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The 18th SEFI Mathematics Working Group seminar on Mathematics in Engineering Education

ABSTRACTS

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Local Organization Committee

Ulla Dinger, Tommy Gustafsson, Sven Järner, Thomas Wernstål

FOREWORD

Welcome to

THE 18th SEFI MATHEMATICS WORKING GROUP SEMINAR

The aims of SEFI MWG stated 34 years ago remain unchanged:

- 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 the continuing education of engineers in collaboration with industry.

The 18th SEFI-MWGEuropean Seminar on Mathematics in Engineering Education organised by Chalmers in June 27-29, 2016 is aimed to promote a fuller understanding of the role of mathematics in the engineering curriculum, and its relevance to industrial needs and continuing education of engineers in the economic, social and cultural framework of Europe. The overarching theme of the seminar is the concept of mathematical competencies reflected in the following themes:

- Transition to higher education for traditional and adult learners
- Learning mathematics through project work
- Mathematical competencies in web-based learning scenarios
- Using technology to improve mathematics education

SEFI MWG seminars are traditionally focused on guided discussions among participants during special discussion sessions. The topics this year are:

- Mathematical competencies
- SEFI Mathematics Working Group Seminars – mission and future

Together with participants from fourteen European countries we have an opportunity to make an impact on engineering education in mathematics for the future.

You are all welcome to participate, learn and enjoy.

Gothenburg, June 2016

Local Organization Committee
Programme Committee

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KEY NOTE PRESENTATIONS

Teaching mathematics to students who are not primarily interested in mathematics

Tom Lindstrøm
Department of Mathematics, University of Oslo, Norway

Most of the students enrolled in mathematics courses are not primarily interested in mathematics. They are there because they have been told that they need to take mathematics in order to become engineers, physicists, chemists, biologists, computer scientists, economists etc., and they seem to regard this advice with increasing skepticism. There are several challenges in teaching students of this kind. The most obvious one is perhaps how to motivate them, but there are deeper, underlying questions on how to teach them and what to teach them. As far as I know, there are no magic solutions to these questions, but I'll try to make the questions a bit clearer and present a few insights that might be helpful.

About the author:

Tom Lindstrøm is Professor of Mathematics and Head of Education at the Department of Mathematics, University of Oslo. He has been involved in mathematics education on the high school and university levels for many years, and he has written textbooks in calculus and mathematical analysis. His research interests are mainly in stochastic processes and nonstandard analysis

Making the Right Choice

Jana Madjarova
Chalmers University of Technology, Gothenburg, Sweden

The first hesitant steps of a new student into the temple of wisdom we call university bear witness to a double choice being made, resulting in a union. The young person has chosen a programme which hopefully will lead to a degree and a successful career, and the university has chosen a student who, again hopefully, will study hard and graduate within a reasonable time. When both sides choose wisely, it may be called a union made in heaven. Unfortunately, this is not always the case. A wise choice is dependent on enough and trustworthy information from both sides. The student's choice is based on presentations of the university programmes, and the choice of the university is based on the applicant's marks or on some kind of test results. There is however a variety of problems bringing a degree of uncertainty into the picture – the virtual impossibility to explain the contents and the level of an educational programme to a person who has not been exposed to it, and the virtual impossibility to find absolutely trustworthy criteria for admission, to name but two.

In this talk we focus mainly on the latter of the two mentioned problems. We discuss why upper secondary school marks may not be the best criterion for admission, and what other methods of choice we have tried. More specifically, we shall discuss our experience of the admission test in mathematics and physics, which exists since 2007, and which is used for several programmes at Chalmers and at the Royal Institute of Technology.

We shall also discuss a related topic which has figured rather frequently in media lately, namely the weaker backgrounds of the new students compared to earlier. Is it a myth? Is it a typical case of "things were a lot better when we were that age"? Is it true that we ask the wrong questions? And if so, what are the right questions to ask? Can we formulate what a student should know in order to be successful? Chalmers has a long history (more than 40 years) of submitting students to a diagnostic test at the very beginning of their studies. We discuss the outcome and give some statistics. The last topic also touches a hobbyhorse of most universities, namely the wish to gain influence over upper secondary school education.

About the author:
Jana Madjarova is professor of mathematics at the Department of Mathematical Sciences, Chalmers and University of Gothenburg. She is president of the Swedish Mathematical Competition for upper secondary school students, and programme director of the educational programme Engineering Physics at Chalmers University of Technology. She holds a PhD in partial differential equations. Her interests are mainly mathematics education and mathematical competitions.

Competency based curricula in mathematics

Mogens Niss
Department of Science and Environment, Roskilde University, Denmark

This talk will begin by presenting the notion and rationale of mathematical competence and mathematical competencies as put forward in the Danish KOM project (KOM is an acronym that stands for "Competencies and the learning of mathematics). The main foci of the talk will be how competency based mathematics curricula can / should be formulated, how teaching / learning environments and arrangements can be established so as to foster and further students' development of mathematical competencies, and what appropriate modes and instruments of assessment of mathematical competencies may look like in different contexts and settings. Finally, issues and challenges to the implementation of competency based approaches to teaching and learning of mathematics will be discussed.

About the author:
Mogens Niss is Professor of mathematics and mathematics education at the Department of Science and Environment, Roskilde University, Denmark. His main field of research is mathematics education, where he has published around 150 papers in scholarly journals and books, as well as having written or edited thirteen books. His research interests are focused on the justification problem in mathematics education, on applications and modelling in the teaching and learning of mathematics, on assessment, on the nature of mathematics education research as a scientific discipline, and on mathematical competencies in mathematics education.

