The 19th SEFI Mathematics Working Group Seminar on Mathematics in Engineering Education

26th – 29th, June 2018

Coimbra, Portugal

Book of Abstracts

Politécnico de Coimbra - Instituto Superior de Engenharia de Coimbra

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Local Organization Committee

Cristina Caridade, Deolinda M. L. Dias Rasteiro, Maria do Céu Faulhaber, Maria do Céu Marques.

CONTENTS

INTRODUCTION

Steering committee of the SEFI Mathematics Working Group proudly presents abstracts of the 19th SEFI MWG Seminar on Mathematics in Engineering Education organized by Coimbra Institute of Engineering in Coimbra, Portugal, on June 26 – 29, 2018.

The aims of SEFI MWG, stated in 1982 when the group was established, remain long 36 years up-to-date and relevant also for the present time:

- to provide a forum for the exchange of views and ideas among those interested in engineering mathematics
- to promote a fuller understanding of the role of mathematics in the engineering curriculum and its relevance to industrial needs
- to foster cooperation in the development of courses and support material
- to recognise and promote the role of mathematics in continuing education of engineers in collaboration with industry.

18 seminars on mathematics in engineering education were held by the SEFI MWG since 1984, to fulfil these aims and maintain international participation. The current 19th seminar taking place in beautiful city of Coimbra, is the next event in this long series of successful meetings of enthusiastic maths teachers. Seminar is aimed to provide a forum for the exchange of views and ideas amongst participants interested in engineering mathematics, in order to promote a fuller understanding of the role of mathematics in engineering curriculum, and its relevance to industrial needs and continuing education of engineers in the economic, social and cultural framework of Europe.

Various identified important topics by the SEFI MWG Steering committee and all other relevant issues in the mathematical education of engineers will be presented and discussed. The overarching theme of the seminar is the concept of mathematical competencies reflected in the following themes:

Putting the concept of mathematical competencies into practise

Rules for assessing mathematical competencies.

Programme of the seminar includes three plenary keynote lectures presented by excellent invited speakers, professors teaching mathematics at universities in different European countries. Professor Edwige Godlewski from the Pierre and Marie Curie – Sorbonne

University, Paris, France will speak about "Mathematics for engineers and engineering mathematics, evolution in the French education system". Professor Jaime Carvalho e Silva from the University of Coimbra, Portugal, will present talk on "Teaching and assessing mathematical competencies and understanding", and finally Professor Morten Brekke from the Faculty of Engineering and Science, Agder University in Norway will discuss topic "Teaching mathematics for engineers as the NORWEGIAN national framework says – is it possible?". Special guest is Professor Carlota Simões from the Department of Mathematics of the Faculty of Sciences and Technology of the University of Coimbra, with the talk entitled "Teaching tiles".

SEFI MWG seminars are traditionally focused on guided discussions among participants during special discussion sessions. Proposed topics include:

- Putting the concept of mathematical competencies into practise
- Rules for assessing Mathematical competencies.

Good response to the seminar call for papers, represented by 37 accepted high quality papers with direct relevance to the seminar themes, resulted in very promising programme including poster session with 11 presentations and 26 paper presentations related to important topics in mathematical education of engineering students. The paper presentations are divided into several topics, most of them in parallel sessions, such as putting the concept of mathematical competencies into practice, assessment of mathematical competencies, motivation and activation of students, technology and software for teaching mathematics, new trends in education.

All accepted contributions are included as full papers in the proceedings that are freely available at the SEFI MWG webpage, to provide a summary of the topics dealt with at the seminar and free access to presented papers to all interested party. The group´s main objectives are to sustain the accumulative process of gathering published materials and reports related to all identified important topics in mathematical education of engineers for building up a sound body of knowledge in this field.

Finally, the author would like to thank all members of the SEFI Mathematics Working Group Steering committee, the language editors, and the local organizers for doing the language check and editing of the proceedings for the benefit of all potential readers.

In Bratislava, June 2018

Daniela Velichová

SEFI MWG chair

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SEFI website: http://www.sefi.be

SEFI MWG website: http://sefi.htw-aalen.de

ISEC CAMPUS MAP

Legend:

1 ISEC Main Entrance

2 Multipurpose Room

3 Auditorium

4 DFM, Department of Physics and Mathematics

MR – Multipurpose Room; LG – Leonor Gouveia auditorium;
BR – Biomedical Room; A1 – DFM auditorium.

PROGRAM OVERVIEW

Tuesday 26/6/2018

Time	*Location*	*Event*
18.00 – 20.30	DFM, Department of Physics and Mathematics	Registration and mingle

Wednesday 27/6/2018

Time	*Location*	*Event*	*Speaker*
8:00 – 9:00	ISEC auditorium	Registration (tea/coffee)	
9:00 – 9:30	ISEC auditorium	Welcome Addresses: Local organizers Mário Velindro, ISEC President Daniela Velichová, Chair of SEFI Mathematics Working Group	
9.30 – 10.30	ISEC auditorium	Keynote Lecture 1 (chair Daniela Velichová)	
		Teaching mathematics for engineers as the NORWEGIAN national framework says – is it possible?	Morten Brekke
10:30 – 11:00	ISEC auditorium	Tea/Coffee	
		Paper Presentations: Putting the concept of Mathematical competencies into practice (chair Burkhard Alpers)	
11:00 – 11:20	ISEC auditorium	One Competency Approach in Mathematics for Engineers	Marie Demlová; Peter Habala
11:20 – 11:40	ISEC auditorium	Teaching Engineers how to communicate mathematically: some first steps	Michael Carr; Eabhnat Ní Fhloinn
11:40 – 12:00	ISEC auditorium	RULES_MATH: New Rules for assessing Mathematical Competencies	Araceli Queiruga-Dios
12:00 – 13:00		Group Discussions on Rules for assessing Mathematical competencies (chair Burkhard Alpers)	
	DFM/109	Group 1, Group leader: Daniela Richtáriková	
	DFM/LG	Group 2, Group leader: Kirsi-Maria Rinneheimo	
	DFM/A1	Group 3, Group leader: Araceli Queiruga-Dios	
13:00 – 14:20	MR	Lunch	
14.20 – 15.00	DFM/BR	Poster Presentations at the exhibition area	
		Design a strategy to decrease failure in mathematics in Engineering	M. Emília Bigotte de Almeida; Carla Fidalgo
		The use of ICT in the support of teaching and learning mathematics in engineering courses.	Arménio Correia
		Employment of Mathematical Skills in Economic Science	Martina Bobalová; Veronika Novotná
		Mathematics competencies in higher education: a case study	Cristina M.R. Caridade; Deolinda M. L. D. Rasteiro

14.20 – 15.00	DFM/BR	Poster presentations at the exhibition area	
		Implementing Computer-assisted Exams in a Course on Numerical Analysis for Engineering: Why, How, and How much does it cost?	Karsten Kruse, Christian Seifert
		Potatoes drying process – a vehicle to put into practice mathematical competencies in engineering students	Madaleno, R.O., da Silva, P.M., Castro L.M.M.N., Coelho Pinheiro, M.N.
		Using Quizzes on a Regular Basis to Motivate and Encourage Student Learning	Marjeta Škapin Rugelj; Jože Rugelj
		Mathematical Economics - Marginal analysis in the consumer behaviour theory	Jorge Marques, Rui Pascoal
		Conservative continuous flows	Marta Peña
		On Grounds for Competency Oriented Teaching and Assessment	Daniela Richtáriková
		A hybrid test for mathematics	Harry Aarts
	DFM/LG	Parallel Paper Presentations: Motivation of Students (chair Angela Schwenk)	
15:00 – 15:20		A learning center for first-year students combining professional competencies and soft skills at Mannheim University of Applied Sciences	Wiebke Werft, Susanne Kreim, Steffen Rasenat
15:20 – 15:40		New Methodologies for Teaching Math Courses in Engineering Degrees	Carla Pinto, Susana Nicola, Jorge Mendonça, Daniela Velichová, Ariane Heler
15:40 – 16:00		Effective teaching of mathematics in engineering courses	Arménio Correia
16:00 – 16:20		Widening Access to Engineering with Mathematics for STEM	C Breen, M Carr, T Brannick, P. Robinson
	DFM/ A1	Parallel Paper Presentations: Education, new trends (chair Ion Mierlus-Mazilu)	
15:00 – 15:20		Assessing Statistical Methods Competencies and Knowledge in Engineering	Deolinda M. L. D. Rasteiro, Cristina M.R. Caridade
15:20 – 15:40		Evolving of Mathematical Competencies by Blended Learning	Kathrin Thiele, Gabriela Bender
15:40 – 16:00		eduScrum - a methodological framework for a mathematical lecture in the first-year education of engineers at University of Applied Sciences. Presentation of the method and first investigations	Pia J. Raab; Anna Luther, Guido Pinkernell, Wiebke Werft
16:00 – 16:20		Future mathematics project: the experiences and practices for mathematics learning and teaching with technology	Kirsi-Maria Rinneheimo, Hanna Kinnari-Korpela, Daniela Velichová, César Benavente-Peces, Ion Mierlus-Mazilu
16.20 – 16.30	ISEC auditorium	End of the day - summary	
16:30 – 17:00	ISEC auditorium	Tea/Coffee	
17:00 – 19:30		Walking tour to the city center	
19:30 -		Dinner at own cost	

