INTERNATIONAL COOPERATION TO TRANSFORM THE STUDY COURSE "MATHEMATICS FOR ECONOMISTS" FOR BUILDING OF THE COMPETENCES NECESSARY FOR SUSTAINABLE DEVELOPMENT
Integration of SD into an educational system at all levels is an important challenge that have been encountered in recent years.

Universities has a particular responsibility and role to play by increasing students’ capacities to achieve sustainable future.

Sustainable development (SD) is an integrated and balanced development of the welfare, environment and economy of the society, which ensures the satisfaction of today's needs without endangering the needs of future generations.

"Our Common Future", 1987
Mathematics role in sustainable development of society

- Mathematics role in sustainable development is characterized by a number of factors.
- Sustainable development is based on three spheres which include a **functioning economy**, **harmonious society** and a **healthy environment** - is desirable external preconditions for an **individual's development**.

### SOCIAL
- Math provides an understanding of the world and its regularities
- **Math as approach to life**

### ENVIRONMENTAL
- Math is a tool to describe and solve the problems facing us
- It provides us with the tools to make informed decisions
- **Math as a technic or component**

### ECONOMIC
- Math provides mathematical models for the help in the planning of resource recovery processes
- Models for controlling or reducing the possible consequences
- **Math as models**

_Gustafsson, Mouwitz, 2004; ACME, 2011; UNESCO, 2012_
New challenges in mathematics education

- **Knowledge, Skills, Competences are not separated**

The Paris Conference of European Ministers Responsible for Higher Education
24-25 May 2018

- **The rise of the top 10 skills by 2022 and beyond**
- **Top 10 skill for employment**

World Economic Forum, 2016, 2018

- **Transformation of the math education into ESD**

Education for sustainable development (ESD)
Math competence compliance with competencies for sustainable development

Problem solving, critical thinking, action competence, systems thinking

**COMPETENCES FOR SD**

- **What the problems are**
  - the capacity to analyse the problems at different scales, with a systems approach

- **How to solve them** –
  - methods to develop technologies that could contribute to solutions

(Mulder, Segalas-Coral, Ferrer-Balas, 2010)

**MATH COMPETENCE**

- The ability to solve everyday problems using:
  - models of thinking (logical or spatial);
  - representation (formulas, design, graphs, charts, etc.).

- The ability to identify the structure and commitment, repetition or regularity

*Key Competences for Lifelong Learning – A European Framework, 2006*
Competence-based approach is the main task of higher education to prepare young professionals for a successful career and to ensure the country's socio-economic growth.

Higher education through the competence-based education interact with the labour market as well as respond to the requirements of sustainable development of society.

Mathematics studies at the university must be more focused on acquiring sustainable development competences in real life context taking into account the characteristic aspects of an engineer's professional activities.
**Analytical skills**: problem-solving and critical thinking

**System thinking**: ability to see the relationship between different dimensions, complexity of systems and/or situations

“**Soft skills”**: Communication, partnership, learning to work together, participation in decision-making

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Textbooks for Sustainable Development: A Guide to Embedding, UNESCO, 2017

"The Framework for Mathematics Study Programs in Engineering", SEFI 2013
Transversal competencies

System thinking

- "Mathematics is a science of structures" (Schreiber, Siege, 2016)
- These structures are securely fixed in the factual world, where they are used for modelling.

Problem solving

- **Problem solving steps in mathematics**: (Zeidmane, Rubina, 2018).
  - identification of the problem
  - interpretation of the problem (to translate it into math language and select appropriate tools or formulas)
  - problem analysis (apply general problem to a specific situation)
  - modelling the problem solving using the deduction method
  - solving the problem and checking the answer

Critical thinking

- Ability to challenge norms, practices and opinions.
- It includes also reflection on one's own values, perceptions and actions, as well as it is understanding of external perspectives.
- ... identification and interpretation of information, information analysis, evaluation of evidence and argument.
“Mathematics for economists”

The aim of the course:
1) to acquire the mathematical knowledge and practical skills necessary for the study of further special subjects
2) to acquire skills for applying mathematical methods in the study of various economic relationships
Factors influencing contribution to the development of competencies

The philosophy of teaching mathematics

Practical tasks to be solved characterize the development of these mathematical competencies.

Professions "Economist" and "Business Management" 5th level of professional qualification

Standard of Economist Profession and Standard of Business Manager Profession:

mathematical knowledge is required at the level of use for the performance of basic tasks of professional activity
It is necessary to develop a \textit{methodical framework} that includes \textit{mathematical competence} and \textit{skills necessary for professional activities} to be developed within a mathematical subject, including also \textit{personal qualities} that are formed in mathematics studies.
Learning for the Future: Competences in ESD, 2011: SD should be seen as a continuous process of learning and change, involving a variety of actors and focusing on professional development in education, curriculum development and monitoring and assessment.

Pidlisnyuk, 2010: Effective ESD depends upon a combination of the following factors: legitimacy through the curriculum, new ways of learning, competence of staff, institutional development, partnership and finances.