Mathematics for carousels and roller coasters: Challenging project work for engineering students

Ann-Marie Pendrill
National resource centre for physics education, Lund university, Sweden

An amusement park is full of examples, that can be made into challenging problems for students, combining mathematical modelling with measurement in the rides. For many years, the new students in the engineering physics program at Chalmers have visited the Liseberg amusement park, with group assignments, to be presented in written reports, as well as in oral presentations to student groups who have worked on other rides. The students have experienced the weightlessness in free fall and the large forces in roller coasters loops. They have observed the Coriolis Effect using a little pendulum in slow carousels. They have also solved relatively straight-forward problems, such as working out and measuring periods in pendulum rides and train speeds in roller coasters. In addition they have investigated more complex questions such as: Does it matter what seat you chose in a roller coaster – and if so, how much? Can any speed difference between different trains be detected? How much mechanical energy is lost during the ride? What temperature do the brake fins reach after stopping the train? The authenticity of the tasks in enjoyable situations often lead to inspiring and enlightening discussions.

About the author:
Ann-Marie Pendrill has a background in computational atomic physics. Since 2009 she is the director of the Swedish National Resource Centre for Physics Education, located at Lund university, where she is now professor in Science communication and physics education. She has used amusement park examples in her teaching for more than 20 years and arranged several large-scale math and physics days at Liseberg.
Read more at tivoli.fysik.org/english

PAPER PRESENTATIONS

Turning a standard statics task into a mathematical modelling opportunity: The case of the „tumbler task“

Burkhard Alpers
Hochschule Aalen, Germany

In the SEFI Mathematics Working Group's Curriculum Document (Alpers et al. 2013) the mathematical modelling competency is listed as one of eight competencies making up the overall mathematical competence. One might assume that this competency is mainly acquired in application subjects like statics where mathematical concepts are used to create models and to solve problems of application interest in such models. Yet, the investigation in (Alpers 2015) has shown that only a few steps of the mathematical modelling cycle described in (Blum & Leiß 2007) are really addressed in statics tasks presented in two widespread textbooks. A typical task in (Hauger et al. 2012) is the "tumbler task" where the tumbler is already idealized as an object consisting of a hemisphere and a cone on top and the question of whether it will work is also already clearly stated by asking when the center of gravity is below the separating plane. In this contribution this task is used as an example for showing how a standard statics task can be reformulated as a project task that offers many learning opportunities regarding the different steps in the modelling cycle. One particular reformulation was given to a group of students as a mathematical project. They had to create a design environment in Maple (R) where the user can specify the cross section of the upper part and the worksheet gives information on the suitability. For some examples, the design had to be exported to a CAD programme in order to create a body which then should be produced using a turning lathe such that the design could be validated. We will report on the results.

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Blum, W., Leiß, D. (2007). How do students and teachers deal with modelling problems? In: Haines, C. et al. (Eds.): Mathematical Modelling, ICTMA 12, Horwood Publishing, Chichester, 222-231

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Using Maple as a tool when studying calculus

Gerd Brandell
Centre for Mathematical Sciences, Lund University, Sweden

A traditional calculus course was reformed in 2003 by integrating the use of Maple. The course is compulsory for all engineering students in the university and the reform was carried out in one of the programs, Environmental Engineering, with 50-60 students every year. The course is given during the second year and its content is calculus for functions of several variables. The use of the mathematical software is not for special laboratory sessions but as an every-day tool throughout the whole course. All students have access to Maple on a personal laptop. Students bring their laptops during lectures, lessons and while studying out of class.

Maple is used for interactive visualisation and easy computations. Visualisations and interactive views are invaluable, considering how difficult it is to sketch such objects as graphs of functions of two variables or direction fields with paper and pencil and how crucial the geometric aspects are. Solving exercises often lead to time-consuming computations involving differentiation and integration. Students who are not fluent with managing algebraic simplifications or finding derivatives and primitive functions will spend a lot of time doing these exercises, without necessarily advancing their knowledge or understanding in calculus.

The use of Maple is autonomous in the sense that it is up to the student in what situations and to what extent he/she will use Maple. Hence, a student may accommodate the integration of Maple into the course to his or her personal learning goals. These may include more or less of computer skills. However during the first week of the course a brief introduction to Maple is presented and all students are required to practice some basic Maple. Successively relevant - but relatively few - Maple commands are introduced. Maple is allowed as a tool during the written examination.

The object of the Maple integration is not just to facilitate the students' learning of mathematics but also to let them experience a professional mathematical software of a kind that most of them will encounter during their continued studies and future careers. One important goal is to illustrate the limitations of the mathematical software.

The course has been well received and attendance has been high. The results of the course will be presented and possible challenges will be discussed.

Embedding mathematics content within the electronics courses for engineering students

Morten Brekke
MatRIC University of Agder, Norway

The aim of this report is to show students' working methods and performance following the introduction of new teaching approaches and integrating mathematics within the programme for engineering students in electronics. In 2014 we started a project to strengthen students' achievement of learning outcomes of the bachelor programme in electronics through integration of mathematics within the study's technical subjects. The intention is that this will contribute to a better learning process and increased understanding of mathematics.

Previous mathematics was taught in one course for all engineering fields. In this way mathematics was taught in general with few examples from each field. Topics taught in the first semester may not be relevant at all or will not appear until maybe the fourth or fifth semester. This can demotivate students since they struggle to see the relevance of the mathematics they study.

The first cohort of this new programme started in the autumn of 2015. The new programme differs from the previous with the following significant changes for the mathematics component:

- Mathematics 1 runs over two semesters (previously only the first).
- Mathematics 2 is taught in the third semester (previously in the second).
- New textbook with many examples taken from electronics.
- No lectures, students watch prerecorded videos, and meet the teacher 4 hours weekly for seminars.
- Grading through digital assessment throughout the courses and digital exams.
- Six digital tests set throughout the course, midterm exam and final exam contribute to the grade (used to be final written exam).

The results so far show that students enjoy this way of teaching. By having seminars instead of ordinary lectures the teacher talks *with* the students and not only to them. There is time for discussion and it is believed there now is more opportunity for understanding of mathematics. They are allowed to take each test on two occasions. They get the same type of problems on their second try but with different values. This is done deliberately to make them work with their errors. The way students work together and help each other to understand their errors after each test really helps them improve their scores. At the midterm evaluation students provide lots of positive feedback. For the first time in many years of experience as a teacher, students say that the mathematics course is relevant to them. And the result of the midterm exam shows grades far better than previous years.