Thursday 28/6/2018

Time	*Location*	*Event*	*Speaker*
9.00 – 10.00	ISEC auditorium	Keynote Lecture 2 (chair Marie Demlová)	
		Mathematics for engineers and engineering mathematics, evolution in the French education system	Edwige Godlewski
	DFM/LG	Parallel Paper Presentations: Instigate students to be active learners (chair Morten Brekke)	
10:00 – 10:20		Recent Developments in Germany on Competence Orientation at School: Statistic on Final School Grades, Examples from Engineering Courses, Urgent Open Letter	Angela Schwenk, Norbert Kalus
10:20 – 10:40		INVOLVE ME AND I LEARN – video-lessons to teach math to Engineers	Cristina M.R. Caridade, Deolinda M. L. D. Rasteiro
10:40 – 11:00		Going up and down by the lift to learn Linear Algebra	Araceli Queiruga-Dios, María Jesús Santos Sánchez, Ascensión Hernández Encinas, Juan José Bullón Pérez, Jesús Martín Vaquero, Cristina Prieto Calvo
	DFM/A1	Parallel Paper Presentations: Math learners' influencers (chair Tommy Gustafsson)	
10:00 – 10:20		Mathematical Academic Malpractice in the modern age. A problem affecting Engineers.	C.D.C. Steele
10:20 – 10:40		Influence on learning outcomes by human factors	Stefanie Winkler, Ruth Leskovar, Andreas Körner
10:40 – 11:00		The contribution of ICT in the acquisition of mathematical, algorithmic and programing knowledge and skills y students of engineering	Arménio Correia, Nuno Lavado, Nuno Baeta
11:00 – 11:30	DFM	Tea/Coffee	
	DFM/LG	Parallel Paper Presentations: Math Education – reflections (chair Edwige Godlewski)	
11:30 – 11:50		Different views of Mathematicians and Engineers at Mathematics: The Case of Continuity	Burkhard Alpers
11:50 – 12:10		Reflections on student-focused initiatives in engineering mathematics education	Folashade Akinmolayan, Abel Nyamapfene, Henri Huijberts
12:10 – 12:30		The Effect of using a Project-based Learning (PBL) approach to improve engineering students' understanding of Statistics.	Fionnuala Farrell, Michael Carr
	DFM/A1	Parallel Paper Presentations: Software for teaching Maths (chair Norbert Kalus)	
11:30 – 12:00		MatLab Presentation	Helen Lomas
12:00 – 12:30		Maple Presentation	Linda Simonsen
12.30 – 12.40	ISEC auditorium	End of the day - summary	
13:00 – 14:00	MR	Lunch	
14:00		Bus to the Coimbra University	
14:30 – 15:15	Science Museum	Teaching Tiles	Carlota Simões (chair Deolinda Rasteiro)
15:15 – 19:30		Excursion	
20:00		Conference dinner at Quinta de São Pedro da Pousada	

Friday 29/6/2018

Time	*Location*	*Event*	*Speaker*
9.00 – 10.00	ISEC auditorium	Keynote Lecture 3 (chair Cristina Caridade)	
		Teaching and assessing mathematical competencies and understanding	Jaime Carvalho e Silva
10:00 – 10:15		Tea/Coffee	
10:15 – 11:15		Group Discussion on Putting the concept of mathematical competencies into practise (chair Burkhard Alpers)	
	DFM/109	Group 1, Group leader: Anna Luther	
	DFM/LG	Group 2, Group leader: Michael Carr	
	DFM/A1	Group 3, Group leader: Emily Cook	
	DFM/LG	Parallel Paper Presentations: Technology (chair Paul Robinson)	
11:30 – 11:50		Competence-based Learning in Engineering Mechanics in an Adaptive Online-Learning Environment	Markus Linke, Karin Landenfeld
11:50 – 12:10		CDF Files to learn mathematical concepts… Why not?	Rodrigues. R.C., Silva, P.M.
12:10 – 12:30		Dynamic Mathematics in Learning Management Systems	Wigand Rathmann, Alfred Wassermann
	DFM/A1	Parallel Paper Presentations: Mathematical Competencies (chair Jaime Carvalho e Silva)	
11:30 – 11:50		Mathematical Competencies through Credentials in a Practice-based Engineering Degree	Emily Cook
11:50 – 12:10		Sense and Nonsense of Teaching Math for Engineers	Reinhard Kahle
12:10 – 12:30		A New Tool for the Assessment of the Development of Students' Mathematical Competencies	Yannis Liakos, Svitlana Rogovchenko, Yuriy Rogovchenko
12.30 – 12.40	ISEC auditorium	End of the day - summary	
12.40 – 12.50	ISEC auditorium	20th SEFI MWG seminar in 2020 Presentation	
12:50 – 13:00	ISEC auditorium	Closing	
13:00 – 14:00	MR	Lunch	

MR – Multipurpose Room; LG – Leonor Gouveia auditorium;
BR – Biomedical Room; A1 – DFM auditorium.

ABSTRACTS

KEYNOTE LECTURES

Teaching mathematics for engineers as the NORWEGIAN national framework says – is it possible?

Morten Brekke

University of Agder, Norway

Teaching Mathematics to engineering students in Norway is a challenge. High failure rate, teaching large student-groups, short semesters, large curriculum and “pressure” from stakeholders and students are always mentioned in discussions about the way we teach. On engineering bachelor programs in Norway, mathematics is generally taught as 2 courses in the first two semesters. The length of the semesters varies from 12-14 weeks of actual teaching and often all disciplines are taught at the same time. How do/can a lecturer provide/teach the students what the National framework say about Mathematics for engineering.

The Norwegian National Framework says that teaching should contain:

- Varied forms of teaching and assessment.
- Computational Mathematics
- Connection between Mathematics and engineering.
- Mathematical modelling to solve engineering problems, and use relevant math-tool for their discipline. Problem based learning using computers.
- Evaluation and grading through exams, tests and project work.

How can all of this be done within the scheduled timetable? Many of engineering students are not motivated for mathematics, they are there because they need to be there. Lecturers face several challenges dealing with large student groups and limited time with students. I will try to give some insights to this by also using the SEFI’s report “A Framework for Mathematics Curricula in Engineering Education” as a reference for discussion. I do not have a solution to these questions, but I will try to give examples from my experience with changing the Bachelor program of electronics to give room for some the bullet points stated above. And give a few insights that might be helpful to others.

Mathematics for engineers and engineering mathematics, evolution in the French education system

Edwige Godlewski

UPMC-Sorbonne University, France

In France, the “lycée” (second level of secondary school) used to propose a scientific curriculum where mathematics played an important role. Students training as engineers had then a strong mathematical education during the “classes préparatoires” (first two years of bachelor’s studies after the baccalauréat). During the three remaining years before graduating as an engineer, the level of mathematical education depended strongly on the chosen engineering school. Altogether the French education system provided the industry with a large number of engineers with a very good mathematical background. This is no longer the case, at least not at the same level, for several well analysed reasons.

At the same time, many attempts to build closer links between research in mathematics and business or industry have been led by the mathematical community, and recent initiatives sprang around MSO (modelling, simulation, optimization). Even if engineering mathematicians are not so numerous, applying mathematics to complex real-world problems finds its place in the industry and creates new opportunities for motivated students.

I will try to give some elements of analysis concerning the French education system and examples of recent developments enhancing the interest for engineering mathematics.

Teaching and assessing mathematical competencies and understanding

Jaime Carvalho e Silva

University of Coimbra, Portugal

As pointed out by the ICMI Study "Educational Interfaces between Mathematics and Industry" we need to "emphasize and organize (...) formation and training on mathematical modelling" because "mathematical modelling plays a crucial role" to connect mathematics and its applications outside mathematics (New ICMI Study Series, vol. 16, p. 441).

As many authors from different areas concluded, "Mathematical competence is the ability to understand, judge, do and use mathematical concepts in relevant contexts and situations, which certainly is the predominant goal of the mathematical education for engineers." (A Framework for Mathematics Curricula in Engineering Education, A Report of the Mathematics Working Group, European Society for Engineering Education (SEFI), 2013). This same report points out that "Modelling mathematically (…) is definitely the one which is covered to a large extent in application subjects. There, modelling principles are developed and used to set up real models where finding an adequate modelling granularity is a major issue. Students also have to interpret the results of working within the mathematical models from an application perspective and have to validate the models, e.g. by making experiments and taking measurements".

It is clear that mathematical modelling is a key mathematical competency we need to introduce in the curriculum at all levels.

There are however challenges to implement mathematical modelling in the curricula in secondary schools or higher education. We will review some of these challenges and make some proposals to teach and assess it effectively, namely:

- developing mathematical modelling modules that contextualize educationally concrete contexts and can be used in the classroom;

- implementing mathematical competitions based on mathematical modelling activities (that, unlike other contests, can take several days to complete);

-develop small mathematical modelling projects to be presented in mini symposia (like the so called "Mock symposia") and credited for assessment.

Special Guest:Teaching Tiles

Carlota Simões

University of Coimbra, Portugal

At the Museu Nacional Machado de Castro in Coimbra, several tiles that in the past served to teach mathematics and astronomy are on display. We know today that they were created to support science education in Jesuit colleges of Coimbra. About two dozen mathematical tiles survived to this day, but they have been more than three hundred. They all reproduce figures of The Elements of Euclid, in the version of Andrea Tacquet, precisely the version that was used in Jesuit schools. There are also four tiles of astronomy, which have been part of a panel which would represent celestial constellations, comets and representations of the solar system.

In 2010, during archaeological excavations near the former College of Jesus, two pieces of tiles that clearly belong to the collection of these teaching tiles were found, so with great certainty, we may conclude that they were on display at a Jesuit college at Coimbra, certainly after 1654 (date of publication of The Elements of Euclid, Tacquet edition) and before the expulsion of the Jesuits from Portugal in 1759.

PAPER PRESENTATIONS

One Competency Approach in Mathematics for Engineers In freshmen courses

Marie Demlova and Peter Habala

Czech Technical University in Prague

While competency and project driven education has proved its benefits, applying it to particular courses may not be easy. The knowledge of physics and other natural sciences that a typical high-school graduate brings to university is rarely good enough to allow for applying knowledge of mathematics to realistic problems.

While practically oriented problem solving competencies may be a problem in freshmen courses, there is one key competency that can and should be addresses right from the start. One of the key problems for students encountering real mathematics for the first time is the unfamiliar language. This aspect is often overlooked, and the learning curve is relatively slow if this problem is not specifically targeted.

