the results of the project available for educators, teachers and administrative staff for developing engineering mathematics at their university.

- These were the main points from WP1
- Thanks for all the partners for their excellent work and collaboration
- Thank you for your attention !

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