A project based learning approach to teaching Second order differential equations to Engineers

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In an attempt to increase the engagement in third year mechanical engineering class a short group work session (6 hrs) was introduced.

Students were asked to use the solution of a second order differential equation introduced in lectures (https://sites.google.com/site/ditmech3/applications-of-differential-equations) to solve one of the following problems.

Design of a simple spring- damper system for one of the following

1. Lorry
2. Digger
3. Truck
4. Tractor
5. Car (large, small)
6. Motorbike (scrambler, moped, road bike)
7. Pogo stick

This project is worth 10% of the module and is done in groups of 4. The groups then give an oral presentation of their results and a written report (4-10 pages) is handed up.

A qualitative analysis of the students subsequent performance in the exam question is presented. In addition a qualitative survey of the students, together with focus groups was carried out. Results of this are presented and we discuss how the process can be improved

On Transition from High School to University

Marie Demlova
Czech Technical University in Prague, Czech Republic

During the last decades teachers at universities of technology often complain that the level of knowledge and skills that new students have when entering HE institution decreased considerably. Moreover, even though the percentage of students entering HE institutions has increased (in the Czech Republic to nearly three quarters) the number of students entering HE institutions in STEM remains the same or is smaller than 10 years ago. As a consequence, the success rate is decreasing for freshmen to successfully finish first year of study. On the other hand, the need of employees for STEM jobs is steadily increasing.

The contribution brings experience gained at CTU to overcome the problem of decreasing success rate of freshmen.

Improved engagement and learning in flipped classroom calculus

Lars Filipsson, Mikael Cronhjort, Maria Weurlander
KTH Royal Institute of Technology, Sweden

We have been experimenting with interactive teaching in Calculus since 2012 at KTH Royal Institute of Technology in Stockholm, Sweden. We report on an effort to measure the effect of replacing traditional lecture-based teaching in a Calculus course with a flipped classroom model, involving preparatory videos with online quizzes and interactive teaching sessions.

In order to compare the two teaching formats we designed a Calculus Baseline Test, a concept inventory for calculus, that was given as pretest and posttest to the students in a flipped classroom group as well as to the students in a lecture-based version of the same course. We also used a questionnaire measuring student engagement, and analyzed student achievement on the final exam.

On the Calculus Baseline Test we calculated the normalized gain for the two groups, flipped vs lecture, in the standard way by taking the posttest score minus the pretest score divided by the maximum possible gain. We found that the normalized gain was 15% higher in the flipped classroom group.

Our engagement questionnaire showed a similar difference between the two groups: the students in the flipped classroom group scored on average 10% higher on the engagement questionnaire.

Analyzing the final exam, we compared the results on the final exam with the results on the final exam previous year for the relevant student study programs. In the previous year the teaching in the course was lecture-based for all of these study programs. We found that the students of the flipped classroom group performed way better than expected, with a substantial decrease in failure rate. In some study programs the failure rate dropped by more than 50%.

Can artificial intelligence help engineering students develop their intelligence?

Larissa Fradkin
Sound Mathematics Ltd, United Kingdom

The word intelligence is widely used and has many meanings. In the educational context one talks of multiple intelligencies, including crystallized and fluid, the crystallized intelligence relying on the so-called declarative memory and the fluid intelligence, on procedural memory. The current approaches to engineering education are trying to shift from developing declarative memory to procedural and thus from developing their crystallized intelligence to development of fluid intelligence. We discuss these concepts in the context of mathematical education of engineers and give examples from our educational practice. We put a particular emphasis on the role of on-line resources and various interactive apps in developing students' intelligence. We discuss further why in our view, this task is important.

Innovation in mathematics education - a synthesis of the debate

Olle Hellblom, Dag Wedelin, Tom Adawi
Chalmers University of Technolog, Sweden

Mathematics is one of three core subjects in Swedish schools and we put a lot of time and effort in teaching all children mathematics. However, many pupils and adults do not understand the purpose of this education and why we all need it. Issues regarding mathematics education are debated on all levels of society, in national politics as well as in local newspapers, and most people seem to have an opinion about what the problem is or what we should do about it. With this background we have researched the question "How do we want to organize mathematics education?" with focus on Swedish upper secondary education. However, we believe that the results are relevant also at the university level.

This paper argues that the debate consists of several different questions that are discussed simultaneously. To better understand what the issues are we have categorized the critique of mathematics education into three main questions: "Why should we study mathematics?", "What should students learn?" and "How should we teach mathematics?" The study is based on interviews and a review of the mathematics education research literature. The interviews present four different professional perspectives on mathematics, problem-solving and creativity, and the review serves as a base for the categorization of both *critique* of the current state of mathematics education as well as *proposals* of what should be done to fix the problems.

The paper presents three common propositions of how to change mathematics education to increase pupils' motivation and knowledge: *a problem-solving approach*, *a modelling approach* and *a redefinition of school mathematics*, and describes how these answer the questions of *why*, *what* and *how* we should teach and learn. A conceptual framework was developed to compare the three different propositions to each other and to the traditional way of teaching, to show the similarities and differences between the different approaches.

The paper concludes that there is no total consensus regarding how we should fix the problems with mathematics education. However, there is also significant agreement on some points, in particular that mathematics education should be an investigative and creative subject where students get to explore, rather than just read and practice what mathematicians have discovered before them.

Using electronic exams to provide engineering mathematics students with rapid feedback

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With increased sophistication and capabilities of e-Assessment systems it would seem that online examinations will become standard practice, particularly for numerate subjects, in the near future. We have gained valuable experience in this area through running online mathematics examinations for over 300 engineering students in January 2015 and January 2016. We used the DEWIS e-Assessment system to run the online examinations.