Thus we propose that freshmen courses should help students acquire one key competency that will be of great benefit to them throughout their studies: The familiarity with mathematical language. The implementation of this idea starts with a lecture, where the lecturer is no longer just a "storyteller" introducing ideas and theories, but also a "translator" who shows students how formal mathematical statements translate into ideas. Every mathematical statement shown in class can be an opportunity for a language lesson. How do we make sense of what it says? Can we express graphically? What would happen if we skip some parts, or change their order?

This approach to lecturing makes it easier for students to learn mathematical language, and in many courses we cannot really do more. However, it can be very beneficial if we can find room in our course to also practice speaking the language. Namely, we decided to include in our exams justifications (proofs) of easy statements/tasks, which also requires that we dedicate some time to it in practical classes.

Not every course is suitable for this, and our experience suggests that one of the best courses for such practice is a Discrete Math course. Divisibility, calculations modulo a natural number, propositional logic, basics of graphs, all these offer a large pool of simple statements that are very suitable for practicing proofs and justifications.

In our talk we discuss these ideas in detail, drawing on our experiences with seeing our courses as "language" courses. We will show concrete examples of problems suitable for training the basic mathematical competence: being able to reason mathematically, and communicate mathematical thoughts using mathematical language. We will also show and discuss samples of students' work.

Teaching Engineers how to communicate mathematically: some first steps

Michael Carr[1] and Eabhnat Ní Fhloinn[2]

[1]School of Multidisciplinary Technologies, Dublin Institute of Technology, Ireland
[2]School of Mathematical Sciences, Dublin City University, Ireland

In his 2002 report, “Mathematical competencies and the learning of mathematics: The Danish KOM project”, Mogens Niss outlines eight “mathematical competencies”. These include thinking mathematically; posing and solving mathematical problems; modelling mathematically and so on. However, Niss’ seventh competency – that of communicating in, with, and about mathematics, is one which may not often be dealt with in sufficient detail in the engineering mathematics classroom.

Given the depth and breadth of engineering mathematics curricula, constraints on time and resources must be taken into account while trying to design an approach for the teaching and learning of effective mathematical communication. In recent years, we have trialled an approach to teaching this competency to undergraduate engineers in Dublin Institute of Technology (DIT) through the introduction of a seen essay-type question onto the terminal examination paper for 3rd and 4th year engineering mathematics. Here, we discuss the progress of this initiative to date, detail the questions involved and analyse student performance on these questions. In addition, we provide a review of literature in this area and discuss the potential for improvement in the teaching of this mathematical competency.

RULES_MATH: New Rules for assessing Mathematical Competencies

Araceli Queiruga-Dios[1], Deolinda M. L. D. Rasteiro[2]

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With the starting point of the Framework for Mathematics Curricula in Engineering Education, developed by the SEFI-Mathematical Working Group, a consortium made of higher education teachers from 8 different European countries work together in new rules for assessing mathematical competencies. The institutions that will take part in this project are: The Institute of Mathematics and Physics from Slovak University of Technology in Bratislava, Gazi University in Ankara, the Czech Technical University in Prague, the Faculty of Mathematics and Informatics from University of Plovdiv Paisii Hilendarski, the Spanish National Research Council (CSIC) in Madrid, the Instituto Superior de Engenharia de Coimbra, the Dublin Institute of Technology, the Technical University of Civil Engineering Bucharest, and the University of Salamanca.

The main objective of the RULES_MATH project is to develop assessment standards for a competencies-based teaching and learning system specifically designed for mathematics in engineering education. From September, 2017, to September, 2020, we plan to work in 3 specific objectives: (1) To develop a collaborative, comprehensive and accessible competenciesbased assessment model for mathematics in engineering context, (2) to elaborate and collect the resources and materials needed to devise competencies-based assessment courses, and (3) to disseminate the model to European higher education institutions through the partner networks and also promote the dissemination all over Europe.

To address these aims and objectives we will use a competencies-oriented methodology. Generally speaking, preparation for a mathematics teaching profession is completely insufficient if it is just about acquiring mathematical mastery, no matter at what level this occurs.

The institutions involved in RULES_MATH project have long experience in innovation and they have adapted their degrees to the Bologna Accord. Despite the differences in teacher training and the organizational frameworks for teaching mathematics, there is a great similarity in the problems, perspectives and discussions regarding mathematics teaching in the different partner institutions. Not only one can learn from the good ideas of other colleagues, but also improve the teaching-learning systems. In this way, from an

international perspective, teaching engineering mathematics is a global laboratory which can be of advantage to our objectives.

Keywords: Assessment methods, competencies-based assessment, competencies-based methodologies

EFFECTIVE TEACHING OF MATHEMATICS IN ENGINEERING COURSES

Arménio Correia

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In June 2017, I received an e-mail from the Center for Innovation and Study of Pedagogy in Higher Education (CINEP) of the Polytechnic Institute of Coimbra (IPC) with the following message on effective and of excellence teaching:

"(...) For the selection of professors, we asked undergraduate students to appoint those they considered most inspiring, effective and stimulating. Your name was the most nominated in the degree(s) you teach. Congratulations! It's a valid and neutral recognition of the positive impact you have on your students."

I ended up participating in the compilation of a document and a video with my testimony as a professor, a long walk with 25 years, made with passion and vocation that I cultivate year after year with and among my students of engineering.

The art and ingenuity of questioning, often leads me to put "that" timely question in the mouth of my students, in classes that should not be merely expositor. On the contrary, I try to make my classes interactive and constructive of learning and skills, to be acquired by students.

In this paper, where I intend to share and reflect about the teaching of Mathematics in Engineering, I will give complementary answers to some questions that I have been asked:

- What do I do to make classes stimulating and inspiring?

- What do I do for the students to learn well?

- What characterizes the perfect class?

- Which are the three main qualities of great professor?

Keywords: Effective Teaching, Mathematics, Engineering

New Methodologies for Teaching Math Courses in Engineering Degrees

Carla Pinto[1,3], Susana Nicola[1,2], Jorge Mendonça[1], Daniela Velichová[4] and Ariane Heler[5]

[1]ISEP/P.Porto; [2]INESC-TEC; [3]CMUP; [4]STU Bratislava; [5]Chemnitz University of Technology

The traditional way of teaching math classes is based on a 'teaching by telling', or 'chalk and talk', approach, especially in the first years of the university degrees. It is based on single lecture-based delivery to large classes. Recently, there has been a growing interest, by the engineering professionals and the bodies for accrediting engineering degrees, in promoting a change in this paradigm. As Einstein used to say "We must revolutionize our thinking, revolutionize our actions." The "change" in the teaching process consists in the implementation of active learning (AL) methodologies.

AL consists in instructional methods that engage students in the learning process, i.e., which require students to do meaningful learning activities and think about what they are doing. Students become an active part of their learning process, by reading, writing, talking, listening, debating, applying principles, and reflecting on the topics they are studying. AL, as opposed to the passive learning, moves the responsibility for learning from a teacher-centered to a student-centered basis. AL fosters skills-development rather than just conveying information to students. All of this aims to promote higher-order thinking, i.e., critical thinking, analysis, and development of soft skills (agility, curiosity, imagination, collaboration, communication).

Some AL instructional frameworks include problem-based learning (PBL), hands-on, eduScrum, Jigsaw. In the PBL curriculum, students achieve competences (soft skills), analyse, identify and solve problems, by relating disciplines to each other. They are an active part of their learning process and the teacher acts as a guide by proposing new research directions, methods, and tools. Hands-on experimentation, or learning-by-doing, is an essential part of the learning process. It enhances the desire to learn, promotes self-learning skills, and offers an efficient involvement of math subjects and engineering environments.

EduScrum is an active collaborative education process that allows students to plan and determine their study activities and their learning process by themselves, supporting responsibility for keeping track of their study progress. While teacher determines why and what to study, the students determine how to organize and manage it. This is resulting in intrinsic motivation, fun, personal growth and better results. Such personalized learning method has a very important role, as it is positively effecting student's creativity, mutual collaboration, profersional communication and critical thinking.

Jigsaw is one of the efficient cooperative learning strategies which enables each student in the small working group to be directly engaged with the material, instead of receiving it presented in a pasive way, which considerably fosters the depth of understanding. Students gain practice not only in self-teaching, but also in peer teaching, which requires them to understand the material at a deeper level than they typically do when they are only asked to perform at exam. This active learning strategy is quite opposite to the exam-driven learning strategy that is usually adopted by the majority of weakly motivated students.

Some practical examples of possible implementation of these innovative learning/teaching strategies in engineering mathematics courses will be presented in the paper.

Keywords: Active learning, Jigsaw, eduScrum, Student-centered learning, Problem solving, Hands-On, Engineering

A learning center for first-year students combining professional competencies and soft skills at Mannheim University of Applied Sciences

Wiebke Werft, Susanne Kreim and Steffen Rasenat

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Major reasons for quitting in the first two years of studies at German Universities of Applied Sciences are: the discrepancy between required and applicable prerequisites in mathematics, the inability to self-assess one's own level of performance, and the lack of autonomy in selfstudy. The Mannheim University of Applied Sciences is therefore establishing a learning center for all first-year-students of engineering faculties. The aim of the center is to design a teachinglearning process in such a way that the students receive individual support according to the respective requirements. The focus lies on mathematical competencies such as "solving problems", "proceeding systematically", "making plausibility considerations" and "communicating and reasoning mathematically". In particular, the advancement of professional competencies is closely linked to the developement of soft skills relevant for the future job such as motivation, endurance, communication and feedback skills, assertiveness, leadership or teamwork.

The heart of the new learning center is a special lecture on basic topics of mathematics. In this competence-oriented lecture, the training of soft skills is integrated into the development or promotion of professional competencies. Key skill is the targeted application of mathematics to the requirements of the respective program. Sustained proficiency in the key skill is achieved by linking mathematical content to the student's everyday life as well as to applications in engineering and real-life practice. A three-step methodology is employed to ensure its mastery: first, requirements analysis is used to identify lack of knowledge and skill. Second, mindset and germane behavior of students as well as lecturers are matched to ensure an effective learning process. Third, an appealing learning environment is realized by meeting state-of-theart educational standards and integrating modern media.