To establish methodological background to assess professionals and stakeholders' mathematics education needs.
**Study program directors, academic staff**

*What, why, how to teach*

**Employers, professional organizations**

*What kind of math is needed, competencies needed for specialists, real situations/tasks to be solved by students ...*

**Society**

*Math competences in the context of LLL, math in professional activities, opinion how to promote math competence in Latvia and Lithuania, etc.*

**Students**

*Math teaching at university, math for studying other subjects, ...*
The design of the Curriculum development

EXTERNAL

Document analysis

The questionnaire MATH IN PROFESSIONAL ACTIVITIES

Attitude to the math

Accordance of mathematical and professional competence

INTERNAL

CURRICULUM ANALYSIS

Questionnaire for directors of study programs, department chair and academic personnel (4 parts)

Interviews with the directors of study programs, chairs of departments and academic personnel

COMPARISON

- Content and volume
- Study process organization
- SWOT

The Analysis of the Research Results

Recommendations for improvement of Math programs
The framework for the transformation of the math education

The needs of employees and employers

Mathematics curriculum rationale

Mathematics studies results - integrative professional and mathematical competence

Eight mathematical competencies

Professional competencies

Content of mathematics course

Pedagogical methods to ensure competencies building
Use appropriate teaching strategies (OECD, 2015):
- The active learning
- The cognitive activation
- The teacher-directed instruction

Pedagogical approaches - constructivist approach:
- Contextual approach: *real-world situations and to perform professional activities*
- interdisciplinary approach
- discipline-based
- information technology methods
"Mathematics for economists" analysis have to be made by four dimensions: contextual learning, interdisciplinary learning, problem-solving, and critical thinking, which are most often cited in scientific literature as key elements of education for sustainable development.

**Standard of Economist Profession** and **Standard of Business Manager Profession**: mathematical knowledge is required at the level of use for the performance of basic tasks of professional activity.

**Contextual approach** is associated by the content-studied with the real-world situations; makes connections between the knowledge possessed by its application; the outcome of learning is meaningful for students.
Interdisciplinary approach to teaching blurs the lines between subject boundaries: usage of knowledge and methods of different disciplines and ability to work on complex problem in the interdisciplinary context.

“Mathematics for economists” includes three components of critical thinking: identification and interpretation of information, information analysis, evaluation of evidence and argument.
Problem-based learning: the development of students' abilities needed for sustainable development: flexible, integrative, multidisciplinary problem-solving, working on complex, real-world problems …

"Mathematics for economists" contributes to the problem solving in three ways: pure mathematics investigation activities, mathematical modelling and solving real life problems, step-by-step transforming based on planning and reasoning.
Critical thinking: information identification and interpretation, information analysis and evaluation of evidence and argument. It includes reflection on one's own values, perceptions and actions, understanding of external perspectives.

"Mathematics for economists" contributes to the problem solving in three ways: pure mathematics investigation activities, mathematical modelling and solving real life problems, step-by-step transforming based on planning and reasoning.
Cooperation forms and their impact on math education development

(Vintere, 2013)

INTERNATIONAL COOPERATION

WITH OTHER UNIVERSITIES

BY PROFILE
E.g. Agricultural

BY LEVEL:
Local, Regional, European

BY PARTICULAR SPECIALTY

WITH PROFESSIONAL INSTITUTIONS

COOPERATION FIELDS – IMPACT ON:

Math curriculum development
conception, content, volume, outcomes

Study process organization
usage ICT, methodical materials, measurement, teaching methods

Support system development
space for exchange experience; ability, motivation, teachers training

In science
math methods used in research; joint research on math didactic

Lifelong learning
math competence required; impact on personality development

ACADEMIC STAFF
Deans, program heads, teachers

HIGH SCHOOLS
High school teachers and pupils

LABOUR MARKET
Employees and employers

LOCAL COOPERATION
Conclusions (I)

- In cooperation with other universities were covered all the mathematics education aspects:
  - mathematics curriculum development at university,
  - study process organization,
  - study support system as well as
  - mathematics in the LLL context

- By evaluating the experience of the cooperation, the strengths and weaknesses of each partner university could be identified. This means that partners’ universities have the potential to learn each from another.

- It also outlines future opportunities for cooperation which should be continued in four directions:
  - at the department level,
  - among academic staff,
  - among students and
  - in research
Conclusions (II)

The **greatest value** of the international cooperation:

- An opportunity to gain new experience
- Obtain new skills and knowledge
- Establish personal contacts with colleagues from other countries
- Develop and enrich the teaching methods and practice
- To compare and discuss our achievements / methods with colleagues from other countries
- We have what to teach our partners from other countries and we can learn from them
- *To learn about other cultures*
- *To meet people from other countries*
- etc.
The study was carried out within the framework of the LLU program's "Strengthening the Scientific Capacity in the LLU" project Z32.
Thank you for your attention!

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