DEWIS is a fully algorithmic open-source e-Assessment system which was designed and developed at the University of the West of England (UWE). It is a completely stand-alone web based system used for both summative and formative assessments. It was primarily designed for numerate e-assessments and is currently used in the fields of Business, Computer Science, Nursing, Engineering, Mathematics and Statistics. This algorithmic approach enables the separate solution, marking and feedback algorithms to respond dynamically to a student's input and as such can perform intelligent marking. In addition, the DEWIS system is data-lossless, that is, all data relating to every assessment attempt is recorded on the server. This enables the academic to efficiently track how a student or cohort of students has performed on a particular e-Assessment.

One of the major advantages to running exams in this way, as opposed to running a traditional paper-based exercise, is that students are able to receive rapid feedback on their work, because their submissions are marked immediately. It also enables academics to quickly identify those students that are at risk on the module, enabling them to specifically target such students early on in the year, at a point where interventions are likely to yield positive results.

Running the exam in this way for the first time in January 2015, students were initially fearful that this method of assessment would produce lower grades. Comparison of marks between the January on-line exam and the traditional written summer exam show good correlation. Additionally we note that the overall module marks were better for 2014-15 than in the previous year, which we attributed in part to the controlled assessment mid-year. It appears that the on-line exam format is a good indicator of student progress.

The Development and Evaluation of On-Line Mathematical Resources for the Teaching and Learning of Calculus, and their Relation to Students' Learning Preferences

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Development of proficiency in mathematics is an essential aspect of many higher education programmes of study. This applies both to specialist mathematics students, and students of many other disciplines, including engineering, most natural sciences and some social/human sciences, business and commercial subjects. Students' knowledge of and expertise in mathematics (or lack thereof), at least at an elementary level, can have a major impact on many other areas of their studies and their subsequent career prospects. However, mathematics is an area which many students find difficult, particularly those from "non-traditional" academic backgrounds, including disabled and mature students, and they often do not realise its relevance and importance to their other courses, nor do they (or can they) devote as much time or effort as they perhaps ideally should, and face to face tutorial support is often limited. Although there have been previous attempts to develop on-line tutorial exercises, with automated marking and feedback, to assist students with their mathematical studies, most of these have either been restricted to multiple choice or numerical answer questions, or have only addressed the most elementary of topics – notably simple algebra, functions & graphs and trigonometry.

In this paper, we describe our efforts to remedy this situation. We have produced a set of resources, called *CalculEng*, including a variety of exercises, on single variable differential and integral calculus, with applications, which can be delivered on-line or using a Virtual Learning Environment such as *Blackboard* or *Moodle*. These exercises, in the form of structured questions developed using the *QTI* framework, allow algebraic input from the student, which is checked for consistency with the "correct" solution, and with the outcomes of anticipated "common errors", using the *MAXIMA* computer algebra engine. The students' responses are automatically marked, with the aid of the Computer Algebra System, and intelligent, relevant feedback - based on the mistakes made by the student - provided. We discuss the design and implementation of resources we have produced, their relevance to various degree curricula, and their evaluation when used on a number of first year mathematical modules within undergraduate engineering degrees. We also describe the reflections and opinions of the students participating in the evaluation, both with respect to their experiences of using *CalculEng*, and regarding their attitudes and preferences towards studying mathematical topics. Analysis of these comments and feedback should facilitate improving *CalculEng* to make it better-suited to students needs and study styles.

Evaluating a course in mathematical modelling and problem solving from students' perspective

Tabassum Farzana Jahan, Dag Wedelin, Tom Adawi, Sven Andersson
Chalmers University of Technology, Sweden

Mathematical modelling and problem-solving skills are important for engineers in their daily work. It is therefore essential that engineering curricula provide students with opportunities to develop these skills needed to deal with complex real-world problems (Alpers et al., 2013; Litzinger et al., 2011). But how do we design courses that help engineering students to develop these key skills? In this case study, using a mixed-method approach (Creswell, 2013), we evaluate the design of a course in mathematical modelling and problem solving, offered to second-year engineering students at Chalmers University of Technology. The dominant pedagogy underpinning the course is inquiry-based learning (Prince & Felder, 2006) and the course is based on a collection of about 30 small but reasonably realistic problems that the students solve in pairs. Scaffolding is provided through lectures and supervision sessions (Wedelin & Adawi, 2014).

Data was collected through reflective reports submitted by 204 students after completing the course. In these reports, they were asked to describe what they had learned in the course and how the different aspects of the learning environment contributed to these learning outcomes. The data was first analysed using a general inductive approach (Thomas, 2006), which led to the identification of a number of categories representing the most significant aspects of the learning environment, the main learning outcomes, and their relation. In the second stage, a quantitative analysis was conducted to explore the frequency of statements belonging to different categories and as a means to develop a graphical visualisation of how students perceived teaching and learning in the course.

The results indicate that the course has significantly developed the students' mathematical modelling and problem-solving skills, metacognitive skills (Flavell, 1979), technical and subject knowledge and has helped them to become more independent problem solvers. The aspects of the learning environment that contributed to these learning outcomes are, in particular, the *authentic* problems, the *Socratic* supervision and the act of *making thinking visible* during the lectures. The aspects of the learning environment that the students emphasized will be discussed in the light of a set of instructional design principles based on situated learning theory (Herrington & Oliver, 2000).

We believe that these findings offer useful pointers for engineering educators wishing to develop their students' mathematical modelling and problem-solving skills and prepare them for real-life engineering problems.

Adaptive teaching of mathematics for engineering students

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One of the common misconceptions in teaching of mathematics is that since the fundamentals of mathematics basically do not change (and when they do, it is not usually at the level taught to undergraduate engineering students), there is no need to change the current mathematical courses that work reasonably well. We claim the opposite - that the approach to teaching mathematics should be very adaptive for several reasons

One reason is that the cohorts of incoming students vary – both in attitude to mathematics, e.g. apprehension, fear, etc. and in their mathematical background. Also the fields they are preparing for are constantly changing (especially so in Computer Science). It is our task to help them learn those topics and adequate level of detail that they will need for their future study and professional work.