The evaluation of the lecture after the first run shows a high level of satisfaction with the offered support. The overwhelming majority of those surveyed stated that they had closed existing gaps.

Keywords: Mathematical competencies, soft skills, learning center

Widening Access to Engineering with Mathematics for STEM

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Many prospective students in Ireland are ineligible for enrolment on STEM programmes because they do not have an acceptable mathematics qualification. For example, a C3 in Higher Level Mathematics (or higher) is typically required for engineering programmes at honours level. This exam is taken as part of the Leaving Certificate, covering several subjects, and can only be repeated as part of a repeat of the entire Leaving Certificate. Failing, or more often not doing, Honours Mathematics (a lower level may be taken) then effectively cuts that student off from STEM programmes at honours level.

In this paper we discuss a joint project between several third level institutions in Dublin and the further education sector to introduce a new 1 year Mathematics course. This is targeted at students who have left school without a higher Level mathematics qualification, but who wish to start a STEM discipline at college at honours degree level. Currently, most third level institutes in Ireland will only accept a passing grade in higher level honours mathematics as an entry requirement for a STEM discipline. This 1 year module will focus on mathematics for STEM disciplines in particular and forms a viable alternative to the 2 year Leaving Certificate qualification for acceptance onto a STEM course for non-traditional students. The course is now currently running in its second year.

In this paper we will look at the collaboration required to create this course and the outcomes in the first and second year. We will discuss the progression of students into honours STEM disciplines (has it had the right outcomes?) and the student/teacher view of the course.

As part of this collaboration an automated testing component of the course has been created between third level and three further education colleges which specifically addresses the basic skills issue. We will discuss the set-up and interaction with teachers and discuss the results of the tests.

Keywords: engineering mathematics, high threshold testing, non-traditional students

Assessing Statistical Methods Competencies and Knowledge in Engineering

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The concepts taught during a Statistical Methods course make use of different mathematical skills and competencies. The idea of presenting a real problem to students and expect them to solve it from beginning to end is, for them, a harder task then just obtain the value of a probability given a known distribution. Much has been said about teaching mathematics related to day life problems. In fact, we all seem to agree that this is the way for students to get acquainted of the importance of the contents that are taught and how they may be applied in the real world.

The definition of *mathemical competence* as was given by Niss (Niss, 2003) means 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. Necessarily, but certainly not sufficient, prerequisites for mathematical competence are lots of factual knowledge and technical skills, in the same way as vocabulary, orthography, and grammar are necessary but not sufficient prerequisites for literacy. In the OEDC PISA document (OECD, 2009), it can be found other possibility of understanding competency which is: *reproduction, i.e,* the ability to reproduce activities that were trained before; *connections*, *i.e,* to combine known knowledge from different contexts and apply them do different situations; and *reflection, i.e,* to be able to look at a problem in all sorts of fields and relate it to known theories that will help to solve it. The competencies that were identified in the KOM project (Niss, 2003, Niss & H∅jgaard, 2011) together with the three “clusters” described in the OECD document referred above were considered and adopted will slightly modifications by the SEFI MWG (European Society for Engineering Education), in the Report of the Mathematics Working Group (Alpers, 2013).

At Statistical Methods courses often students say that assessment questions or exercises performed during classes have a major difficulty that is to understand what is asked, i.e, the ability to read and comprehend the problem and to translate it into mathematical language.

The study presented in this paper reflects an experience performed with second year students of Mechanical Engineering graduation of Coimbra Institute of Engineering, where the authors assessed statistical methods contents taught during the first semester of 2017/2018 academic year. The questions assessment tests were separated into two types: ones that referred only to problem comprehension and its translation into what needed to be calculated and others where students need only to apply mathematical techniques in order to obtain the results. The research questions that authors want to answer are:

- What are the competencies that students found, in a Statistical Methods course, more difficult to obtain?
- Having the idea that learning concepts applying them to reality is much more fun and worthy for students, is it really what we should assessed them for? If not, how can knowledge be transmitted to students and be transformed into significant learnings?

Keywords: Mathematics Competencies; Higher education; Statistical Methods.

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Evolving of Mathematical Competencies by Blended Learning

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We noticed that students have major deficits in understanding mathematical texts and correctly formulating questions. But this is necessary to acquire knowledge by oneself. These are fundamental competences, not only in mathematics, but also in engineering and economics, since mathematical terminology are used here.
Especially with first-year students, we observe a reluctance to use mathematical textbooks. Therefore it is extremely important to develop and stimulate the reading and expression skills of students.
The presentation will show how the e-learning program LonCapa is used to stimulate these competences. The students receive suitable assignments in LonCapa for the upcoming topics. So the contents have to be prepared on their own. Students are requested to ask questions about the content and formulations of the assignments online. Formulating questions in the online environment is a part of the task. In the lecture, not only the content but also the formulation of the questions is discussed. The students receive feedback on their mathematical formulations.

The authors wish to share this experience, their success and their disappointment.

eduScrum - a methodological framework for a mathematical lecture in the first-year education of engineers at University of Applied Sciences. Presentation of the method and first investigations.

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At Universities of Applied Sciences in Germany first-year-students start their studies with different learning prerequisites. This heterogeneity is due to the many possibilities of admission criteria. Hence the variation of mathematical knowledge of the first-year-students is very high. Therefore the traditional concept with a lecturer standing in front of the class does not take the individual support into consideration.
For this reason, a new lecture concept, called *eduScrum*, is presently being introduced at the Mannheim University of Applied Sciences (Germany) in mechanical engineering. This concept is based on a project management method called *Scrum.* First experiences have been made at high school level in the Netherlands.
Using eduScrum in mathematical education in a University of Applied Sciences is a novel approach.

The main characteristic of an *eduScrum* lecture is that students work self-dependent and self-organized in teams on mathematical topics of the curriculum while observing a framework set up by the *eduScrum* guidelines. The guideline specifies a recurring circle, called *sprint*, of *planning, doing, review* and *retrospective*. The mathematical content of each *sprint* is translated into learning goals, called *acceptance criteria*, provided by the lecturer. In *eduScrum* the lecturer takes over the function of a coach and supports the teams in achieving the learning goals.

As part of a cooperative research project between Heidelberg University of Education and Mannheim University of Applied Sciences, the implementation of *eduScrum* in a first year lecture follows a Designbased Research approach, repeatedly evaluated and modified using a quasi-experimental design. The paper will present the project and future results of the first (still ongoing) implementation phase.

Keywords: eduScrum, mechanical engineers, mathematical education, first-year students, DBR, self-dependency, assisted learning, learning in teams, motivation

Future mathematics project: the experiences and practices for mathematics learning and teaching with technology

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Future Mathematics (FutureMath) project aims to enhance learning and teaching of engineering mathematics by exploiting educational technology and exploring pedagogical aspects for that. The project's objectives are to explore and develop methods to learn and teach engineering mathematics by utilizing different type of educational technology and using digital contents.

FutureMath is a three year project funded by the EU Erasmus+ Programme which started on September 2015 . This paper introduces main outputs of the project and experiences on the use of educational technology in mathematics learning and teaching. The main outputs of the project are as follows
a) Mathematics Online Pedagogy (MOP)
b) Mathematics Learning Platform (MLP)
c) Mathematics Learning Resources (MLRs)

Mathematics Online Pedagogy (MOP) combines best practices and pedagogical point of views for meaningful utilization of different types of educational technology in mathematics learning and teaching context. Mathematics Learning Platform (MLP) is a comprehensive framework for mathematics learning and teaching in web. It is a versatile repository for technology enhanced materials, activities, assessment and tools. Mathematics Learning Resources (MLRs) are different kind of resources planned, produced and tested in the project. The MLRs encapsulate a vast variety of ICT based learning and teaching resources such as short vídeo lectures, lecture materials, online learning materials, online assessment components, authentic learning modules and online resources for learning, for example.

These three outputs are the main outcomes of the project. As an overall outcome of the project, these outputs provide a collection of best practices, useful resources and pedagogical practices for online learning and teaching of mathematics. Outputs such that have a potential to make learning of mathematics more motivational, personalized and interesting but also to increase accessibility and the alternative modern methods for learning.

Functionality of developed MLP, experience with its utilisation at the institutions of project partners, and various kinds of available learning resources will be the main contents of the presentation at the conference.

Keywords: mathematics learning, mathematics teaching, technology, research projects, digital contents, technologies

Recent Developments in Germany on Competence Orientation at School: Statistics on Final School Grades, Examples from Engineering Courses, Urgent Open Letter

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Over the years from 2006 to 2015 a statistical analysis of the final secondary-school examinations in Berlin reports that the grades are enhancing with respect to the parameters average of grades, the portion of best possible grades and the number of failed examinations. But the mathematical competencies of first-year students at university have an opposing trend.

We will demonstrate these observations from the point of view of engineering study courses at a university of applied sciences and we will give examples. The specific features of these examples are: our colleagues of the engineering faculty collected them out of their engineering modules, the focus is on simple practical application and the mathematical requirement is very low.

So far the universities in Germany watched quietly this situation and limited themselves to repairing actions like bridging courses. In March 2017 130 German professors and some teachers at schools had sent an open urgent letter to the ministers of education complaining the decline of the mathematical competencies and stating the shift to competence orientation at school as one reason. The German media have picked up this topic for about six months. A broad discussion has been set up. Now even didacts and education experts admit the existence of the mathematical gap between school outcome and university requirement. They also surprisingly stated that the task of schools is not preparing for STEM programes at universities but to provide a general mathematical education being relevant for all students in their later life.

We will also report on these discussions in Germany and we will point out that even the promised general mathematical competency is not reached at school.

Keywords: Competence orientation, actual situation in Germany, statistics of final secondaryschool examinations, transition from school to university, lack of mathematical competencies

INVOLVE ME AND I LEARN – video-lessons to teach math to Engineers

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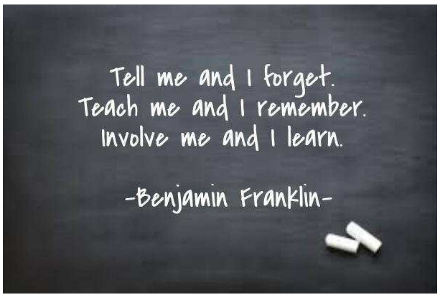

One way to enrich mathematical learning experiences is through the use of different types of activities. Although the use of these experiences does not determine learning by itself, it is important to provide several opportunities for contact with different activities to arouse interest and involve the student in mathematical learning situations.

Videos have assumed a growing and promising role in teaching, particularly as a different and motivating activity at the service of education (Stefanova 2014; Willmot 2012). A number of initiatives and studies have already been carried out in this area, such as Moran (1995), who discusses different possibilities for the use of this material in the classroom, as "simulation" (to simulate an experiment) or as "teaching content" (to show a certain subject), among others. Currently the videos available on the internet of small parts of classes are the most viewed by the students, who watch them when they have some conceptual questions. Videos of this nature have also gained space in Distance Education (Koppelman 2016). In the scope of mathematics education Clarke et. al. (2011) point out that video can be used in an interactive environment in order to enhance expression and communication, as well as a pedagogical action that motivates learning.

In the field of mathematics education, video can be used as a pedagogical action that motivates learning. In this sense during this school year, in the Mathematical Analysis I course of the degree in Electrical Engineering in Coimbra Institute of Engineering, we proposed to the students the development of a video-lesson about the contents taught in course. We wanted to motivate the students to dedicate themselves to study contents in greater depth, to plan the information to be presented, to improve the way of expressing themselves especially in mathematical language, to promote creativity and to involve students in learning

About 80 students (2 students by group) presented their video-lesson and participated in the visualization and evaluation of both their work and the work of their colleagues. The evaluations focused on the form (argument, sound, aesthetics and editing), language (including mathematical language) and content (clarity, narration, creativity, research and exploration) of video-lessons.

The reasons that moved us into propose this work, and were referred above seemed to be achieved taking into account the results obtained and the student's testimony.

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Going up and down by the lift to learn Linear Algebra

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Calculus, Linear Algebra, Numerical Methods, and in general mathematics, could be considered as tools in the training of engineering students. In recent years, teaching and learning methodologies have changed considerably. We moved away from master classes with separate hours of theory and problems, to different attempts to apply mathematics to engineering courses, which motivates students and make them acquire the mathematical competencies.

We have developed several engineering problems and situations according to the different mathematical levels in engineering degrees. In this paper we show how students could learn the calculations of eigenvalues and eigenvectors solving a mechanical problem of vibrations. From a one degree of freedom system and its physical and mechanical knowledge, students are able to acquire the mathematical competencies and get the values of frequencies and vibrations modes.

We started with the proposal of using the mobile phone as a pendulum together with a computer algebra system. Once students collect the data from their devices, they were able to calculate the frequency of a pendulum on a spring and this leads them to study the vibration of a system with one, two or more degrees of freedom. Mobile-aided learning and computer-based learning in general help students to be motivated. The use of devices awakens their curiosity and captures their attention.

We present in this study the results from linear algebra course from different years, using different methodologies and also different assessment methods.

Keywords: Mobile-aided learning, computer algebra system, Linear Algebra, Physical equations

Mathematical Academic Malpractice in the modern age. A problem affecting Engineers

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Academic malpractice is a problem plaguing University Teaching of mathematics and affects the teaching of Engineers and others who apply mathematics as much as specialists in mathematics. Often, malpractice can result in a distorted picture of whether students demonstrate the mathematical competencies. Some methods of avoiding malpractice e.g. having in-class tests rather than take-home assignments may, in the long term, be detrimental e.g. not giving the students an in-depth investigation. Attention from central university authorities concentrates on software such as Turnitin which does not report the kinds of problems affecting mathematics. The advent of computerised assessment, while a very positive step, does introduce new issues in malpractice.

In many ways, as users of mathematics, malpractice in mathematics can affect Engineers more than mathematics students. For example, it is possible that an engineering student could regard a mathematics course as slightly isolated from other courses (although teachers of both mathematics and engineering courses should work to minimise this) and may end up desperate and hence succumb to temptation.

This contribution will disseminate the results of a UK initiative on academic malpractice in mathematics including a survey and culminating in a meeting in Manchester, May 2018. It is hoped that cases of good practice in UK universities can be mentioned and highlighted.

Influence on learning outcomes by human factors

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Since 2006 the research group mathematical modelling and simulation which is situated at the faculty of Mathematics at the TU Wien developed several blended learning courses. These classes deal mainly with calculus for electrical engineers or modelling and simulation. The courses use Moodle to administrate lecture materials and interactive MATLAB and OCTAVE applications as well as exemples hosted on an external web server. In 2007 the group included a computer algebra system based on Maple, called Maple T.A. to enlarge the range of tools and pool of examples. Using Maple T.A. allows to facilitate classes for calculus for engineering students in the first semesters due to his symbolic calculation power. This tool is primarily used to support blended learning courses in mathematics for beginners and as well for electrical engineering and geodesy students in the first two to three semester.

In the last decade, the understanding and use of eLearning, blended learning as well as online support changed significantly. Nowadays, there is a certain need and increased importance due to the fast progress in technology and the current generation of digital natives. This development also leads to improvements of Moodle and Maple T.A. enabling more interactive possibilities.

The blended learning course structure of Mathematics 1, 2 and 3 for electrical engineers adapted over the last ten years to meet these requirements to include online tools into the concept. Additionally, these classes are one of few using online assessment not only for formative but also for summative assignments. In order to develop a student-friendly and forward-looking assessment, the content was defined together with staff and students of the faculty of electrical engineering. The criteria and demands of the course are well-defined and communicated from the first day on to avoid any confusion or misunderstanding. An online assessment system which is also used to determine students' grades additional to self-assessment leads to strict but fair grading. Therefore it is even more important to clarify all the requirements at the beginning.

Starting with only two components, homework and presentation, the concept consists of four main requirements today. There are three formative online tests whereby the students have to fulfil certain limits for each test and in total. Further, the students have to prepare examples as homework and present them in front of small groups and their tutor. They have to calculate correctly at least 60% of this examples and show during the presentation that they understand the underlying theory. At the end of each lesson they have to do a short written test to feedback if they understood the presented topics.

In several points, humans influence significantly the success of this concept. First, the tutor leading the exercise guiding the students has a great impact on their motivation and progress in understanding the mathematical background. Secondly, the professor giving the lecture dominates the big picture of the course and gives the students the main focus and most important points. One might think that only the tutor, sharing time with small student groups, has the important impact on students. Evaluating the last 5 years of this course showed, that the lecturer defines the atmosphere and level of motivation in a greater way than one would expect.

In this contribution we would like to present the concept of our blended learning courses designed over the last years as well as the influencing human factors and its consequences in their students' success.

Keywords: Blended Learning, Learning outcomes, motivation, human factors, computer álgebra system

THE CONTRIBUTION OF ICT IN THE ACQUISITION OF MATHEMATICAL, ALGORITHMIC AND PROGRAMMING KNOWLEDGE AND SKILLS BY STUDENTS OF ENGINEERING

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The fast technological evolution forces schools to countinuously adapt to a new reality, to be able to give students the necessary training to successfully face increasingly complex situations. For this to be possible, in addition to a solid scientific training, it is necessary to use up-to-date tools and working methodologies, where professors frame the use of information and communication technologies (ICT). In particular, mathematical software, e.g., Matlab, Maple, GeoGebra, and e-Learning platforms, must be used as a complement to the conventional face-to-face classes on mathematics curricular units of engineering courses.

In this work we present a Matlab application developed during classes of a Mathematical Analysis course for Informatics Engineering. This application evaluates if a real function of two real variables is harmonic and, at the same time, plots their graphs - surface and contour lines.

This approach leads us to ask how the use of ICT and, in particular, the use of mathematical software and e-Learning platforms, increases the students mathematical, algorithmic and programming skills, therefore generating success? The accumulated experience of several years of teaching Mathematical Analysis courses in engineering has shown us that the increased focus on Computational Mathematics has been successful. Final evaluation results improved, as well as the acquisition of mathematical, algorithmic and programming skills.

Keywords: Computational Mathematics, ICT

Different views of Mathematicians and Engineers at Mathematics: The Case of Continuity

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Dray & Manogue (2005) state in their paper on the gap between mathematics and the physical sciences: „Mathematics may be the universal language of science, but other scientists speak a different dialect“. This way they express that mathematicians and physicists have their particular view on mathematics, its value and potential use. The same holds for mathematicians and engineers. In a competence based approach to the mathematical education of engineers (cf. Alpers et al. 2013), it is important to take into account the engineering "view" in order to enable students to understand and use mathematical concepts in relevant engineering contexts and situations.

In this contribution, I will first elaborate on the concept of "view" and methods to capture its components. I will use the mathematical concept of "continuity" as an example to demonstrate the different view of mathematicians and engineers. For doing this, I will investigate the treatment and use of this concept in two widespread German textbooks on analysis (for mathematicians: Heuser 2009) and on engineering statics (Gross et al. 2013), respectively. Moreover, for capturing the engineering interface more widely, I will also consider the use of continuity in an industry guideline issued by the German association of engineers and in a practical task from industry I encountered when doing consultancy work. The contribution closes with a discussion of potential consequences for the mathematical education of engineers.

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Reflections on student-focused initiatives in engineering mathematics education

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During the first and second year of an undergraduate engineering programme, mathematics modules are used to primarily develop the mathematical skills and concepts that underpin the study of higherlevel discipline specific modules. Given the importance of mathematics to engineering, it would be expected that all engineering students fully immerse themselves in studying and mastering mathematics, especially those topics that are relevant to their discipline. However, as the literature points out, this is not always the case (Alpers, 2010; Klingbeil et al., 2004). In the work reported in this study, we use large class teaching (up to 450 students at a time), an approach commonly used in introductory modules across higher education in research-led institutions in the UK. In our experience, reliance on large class teaching has tended to exacerbate issues relating to student motivation in mathematics classes.