Therefore, we have put the emphasis on teaching mathematical thinking, identification and formulation of questions and on problem solving strategies, not just exact mathematical theories, facts and formulas. At the same time we try to instill the notion that mathematics is one of the most helpful tools they will use in the future and not a necessary hindrance. The learning should be based on the students’ previous life-experience and directly relevant to their primary field of study instead of being a disconnected theoretical area. We should also adaptively use technology already familiar to the students that will support our teaching of mathematics instead of becoming another topic to learn.

In this work, we discuss these principles, provide the theoretical background (learning phases and theory of generic models) and illustrate them on examples taken from an undergraduate course Mathematics for Computer Science.

Explorative Computer-Assisted Learning of Partial Differential Equations in a Mixed Group of Students from Mathematics and Engineering – Examples of Classroom Practices

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Beuth Hochschule für Technik Berlin Fachbereich II Mathematik-Physik-Chemie, Germany

The framework is the Master of Science (MSc) scheme in “Mathematics – Computational Engineering” for “Virtual Product Development”. This course typically comprises 20 students; one half of them hold a BSc degree in Mathematics the other half a BEng degree in Engineering Sciences. One module in this course is “Modelling with partial differential equations using Computeralgebra Software Systems”. The required mathematical competencies as well as the required competencies in the application field of engineers have to be taken into account. The students will discover by themselves essential, relevant aspects of partial differential equations in an explorative manner by guided virtual experiments they have to perform with the Mathematica software system®. Examples of teaching practices are presented. It will be reported on the implementation within the curriculum at Beuth University of Applied Sciences Berlin, the classroom experiments and the teacher’s role.

A Blended Learning Scenario for Mathematical Preparation Courses – Video Based Learning and Matching In-Class Lectures

Karin Landenfeld[1], Martin Göbbels[1], Antonia Hintze[1], Jonas Priebe[1], Ann Sophie Stuhlmann[2]
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At many institutions, it is now common to offer preparation courses in mathematics for students in STEM fields in order to close the gap between school and university. Within the project viaMINT, located at the Hamburg University of Applied Sciences, such courses are developed based on a blended learning concept: firstly, the students work autonomously on various topics of school mathematics in an online learning environment. Then these issues are deepened in subsequent in-class lectures which are precisely designed to match the online modules.

In the online learning environment viaMINT (https://viamint.haw-hamburg.de/) students initially go through an online test generating recommendations which modules (topics) they should concentrate on. Recommended modules are placed on their personal online desk providing comprehensive information about their individual learning progress and supporting the students to work self-directedly. The online modules are video based and focus on varied tasks to practice and help consolidate the issues taught. In this way the competency to deal with symbolic, formal and technical elements of mathematics is fostered.

It is difficult, however, to address and promote other mathematical competencies such as problem solving, modelling, communicating and reasoning within pure online courses, as well as the use of mathematical representations and social skills. Moreover, students regard in-class lectures as an important part of preparation courses and benefit from the possibilities to socialize. Due to this, in-class lectures are a further component of the blended learning course. They are based on Inverted Classroom Model concepts and focus on practising, deepening and consolidating the content presented online by means of application and modelling tasks. Teaching methods and formats such as group work, peer instruction and other activating methods are applied to train not only the mentioned mathematical, but also social and linguistic competencies.

The first in-class lectures offered in this blended learning scenario were deployed in September 2015. In a first evaluation, the concept has been approved of by the students. In spring 2016 the courses are expanded and further evaluations are planned.

In this paper the concept of the in-class lectures as well as results of evaluations, experiences and impressions will be presented.

A calculus course in knowledge feedback format

Håkan Lennerstad
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This presentation describes a format of a calculus course (taking place 2015) with the main intention of interchanging two different elements during the course. The first is examination in small format, and the second is an examination-free opposite: maximal openness towards student's mathematical problems in the spirit of ”It's better to do the errors now than at examinations”. Also, students got used to verbal presentations during lectures since they did this every week. The gothenburgian method of pre- and postlectures was applied. In this method, new concepts are merely illustrated in the prelecture. Proofs are given mainly in the postlecture, which occurs after the students have some calculation experience of the new concepts.

Each week had a one page plan including main themes, goals,” 6 teacher's problems” and ”6 student's problems”. In the end of the Tuesday's prelecture the 6 teacher's problems were calculated. The first thing in the Friday lecture, students were expected to solve the 6 student's problems, which was followed by a postlecture. All 42 student's problems were actually solved by students during the course. Being explicitly non-examination encourages a more genuine mathematical dialogue. Teacher's learning of students' mathematical difficulties allows fine-tuning of lecture's level. The Fridays were complemented by true-false-quizzes every week that pre-covers theory, i.e. basic intentions and properties of new mathematical concepts. Students must complete each quiz online before each student lecture.

The curriculum of the course was Taylor series, integration, and linear and separable differential equations. Central to the course result is the way in which the teacher comments the students activities and makes it useful for listening students. There are many requirements for this teacher-to-student feedback:

1. To put mathematical problems and issues at the center of attention.
2. To encourage student activity the following weeks.
3. To make obvious common students mistakes in order to avoid them.
4. To encourage reflection about calculations, and thus a deeper understanding of mathematics.
5. To make the connection theory-calculation obvious.

The experience was that feedback almost always can be done both mathematically accurately, relevantly, encouraging, and so it is useful time for listening students.

Results
The students supported the organization of the course strongly. 98% of students participated in the final written exam, and 52% of them passed, which is a higher share than usual for this course. The exam was probably slightly more difficult than usual.

UniDoodle: A Multi-Platform Smart Device Student Response System – Evaluated in an Engineering Mathematics Classroom

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The use of student response systems, such as Clickers, is slowly becoming more commonplace in the classroom today. The research literature clearly documents how such systems offer many pedagogical benefits ranging from improved student learning to better classroom interaction. However, to date, these systems only allow for limited input capabilities, whereby students can only input a numerical, and in some instances, a textual response. Hence, mathematical equations, circuit diagrams, sinusoidal responses, cross-sectional diagrams, etc. are all beyond the capabilities of existing SRSs.