An in-depth review across two institutions, Queen Mary University of London and University College London, aims to explore some solutions that have been developed to address issues relating to motivation in large class teaching of engineering mathematics. Main solutions analysed will be the integration of student feedback for the development of curriculum supporting materials, the development of smaller working communities within a large class environment, the use of audience response systems, and the use of online quizzes and assessment.

One of the main issues encountered is that in large class environments, even for cohorts of ˜150 students, it is difficult to provide sufficient attention to struggling students. To alleviate this, principles from team-based learning (TBL) have been used to develop a student management system for large student workshops to encourage a smaller community of learners. This system ensures there is ample support through dedicated teaching assistants, peer support within student groups and a clear view on any struggling students.

E-learning tools have also been developed and deployed to supplement the traditional lectures. This includes the use of peer-to-peer study videos that focus on areas of the module where both the student developers and other students who have gone through the modules have experienced some challenges.

This presentation will analyse the development and execution of these initiatives to motivate engineering students. In particular, emphasis will be placed on how to facilitate large cohorts of over 150 students, and how effective peer-led learning can be developed and supported. We will also use student feedback to reflect on the different experiences in learning mathematics by way of engineering examples. Further, comparisons will be made with the student experience in traditional engineering mathematics teaching that focuses primarily on the theory of fundamental mathematics.

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The Effect of using a Project-based-Learning (PBL) approach to improve engineering students' understanding of Statistics.

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Over the last number of years we have gradually been introducing a project based learning approach to the teaching of engineering mathematics in Dublin Institute of Technology. Several projects are now in existence for the teaching of both second-order differential equations and first order differential equations. We intend to incrementally extend this approach across more of the engineering mathematics curriculum. As part of this ongoing process, practical real-world projects in statistics were incorporated into a second year ordinary degree mathematics module.

This paper provides an overview of these projects and their implementation. As a means to measure the success of this initiative, we used the SALG instrument to gain feedback from the students. The SALG online tool - Student Assessment of their Learning Gains - *https://salgsite.net/*; is a free course-evaluation tool that enables third-level educators to gather feedback specifically focused on what the students gained through the learning exercise they experience. It can be used to measure students' learning gains. Pre-developed surveys are available which can be modified and are stored in a repository for ease of access. Results are anonymous and there is the ability to download comments and basic statistical analysis of responses. Feedback from the survey points to a large increase in understanding of the material coupled with an increase in confidence. In addition we outline some of the limitations of our initial implementation of this approach and what we hope to improve on for the next academic year.

Competence-based Learning in Engineering Mechanics in an Adaptive Online-Learning Environment

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In engineering sciences like mechanical or automotive engineering pre-knowledge in mathematics is required to deeply follow specific engineering lectures. The mathematical competencies are essential preconditions to complete successfully the engineering lecture.

It is necessary, that these pre-competencies are identified for each engineering lecture. Before the specific engineering lecture takes place, these competencies are tested for each individual student and learning opportunities are provided according to the individual student needs.

Within this paper an approach of competence-based learning in Engineering Mechanics is presented. This approach is assisted by an online learning environment which is adapted and extended by several features in order to enable a competenceoriented learning strategy. Computer assisted tests are used for measuring mathematical pre-competencies. Moreover, a mastery learning approach based on exercises is utilized in order to secure a certain competence level before the student moves forward to learn subsequent competencies. Test results and exercises are influencing the individual learning path with different individual suitable learning elements offered to the single student.

The competence oriented teaching approach in Engineering Mechanics is exemplarily explained using examples particularly with regard to mathematical preknowledge. This comprises different competencies of the lecture of Strength of Materials which is an important course of basic engineering studies.

Keywords: Competence based learning, Engineering Mechanics, Mathematics, E-Learning, Online-Learning Environment

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CDF Files to learn mathematical concepts… Why not?

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The CDF format (Computable Document Format - introduced by Wolfram Research in 2011), is an important tool to communicate complex concepts, since it enables documents to come alive with dynamical interactive contents. The use of this type of documents is a key point in teaching mathematics to engineering students, where a clear illustration of a concept is a fundamental way to motivate them to fully understand. To view a CDF file one needs a reader, the CDF Player, available free of charge at http://www.wolfram.com/cdf-player/. Software Mathematica and programming skills are needed in order to create a CDF file.

In this communication we share our experience in teaching mathematics to engineering students using CDF files, which are available online through the following website http://www.isec.pt/~ppr. In this website one can find the treatment of different themes of mathematics and physics with a selection of concepts usually presented in engineering classes. Each CDF file includes the description of a concept with a theoretical explanation and an interactive window with an animation or an example. We point out that this is an ongoing work where the treatment of new concepts can also be suggested by users. Finally a practical problem will be solved using Mathematica and its illustration will be presented in a CDF file.

DYNAMIC MATHEMATICS IN LEARNING MANAGEMENT SYSTEMS

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In e-Learning environments, the Learning Management Systems (LMS) play a central role. The LMS Moodle and ILIAS are widely used at universities and Universities of Applied Sciences. But even nowadays, it is still a challenge to use the possibilities given by digital materials to create learning content which offers more than a classical textbook. Several tools are available to show, explain and dynamically explore mathematical concepts, among them are CoCalc (former SageMathCloud), SageCell, CDF-Player, JSXGraph and GeoGebra. It is still quite common that content for a lecture is provided inside the local LMS, while the learner has to open another platform or software to use the dynamic mathematical tools for exploration of the content. In our contribution (talk or poster) we will show our approaches to include dynamic mathematics inside LMS.

In particular, we use JSXGraph for dynamic 2D diagrams and the SageMathCell for a wide range of mathematical aspects. JSXGraph is a JavaScript library, which is quite easy to use and which offers the possibility to include user interactions via HTML-forms. The advantage is that the computations are done in the browser on client-side. On the other hand, SageMathCell has a huge variety of tools already included, like Maxima, R, Octave or Python. Furthermore, it is very easy to show 3D-diagrams. This is made possible by executing the computation on a remote server, which has to be connected from the content.

We include JSXGraph and SageMathCell in classical HTML-Pages as media content and through dedicated plug-ins for the LMS Moodle and ILIAS. During the ”Mathematics for Engineers” (part 1-3) we provide additional material for several topics, e.g. series, (un)-constrained optimization, integration, parametrization of curves and surfaces or differential equations. We see the advantage that the diagrams will become an integral part of the learning modules and the learning unit does not look like patchwork.

Further, the learners can focus on the content and do not have to bring additional software or to login in a second learning platform. During presence lectures the lecturer can use the same LMS as the learnersdo for their follow-up work.

For JSXGraph, there is a plug-in for Moodle, for the usage of SageMathCell inside ILIAS the first author could initiate the development.

Keywords: dynamic diagrams, content elements for LMS, mathematics

Mathematical Competencies through Credentials in a Practice-based Engineering Degree

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In the context of a new engineering practice-based degree, in which students study as if working and undertake industry-set projects throughout their degree with no traditional lectures or classes, it was necessary to find a novel way to support their learning of fundamental knowledge such as mathematics. This required a just-in time learning approach with topics taught as required by specific projects. The solution was a series of 'credentials' which are small, online modules. There is a synergistic relationship between credentials and projects, with credentials providing the knowledge required for the project, and the project providing an opportunity for students to gather evidence of their ability to apply the mathematical concepts in practice.

Credentials are not graded but are either marked as achieved or not yet achieved. Assessment is based on the evidence students collate from application in their project work. Students must be proficient or advanced in all of the assessment criteria to achieve the credential. These criteria include aspects of all mathematical competencies such as mathematical communication and using software as well as more traditionally assessed competencies such as applying mathematical procedures.

The modularity of credentials means there is a complex web of prerequisites, as mathematical knowledge and skills require building from foundations upwards and complex topics cannot be taught before basic ones have been mastered. However, as credentials can be distributed across all four years of the degree, they also remove the need for front-loading maths into the first few years of engineering degrees which often presents challenges for students as they transition into tertiary education.

This paper will present the rationale and structure of the credential system and demonstrate how it can be used to assess mathematical competencies.

Keywords: practice-based, credentials, competencies

Sense and Nonsense of Teaching Math for Engineers

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Based on experiences with teaching Calculus II for engineering students at the Faculdade de Ciência e Tecnologia of the Universidade Nova de Lisboa we identify one particularly worrying problem with this teaching: the existence of fundamental errors which, normally, should result in an immediate failure of the student. However, these errors are not about the material lectured in this course, but from Calculus I or even from high school mathematics. The seriousness of the problem results from the fact that these errors compromisse the entire knowledge acquired in Calculus II.

The problem is illustrated with a concrete example from a test we had to mark:

4. Considere a curva paramétrica definida pela função vetorial $\vec{r}:[1,2]\to\mathbb{R}^3$, $\vec{r}(t)=\left(t,\log t,2\sqrt{2t}\right)$.
   (a) Verifique que $\|\vec{r}\prime(t)\| = \frac{t+1}{t}, \quad \forall t \in [1,2]$.
   (b) Determine o comprimento da curva.

For a) many students didn't manage to derive log(t) or $2\sqrt{2t}$; this is not good, but maybe not particularly worrying. The problem turned much more serious when a significant number of students tried desparetely to correct the errors from the differentiation, concluding that

$$\sqrt{1+t^2} = 1+t. \tag{1}$$

And the problem repeted itself for b). Many students did know—to our surprise—correctly the formula for the length of curve:

$$L = \int_1^2 \|\vec{r}'(t)\| dt = \int_1^2 \left(\frac{t+1}{t}\right) dt. \tag{$*$}$$

But they didn't know to integrate $\frac{t+1}{t}$, up to solutions of the form

$$\int_1^2 \left(\frac{t+1}{t}\right) dt = \left[\frac{t+1}{t}\right]_1^2. \tag{2}$$

Our question is: what is the knowledge of material of Calculus II worth, when it is obvious that a student doesn't know the elementary mathematics to apply this material in a meaningful context?

In our talk we will discuss some possible answers to this question.

A New Tool for the Assessment of the Development of Students' Mathematical Competencies

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In this talk, we are concerned with the assessment of mathematical competencies of students. Mathematical modelling tasks with biological content were introduced to engage biology students more actively into learning mathematics. Mathematical competencies profiles for individual learners were created to follow their development from session to session. From a wide selection of approaches to the notion of mathematical competencies reported in the literature (Maaß, 2006, Boesen et al, 2014, Weinert, 2001), we have chosen a competence framework from the Danish KOM project (Niss, 2003). Viewing a competency as an individual's ability to use mathematical concepts in a variety of situations, within and outside of the normal realm of mathematics (Niss, 2003), we retained five basic families of mathematical competencies out of the eight suggested in KOM. These are: thinking/acting mathematically, modelling mathematically, representing and manipulating symbolic forms, communicating/reasoning mathematically, and making use of aids and tools. During the data analysis, fifteen competencies in five families are coded separately in a reliable unambiguous manner. The records of each competency's frequency and strength (beginning, intermediate, developed, exemplary) are kept. This procedure creates big data sets which we analyse in order to properly assess and timely monitor students' competency development. To this end, we rely on a new monitoring tool developed by the authors. First, we convert the strength of each competency into numerical value. This results in large data sets containing long sequences of numbers. Our goal is to translate information in large data sets into much smaller number of essential parameters (like, for instance, a *winding number* – the number of changes of monotonicity). This smaller set of parameters reflects most significant details which are then used for further analysis and monitoring. We present this assessment tool, illustrate its use on examples, and discuss advantages and disadvantages of a new approach.

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POSTER PRESENTATIONS

Design a strategy to decrease failure in mathematics in Engineering

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Students of Engineering degrees often have many difficulties in Mathematics which leads to a high failure rate and therefore to a demotivation of all those involved in the educational process. Thus, teachers are in constant self-reflection about the appropriate strategies to adapt, as well as possible, to the increasing heterogeneity in the knowledge that students entering higher education have.

In this context, from the school year 2010/2011, those in charge of the Differential and Integral Calculus courses, were asked to do systematization of information reports that addressed the syllabus, the evaluation methodologies applied, the skills to be developed as well as the attendance and approval rates. According to the results obtained, an exploratory study was made and it was concluded that the success in the integration of the students in those curricular units depends on the compatibility of basic knowledge in mathematics, acquired during secondary education, with the knowledge considered essential for engineering students to attend first year math curricular units. It is from this compatibility that better integration of students arises and that the degree of demotivation leading to early school dropout, and consequent implication in academic failure, can be reduced. Thus, it became urgent to develop an intervention that would allow the link between secondary and higher education. For the promotion of various activities, it was necessary to carry out a preliminary study that allowed to analyse the degree of knowledge in the mathematical contents, at the basic and elementary level, that the students placed in ISEC have, using a diagnostic test. Following the poor results obtained in the diagnostic test, in 2013, was started a process of awareness, of the educational community of ISEC, for the need to implemente a Support Center for Mathematics in Engineering-CeAMatE, which was created in 2015.

This paper intends to describe the entire design process (analysis, design and development) of a strategy to combat math failure in Engineering, in order to improve academic performance of higher education students.

Keywords: Failure, Mathematical knowledge, Teaching, Learning

THE USE OF ICT IN THE SUPPORT OF TEACHING AND LEARNING MATHEMATICS IN ENGINEERING COURSES

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A transversal goal in mathematics courses in engineering is the realization, by the student, of the structuring role of Mathematics, as a basic science and a tool to support a logical and structured reasoning, indispensable in engineering.

To show that it is impossible to solve and to implement/program a wrongly formulated problem is one of the pillars of a good scientific training. Such training needs to be solid and make use of complementary tools and methodologies, such as the use of virtual laboratories and computational simulation.

In the Mathematical Analysis II course in Computer Engineering, the program is structured in two parts: Part 1 - Topics of Numerical Methods, Part 2 - Differential and Integral Calculus in IR^n. The existence of laboratory classes makes it possible to provide programming training in Matlab and computer algebra systems. Throughout the semester, activities are proposed to create teaching and learning objects that facilitate understanding, 3D visualization and assimilation of the curricular program contents.

In the Applied Mathematics course in Biomedical Engineering, the study of differential equations is the main goal. In addition to the theoretical classes, there are also laboratory classes, where the provided training allows students to acquire programming knowledge in Matlab GUIs. For exemple, during these classes students create GUI objects about Laplace transforms and their applications – e.g., the evaluation of the amount of a drug in the blood stream.

Keywords: Mathematics, Engineering, CAS, Matlab

Employment of Mathematical Skills in Economic Science

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In courses at economic or technical universities, mathematics plays a significant role, which is mainly apparent in the first years of study as they cover most of the mathematics courses. Mathematics courses are presumed to be the most difficult ones in terms of the results achieved by the students and they may be considered one of the main reasons why the number of students in the first or sometimes second year of study decreases. Usually, the significance of mathematics courses in the schooling of the future graduate is not questioned, yet in the long-term perspective we can see that the number of classes dedicated to mathematics is going down and this results in a reduction of more problematic parts. This process is often associated with the idea of making these courses easier to pass, but the experience shows us that this idea is mostly wrong.

At first sight, mathematics and economics are sciences that do not like each other. Economics is, quite legitimately, considered a social science, and hence we could expect that the application of mathematical methods will be very limited. Simply, mathematics in the economics sometimes tends to be underestimated and degraded to a mere tool for the valuation of book entries. However, the contrary is the case. Mathematics has been an integral part of the economic theory for decades, maybe centuries. Economists now owe mathematics that they are able to clearly prove certain regularities existing at real markets or entire real economies. Without mathematics we could just forget the whole of modern microeconomics. Without mathematical tools we would not know the significance and importance of limit quantities throughout the economic theory, we would not be able to derive and use basic economic functions – the supply and demand. Briefly, economics cannot do without mathematics nowadays.

On the other hand, though, we may say that it is because of mathematics that the economics is sometimes considered (unjustly) a science a standard human being is not able to understand or even apply. The objective of this article is to share our experience in the teaching of economics and employing the mathematical apparatus to illustrate basic economic regularities and relations. Mathematics surely cannot create a universal model of human behavior, but it undoubtedly is a very useful science enriching the economics and helping us comprehend real economic phenomena, explain them and predict the effect of a certain measure, a certain change or see how they will affect the economic reality should the external conditions change.

It is also very important to choose appropriate teaching methods – this is one of the teacher´s key competences. Nowadays, the teachers are under a big pressure in this regard, because more and more emphasis is given to active involvement of students in the class. New methods and trends appear in the teaching of mathematics courses. Computers and mathematical software are used more and more for the computation and simulation of mathematical and economic phenomena. There is a focus on online tests and quizzes that correct automatically or tell the student how to proceed.

Keywords: mathematics courses, mathematical methods, mathematical software, model, portfolio optimization, teaching methods

Mathematics competencies in higher education: a case study

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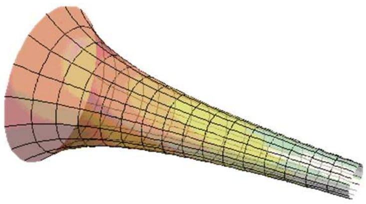
In higher education, mathematics has an important role in engineering courses. From the curriculum of the first year there are Curricular Units (CU) in the area of Mathematics that are fundamental for students to acquire the necessary basic knowledge to the most specific CU of each course. Without this well-established mathematical foundation, success in applied CUs is seriously compromised. During an Engineering course, students learn and consolidate the basic principles of Mathematics to solve practical problems, reinforcing their concepts mathematical knowledge. However, although Mathematics is a basic discipline in admission to Engineering courses, difficulties are identified by engineering students in CU related to mathematic basic core. In this context, it seems pertinent to identify the mathematics competencies attained by engineering students so that they can use these skills in their professional activities.

Mathematics competencies is the ability to apply mathematical concepts and procedures in relevant contexts which is the essential goal of mathematics in engineering education, that is, to help students to work with engineering models and solve engineering problems [1]. According to Niss [2] eight clear and distinct mathematics competencies are: 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 and making use of aids and tools.

This research pretends to demonstrated whicht are the competencies that engineering students can have or, acquire, when new contents are taught to them. A questionnaire approach was conduce before and after mathematics contents were presented with the same questions. Then, and according the competencies defines by Niss, we would like to analyse the perception of students, in the acquisition of teaching competencies regarding mathematics.

A questionnaire was applied to 35 students of the Calculus I course (first year) of Electrical Engineering in beginning of the class. Then and for the first time students are introduced to the concept of improper integral using a real and very informative example.



The surface of revolution obtained by revolving the hyperbola y = 1/x around the x-axis cut off at x = 1 is known as Torricelli's Trumpet and also as Gabriel's Horn. Playing this instrument poses several challenges: 1) It has no end for you to put in your mouth; 2) Even if it did, it would take you till the end of time to reach the end; 3) Even if you could reach the end and put it in your mouth, you couldn’t force any air through it because the hole is infinitely small; 4) Even if you could blow the trumpet, it’d be kind of pointless because it would take an infinite amount of time for the sound to come out. And others additional difficulties (infinite weight, doesn’t fit in universe), that you can imagine [3]. Believe it or not, despite the fact that Torricelli's Trumpet has a finite volume, it has an infinite surface area! The volume of Torricelli's Trumpet and its area can be presented to the students as an example of applicability of the concept of improper integral. In this way the students can explore the inherent mathematical concept and mathematical competencies developed by them.

The Mathematics competencies questionnaire for students is composed by eleven questions about what means revolution surface, improper integrals and Torricelli's trumpet; how we can describe and represent it mathematically, how we can model it, and how can we resolve it using or not graphical applications and computers. The results from the questionnaires indicate that all the students have acquired the intended competencies although some more than others. Some of Niss's eight mathematics competencies are more developed than others. The most relevant elements in mathematical competencies are the interaction with the problem, its comprehension, how to describe the problem in mathematical form and its resolution. The example presented helped to improve understanding the theoretical definition of improper integrals and placed the student in a practical and engaging situation of the use of mathematics. As one of the students said "An enriching situation because I learned new knowledge that I did not have".