This lack of freeform input is a significant drawback for the Science, Technology, Engineering and Mathematics (STEM) disciplines where equations, circuits and diagrams are important aspects of the student learning experience. For example, consider the solving of an algebraic equation, the designing of a circuit, the sketching of a mathematical function, presenting the forces of a moving object on a free body diagram, the minimisation of a Boolean function using Karnaugh Maps, sketching the root locus of a control system, etc. The list of such examples is endless and it is very important that students of STEM disciplines, in particular, can carry out such fundamental processes and methodology. In order to capture the real-time feedback of the students' grasp of this information it is necessary for a SRS to facilitate freeform input.

Here, we propose and present a novel multi-platform smart device-based student response system, called UniDoodle, that allows for a more generic and flexible input. This system consists of a student application that allows for freeform input, through sketching capabilities, a lecturer application that allows easy viewing of multiple sketch-based responses and a cloud-based service for co-ordinating between these two applications. In essence, students can now respond to a question posed by the lecturer using sketches and, hence, mathematical equations, circuit diagrams, graphs, etc. are all possible on the UniDoodle system. In addition, the lecturer can now gain a richer and more useful insight to the students' understanding of the relevant material. This new system currently operates on any device that has an ios (ipads, iphones) or Android (smart phones and tablets) operating system.

Finally, we evaluate the UniDoodle system on a first year Engineering Mathematics module. Details of the UniDoodle system, the evaluation process and the feedback obtained will be presented in the final paper.

Computer-aided assessment (CAA): An effective way of teaching, assessing and supporting engineering students at Brunel University

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The ongoing gap between secondary and university level mathematics continues to be a major concern to higher education institutions. The increase in diversity of students' backgrounds in mathematics, from students who have studied the more traditional A-level programmes to students with BTEC (the Business and Technology Education Council qualifications) or international qualifications as well as part-time students who have been out of education for long periods, is a growing issue at Brunel University. Many of these students are admitted by the College of Engineering, Design and Physical Sciences and are looking for support with maths and mechanics.

The CAA package Maths e. g. (formerly "Mathletics") which is being developed by Martin Greenhow has been used for teaching and assessing Brunel students for many years now. Computer tests (diagnostic or assessment) based on the Maths e.g. question database are embedded into several engineering courses. Students also have access to the Maths e.g. either via computers on campus or via the national Maths Centre website which allows them to use this program as a learning resource.

The Maths e.g. package is also widely used by the Brunel maths and numeracy support team (ASK service). The ASK service also offers help and support in practical work with Maths e.g.

This practice definitely helps students to prepare for exams, build their confidence, become independent learners and to improve their exam performance, as a result to improving the transition, progression and retention of engineering students. The students who have used CAA are more likely to successively complete their course.Details of the content of support via CAA along with student feedback will be presented with scope for some critical discussion around some of the issues which arise.

Another positive is that some students are able to take part in the development of new CAA maths and mechanics questions via SIGMA-funded internships. Two projects funded by SIGMA (one over last summer and the second over the current academic year) allowed to increase the number of questions and gave a chance for the interns to bring fresh ideas and develop significant programming and pedagogical skills. Some details of this Student Internship Programme will also be reported.

Models of re-engaging adult learners with mathematics

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So called ‘Maths anxiety’ can be a key inhibitor for some adult learners considering higher education. The Institute of Technology Tallaght Dublin (ITTD) hosts a mathematics education research group, designated as the ‘Centre of Expertise for Adult Numeracy/Mathematics Education’, which is a hub of EPISTEM (formerly known as the *National Centre for Excellence in Mathematics and Science Teaching and Learning* (NCE-MSTL)). Members of this group have identified the key issues that informed the design of enabling-mathematics courses for adults returning to higher education; how to structure this process of re-engagement, and how to adapt the re-engagement process to practical time constraints.

This paper outlines how insights from the successful *Primer Mathematics* module for mature students intending taking the FLASHE (FLexible AccesS to Higher Education) Higher Certificate in Electronic Engineering at ITTD were used to identify the key elements of a model that should shape such courses. For example, the imperative in bringing prospective students back into contact with mathematics in a way that boosts their confidence in their mathematical ability, rather than placing an emphasis on addressing all deficits in pre-entry mathematics learning, emerged as one key element for such modules.

How these key elements were used to design and implement a different pair of complementary modules in preparatory mathematics for students entering all modules in ITTD, as part of *Certificate in Preparatory Study for Third Level*, is explained. The positive impact of these new modules on student learning as evidenced by the evaluative student feedback is examined. More critically, the strong, positive correlation between favourable progression rates and those who completed the module, compared with those who did not, is discussed.

Case study: Acquisition of Mathematical Industrial Engineering competences during the first year

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The Department of Applied Mathematics from the University of Salamanca is the responsible of teaching mathematics to almost all the engineering students at this university. One of the topics that our students have in common is the differential equations: Ordinary Differential Equations and Partial Differential Equations. Our main goal is to integrate the mathematical competences with the competences required for getting an Engineering Bachelor Degree.

The Engineering Degrees of the Industrial Engineering branches are special cases as they are regulated by the Order CIN/351/2009, of February 9, 2009. This order established by the Ministry of Science and Innovation from the Spanish government enumerate the competences that should be acquired by the undergraduate students.

From the first course students at the School of Industrial engineering should work in these two competences: (a) Knowledge of basic and technological matters that will enable them to learn new methods and theories, and equip them with versatility to adapt to new situations, and (b) The ability to solve problems with initiative, decision making, creativity, and critical thinking, and also to communicate and transfer knowledge, skills and abilities in the field of Industrial Engineering.

The publication of the results of the Danish KOM project in 2011, and the Framework for Mathematics Curricula in Engineering Education by the SEFI's Mathematics Working Group in 2013 allow us the integration of the mathematical competences inside the undergraduate degrees' curriculum.

We have proposed our students from the undergraduate degrees in Electricity, Electronic and Mechanical Engineering the elaboration of a cooperative and collaborative team work where they will acquire the competences adapted to engineering context: (1) thinking mathematically; (2) posing and solving mathematical problems; 3) modeling mathematically; 4) reasoning mathematically; 5) representing mathematical entities; 6) handling mathematical symbols and formalism; 7) communicating in, with, and about mathematics; and 8) making use of aids and tools.

The proposed work should include, apart from an introduction, a summary and the references, an application to engineering, or a problem solution with a CAS, or the history of the mathematical formulation. We have analyzed the results in two ways: the students' assessment using a rubric-survey where each student has to assess the rest of their classmates (the public exposition, the originality, the actuality, the use of technological tools, the relation to engineering subjects, etc), and a general overview of the 12 groups paying attention to the acquisition of competences.

Lesson Moodle for a self-directed learning of mathematics

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Moodle (Modular Object-Oriented Dynamic Learning Environment) is a course management system to promote interactive and collaborative learning activities. In Coimbra Institute of Engineering, the project e-MAIO (Interactive Online Learning Modules) collects and describes a set of interactive tools for teaching, and learning, mathematics to engineering students through a technology-enhanced environment on the Moodle platform.

This paper aims to present the activity Lesson, available in e-MAIO, one of the most complex and interesting activities in Moodle. This activity enables the formation of theoretical thinking, based on reflection, analysis and planning which leads to mental and intellectual development of students. The students get a self-directed learning, taking the initiative and responsibility for their learning. Therefore, they can guide and evaluate their own learning activities, which can be realized anytime and anywhere.

The Lesson is a set of pages with information and leading questions, with the main objective of teach and test students' knowledge. The lesson can contain a set of alternative paths, providing different content, depending on the student's answers. This feature allows to create adaptative content, being especially useful in contexts of heterogeneity of the prior knowledge or the past students' learning process.

In this Lesson, student learning is self-directed and can be repeated several times to strengthen the knowledge and the understanding of the student. Can be performed anywhere, anytime and can contains materials of any discipline, so it is very flexible. The Lesson is an excellent activity to present the material to students in a structured and interactive way so it can be used as an open educational resource to all students with audio, video, animations, text, questions and images.

In order to reflect and analyse the skills acquired by students when using the Lesson activity and to define strategies for their development, a small pilot study was conducted. Initially it was made a first test about the subject of the Lesson before the students are involved in the learning process. At the end, the students make the same test to be able to assess the knowledge and skills obtained during the Lesson. Furthermore, an inquiry and an interview were made to collect some conclusions and suggestions in order to improve the development of such activities.

Future mathematics – using technologies to improve mathematics teaching and learning in engineering studies

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Mathematical skills are a prerequisite in technical studies and mathematics lay the basis for understanding different engineering disciplines. Unfortunately, various studies have shown that mathematical competence in Europe has weakened in recent decades. The weakened mathematics skills, large and heterogeneous study groups and decreasing resources have been problems encountered especially in engineering studies during the past decades. Nowadays students expect more digital learning possibilities and utilizations of ubiquitous technologies and devices in mathematics' studies. This is a very natural drift as the whole of society is changing through the use of social media and new ICT (information and communication technologies). Big data, open data, cloud services, digitalization, IoT etc. affect society and social activities on a large scale. As working life is constantly changing, its expectations and requirements have become more diverse. The 21st century skills, such as collective thinking, collaboration, creativity and shared problem solving skills are key components in modern working life and therefore the university teaching and learning should also train these skills.The European Union has as its stated ambition the goal of 40 % of all young people having graduated from higher education by 2020. In the Agenda for the Modernisation of Higher Education, it was stated that to achieve this goal the focus will be on the quality of teaching and learning [1].

Three year project FutureMath, funded by the EU and started on September 2015, aims to develop methods to better exploit the ICT in engineering mathematics teaching and learning. Project's main focus is to improve innovative ways of learning and teaching of mathematics through digital contents and with the help of technologies. The project will combine best practices for meaningful utilization of e.g. ICT-tools, learning environments, social media and mathematical software in mathematics learning and teaching context. Furthermore, a theoretical research carried in the field of mathematics online pedagogy during the project is supposed to provide a collection of pedagogical approaches, best practices and useful resources for designing and implementing web-based teaching and learning of mathematics. A Mathematics Learning Platform (MLP) will be created in the project. MLP is a comprehensive framework for mathematics learning and teaching in web (versatile repository) and it will bring together technological innovations and best practices for mathematics learning.

One key output of the project is Mathematics Learning Resources (MLRs) such as e.g. short video lectures, podcasts, vodcasts, personalized learning materials, lecture materials, online learning materials, online assessment components, authentic learning modules, online resources for learning etc. [2] Thus the MLRs encapsulates a vast variety of ICT based learning and teaching resources.

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Do you really know what resources your students use to learn mathematics?

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During the last 30 years there have been numerous discussions and studies regarding the possibilities offered by the new technologies/digital resources for the teaching and learning of mathematics. Universities have started providing a wide range of resources, from virtual learning environments (VLEs), to recorded lectures and mathematics specific software such as computer algebra systems (CAS). In addition, there have been developments in providing support to students through tutorials, printed material especially designed for engineers and more recently support centres (e.g. the Mathematics Learning Support Centres, MLSC). Moreover, students themselves are now exposed to a greater variety of digital/online resources which can hypothetically be used (or not) in combination with the resources provided by their institutions for supporting their mathematics learning.

However, there is limited literature exploring the kind of resources that students *actually use* and *combine* when studying mathematics, with previous studies focusing mostly either on one resource and/or on university-led resources.