Keywords: Mathematics Competencies, Higher education

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Implementing Computer-assisted Exams in a Course on Numerical Analysis for Engineering: Why, How, and How much does it cost?

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In many courses on applied mathematics, in order to give a glimpse on realistic problems one is faces with large computations which are typically done by computers. However, when it comes to exams on such topics students are often asked to apply the learned methods-suited for large systems-to very small problems by pen-and-paper. In order to overcome this gap one can either stop teaching these methods or change the way of examination. In this talk we will try to answer in more detail why, and how, we implemented computer-assisted exams in a particular course. We will also comment on the costs doing this in order to compare with the expected gains. The framework for the exam may serve as an exemple which can be easily transferred and adjusted to other courses, institutions and need.

Potatoes drying process – a vehicle to put into practice mathematical competencies in engineering students

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Identifying a problem, develop and implement a mathematical model to describe the physical phenomena associated, analyze the predictions obtained and gather it with data for model performance evaluation, are fundamental steps for students to build up modeling skills and understand the importance of mathematics as a tool in science and technology education. As students' learning motivation is improved using a particular application of the subject studied, the drying process of potatoes was selected.

The air drying process applied to food industry is a process commonly used to preserve food, extending the shelf life of a product. This work is devoted to the drying process of fresh potatoes (*Red Lady*) with the aim to study the water diffusion within it cellular structure to the surface exposed to the hot air stream, followed by evaporation. The potatoes were cut in thin squares and dried in a convective air drier cabinet with controlled temperature and air velocity at 50°C and 1.6 m s^{-1}. Once the steady state conditions were reached, the weight of (humid) potatoes was monitored and acquired each 40 s. For the same air conditions, two sets of experiments were carried out using sliced squares of potatoes in a metallic tray and a metallic net in the dryer compartment. The evolution with time of potatoes'humidity for these two cases allowed to show the differences between drying a single layer of potatoes exposed to the air stream from only one side and from both sides.

A simple mathematical approach was used in processing the data acquired in order to obtain drying curves, drying rates, critical drying times and effective moisture diffusion coefficients. As expected, the obtained results showed that fresh potatoes dried with two open areas to mass and heat transfer dried faster compared to those dried in a tray with only one surface exposed to the hot air stream. To decrease water content in potatoes from 4.42

$kg_{water}/kg_{dry\ solid}$ to 0.17 $kg_{water}/kg_{dry\ solid}$ takes about 277 min when potatoes were dried in a tray compared to 197 min for the case where drying takes place with potatoes in the metallic net.

Assuming that water diffusion within the potatoes' layer is the dominant mechanism in the mass transfer process during the falling drying rate period, a simple model was developed using the classical diffusion equation and a numerical method was used to simulate both cases, considering one or two open areas to mass and heat transfer. Predictions were compared with data obtained from the two experiments performed.

The successful case presented, while integrating mathematical modeling and problem-solving analyses, is very useful for students realize the importance of interdisciplinarity and multidisciplinarity of subjects in applied problems solutions. Concerning the learning outcomes in engineering students, this allows bridging "*reality and pure mathematics*" and learn how to "*apply math as an engineer*" as reported by Wedelin *et al.* (2015).

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Using Quizzes on a Regular Basis to Motivate and Encourage Student Learning

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A lot of students have problems in the first semester to adapt to studying mathematics at a university. Some of them do not have enough basic calculating skills that are expected at this level and almost all of them have problems because they are not used to acquire so much new knowledge in a short time.

We tried to solve this problem by improving student learning using quizzes in Moodle environment. Correctly solved quizzes were a prerequisite for taking the exam.

We prepared a short quiz with five questions every week. Each question is randomly chosen from a pool of each category. Some categories consist of multiple versions of a question with different numerical values, others contain equivalent questions on the same topic. A student is deemed to have passed the quiz when she correctly answers all questions in a single attempt.

Students become familiar with different question formats. Some types of questions check calculating skills and other types of questions check understanding. Some questions have deferred feedback with a fully worked answers.

The results of the exams at the end of the semester showed statistically significant improvement of students' grades. We also checked the reasons for the improvement with a survey.

Keywords: math course, Moodle quizzes, motivation, feedback

Mathematical Economics - Marginal analysis in the consumer behavior theory

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From the neoclassical perspective, the economic value of a good is determined by the benefit that each individual consumer attributes to the last ("marginal") unity consumed. The economists Walras, Jevons and Menger, the founders of the marginalism, have introduced the marginal analysis to study the theory of value. Since the so-called marginalist revolution in the 1870s, the differential (or infinitesimal) calculus has been applied in the mathematical modeling of the economic theories. Our goal is to present some models of the consumer behavior, their advantages and limitations, using the methodology of the economic science. It should be emphasized that each (re)formulation is based in different economic principles: diminishing marginal utility, diminishing marginal rate of substitution and revealed preferences.

Keywords: consumer behavior, preferences, marginal utility, marginal rate of substitution, differential calculus

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Conservative continuous flows

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In many fields of engineering and other applications, problems related to network flows appear: vehicle traffic, electrical circuits, information transmission, manufacturing lines, storage and distribution, effects of infection …

In particular, the conservative continuous flows are very frequent, that is, those that comply with the law that in each knot the sum of inputs must be equal to that of outputs. The basic (non-trivial) result for this kind of fluxes for planar networks is that they form a vectorial subspace (of the vectorial space of all kinds of flows) of dimension the number of meshes and that a base is formed by the so-called flows of mesh. In this work we present two significant examples, which do not require these general theoretical results, but which illustrate and motivate them.

The first is a simple example of a roundabout traffic where 3 double-way routes converge. Using basic techniques, it is concluded that, if natural conditions of compatibility are verified, the solutions depend on one free parameter, that is, they form a vectorial subspace of dimension 1, in accordance with the general result referred to above. Moreover, the possible base vectors have all the coordinates of the same sign, so that positive solutions are guaranteed, as expected.

In the second example it is considered a more complex network, with several meshes, which already require more elaborate calculations to reach the aforementioned general conclusion. It is clear, then, that a general theory will be absolutely necessary when networks of médium or large complexity are considered.

Keywords: continuous flows; networks; vectorial subspaces

On Grounds for Competency Oriented Teaching and Assessment

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The paper will discuss the very current topic of recent years on acquiring mathematical competencies in education at technical universities and putting it into practice. Besides polemics on goals of mathematical education, range of mathematical courses contents, and priorities setting within limited time, it will take into consideration also psychological and social foundations. With respect to goals of new international Erasmus plus project Math_Rules, coordinated by Salamanca University, the paper will deal also with mathematical competencies assessment. "A Framework for Mathematical Curricula in Engineering Education" supplemented with taxonomies of educational objectives, importance of pedagogical education of university teachers, and influential element of forming learners attitude to mathematics outline our consideration focus.

Keywords: mathematical competencies, educational objectives, assessment, technical university

A hybrid test for mathematics

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This poster describes a study to summative testing of mathematics at the University of Twente, The Netherlands. The goal is to examine to what extent traditional exams in mathematics can be replaced by ICT exams. The project focuses on the educational aspects concerning the differences between mathematical exercises in open and closed form. A summative hybrid test is constructed consisting of 1/3 traditional open exercises and 2/3 closed (ICT) exercises. This test was subjected to 494 first year students of the various programs of the university, and the results are analyzed. The main conclusions are that complex exercises in traditional tests should not be posed in final answer form. Most of these exercises, however, can be divided into separate parts and formulated in closed form, without violating the corresponding educational targets.

HISTORY OF SEFI-MWG 1984 – 2018

Mathematics Working Group (SEFI-MWG) was founded in 1982 under the co-chairmanship of Professor D.J.G. James (Coventry University, England) and Professor K. Spies (University of Kassel, Germany) and succeeded in 1990 by Professor L. Råde (Chalmers University Gothenburg, Sweden), and in 1996 by Dr. F.H. Simons (University of Eindhoven, Netherlands). In 1997the working group chairmanship was awarded to Dr. Leslie Mustoe (Loughborough University, UK), and followed by prof. RNDr. Marie Demlová, CSc. (Czech Technical University in Prague, Czech Republic) in 2002. Prof. Dr. Burkhard Alpers (Aalen University in Germany) was elected as the SEFI MWG chair in 2008, and replaced by the current chair, doc. RNDr. Daniela Velichová, CSc. (Slovak University of Technology in Bratislava, Slovakia) in 2014.

SEFI MWG	Year	University	Place	Country
19th	2018	Coimbra Institute of Engineering	Coimbra	Portugal
18th	2016	Chalmers University of Technology	Gothenburg	Sweden
17th	2014	Dublin Institute of Technology (DIT), Institute of Technology Tallaght (ITT Dublin) and IT	Dublin	Ireland
16th	2012	University of Salamanca	Salamanca	Spain
15th	2010	Hochschule Wismar - University of Technology,	Wismar	Germany
14th	2008	Institute of Mathematics and its Applications	Loughborough	England
13th	2006	Buskerud University College	Kongsberg	Norway
12nd	2004	Vienna University of Technology	Vienna	Austria
11st	2002	Chalmers University of Technology	Gothenburg	Sweden
10th	2000	University of Miskolc	Miskolc	Hungary
9th	1998	Arcada University	Espoo	Finland
8th	1995	Czech Technical University in Prague	Prague	Czech Republic
7th	1993	University of Technology Eindhoven	Eindhoven	Netherlands
6th	1990	Budapest University of Technology and Economics	Balatonfűred	Hungary
5th	1988	Plymouth Polytechnic and Royal Naval engineering	Manadon-Plymouth	England
4th	1987	Chalmers University of Technology	Gothenburg	Sweden
3th	1986	Polytechnic of Turin	Turin	Italy
2nd	1985	Engineering Academy of Denmark	Lyngby	Denmark
1st	1984	University of Kassel	Kassel	Germany