This paper presents findings from investigations into the resources used by second year engineering students at Loughborough University. Loughborough has one of the largest cohorts of engineering students (over 3000 undergraduates) in the UK and is a leader in the provision of Mathematics Support. Loughborough University has also led on significant projects producing high quality printed material (e.g. the HELM project) and so students had much choice in available resources.

We will present initial findings from a survey in which students were asked about their conceptions of mathematics; the resources they use when studying mathematics and; the goals they set for their mathematics modules. The survey was completed by over 200 students studying mathematics in the first Semester 2015-16. This is part of a larger study which aims to identify what kind of resources undergraduates use and how these resources support their learning of mathematics.

Computer aided assessment in mathematics courses for engineers

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Since 2013 the computer aided assessment system Maple T.A. has been used as the platform for the weekly problem sets in the first two calculus courses for students in the Master of Technology programmes at the Norwegian University of Science and Technology. Maple T.A. is based on the kernel of the CAS Maple and can evaluate answers given in numerical or algebraic form provided the Maple syntax is being followed.

The students are given one problem set in Maple T.A. each week, 12 sets per course, and to be accepted for the final exam at least 6 out of 12 sets have to be completed to satisfaction. By completing 10 or more problem sets to satisfaction a student gets 10 points credit, out of 100, for the final exam. This way of using the Maple T.A. tests makes them play an important role in the students' regular work with the mathematics courses. It is therefore to be expected that the students spend quite a lot of time working on the problems given in the Maple T.A. tests.

Introducing Maple T.A. as an artefact in the students' learning environment is expected to influence the way students work with mathematics. In this talk I will address the question, what implications can the use of Maple T.A. as an assessment system have on the students' ways of working with mathematics?

To answer the question I will draw on data that are collected from surveys conducted among all students on the technology programmes (around 1500). These surveys contain both quantitative and qualitative data. In addition we have data from focus groups interviews where students have been asked to give an account of how they work with the Maple T.A. problems.

Learning mathematics through classroom interaction

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We have used flipped classroom for three years running in our module on Discrete Mathematics for the undergraduate programme in computer engineering. Video lectures available online frees up classroom time for active learning. Over the three-year period we have experimented with different classroom activities, incl. both individual work, group work, and plenary discussions. The most effective learning activities turns out to be various forms of interaction, be it student-student or student-lecturer. Debating exercises and solutions is generally more rewarding than individual problem solving.

The success of flipped classroom depends very much on what replaces lectures in the classroom and how this is implemented. A naïve and straight-forward introduction of flipped classroom does not suffice, an observation which has also been made by Njål Foldnes (2015).

Even though mathematics is not usually seen as a `chatty' subject, there is a strong theoretical basis to increase all forms of social interaction also in mathematics education, from informal chatting to more formal discussion. Feedback is a well-known bottleneck when students work individually with exercises. Through dialogue, the participants can get prompt feedback both from peers and from participating tutors. The developmental psychologist Vygotsky's observation that children's problem solving is hampered when they are not allowed to speak may also be relevant. It is known that many students who struggle with mathematics simply do not posess the language to ask the right questions for help. Discussion may help to develop the necessary vocabulary and mathematical language.

In this paper we report on a detailed, quantitative survey conducted in the 2015 class, close to the end of term. We will give an overview of different learning activities that we have tested, and evaluate them both in terms of the student survey and their theoretical justification.

We note that the majority of students think flipped classroom works better than traditional methods. However, it is more interesting to see how each individual type of learning activity is perceived. Almost a fourth of the students felt that they learnt less in the flipped classroom, and their views are particularly useful. Most of the students, also among those who did not like flipped classroom, thought that they learn much from discussing problems in groups or in class. These results support the theoretical reasons for choosing these active learning strategies.

Is it feasible to replace teachers by e-learning in introductory mathematics?

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Background: At Technical University of Denmark (DTU) we run a big 20 ECTS points introductory course, Mathematics 1, which includes linear algebra, differential equations and multivariable calculus. This curriculum is worldwide regarded as fundamental service material and at DTU there is a strong belief that all B.Eng. should be familiar with it. Hence Mathematics 1 is mandatory for all 16 very different study programs from say “Bio-Technology” via “Software Engineering” to “Physics and Nano-Technology”. On the other hand we have to realize that our students initially have very different attitudes to mathematics as a subject and to how helpful mathematics is in their respective studies and future professions.

Current teaching innovations: Since the introduction of the first version of Mathematics 1 in 2000 the course has been in a state of ongoing innovation in order to motivate and encourage the students. The following elements have gradually been implemented:

1. Very experienced TAs, i.e. teachers from surrounding high schools, to support the group work and to remedy well known transition issues.
2. Thematic exercises: One day group exercises exposing a math subject which just has been taught. To give a “first smell of application”.
3. A big four week project-based group exercise in the end of the course to demonstrate the usefulness and joy of mathematics in applications relevant for the different study programs.
4. Full integration of a professional CAS (Maple). The program is used in the daily training and it is an indispensable and vital devise in thematic exercises and projects.
5. The course is based on a learning management system which provides a wide range of e-learning objects including video samples, easy-to-search theory eNotes, video recorded lectures, online exercises with clickable links and hints etc. The system is built up from scratch to fit our special requirements and renew our local teaching traditions**.**

New challenges: So far money has not been a main issue in the ICT-based innovations. But now, due to general cost reductions in the education system imposed by the national government, the course is facing heavy budget cuts with effect already from the academic year: Autumn 2016/Spring 2017. Accordingly, the course responsibles have received a hard assignment: To save costs without cuts in the curriculum and without compromising the teaching quality.

The proposed paper: The paper will present a full course redesign program aimed at saving costs while keeping the teaching quality. The starting point will be an analysis of the mutual balances in the present setup between the above-mentioned course elements, the competencies they represent, the e-learning objects and the teacher involvement. On this basis the paper will try to answer the following questions: Which competencies need direct teacher involvement. And similar, in which course elements is it feasible to replace direct teacher involvement by digital assessment? Finally, is it feasible to run sufficiently advanced digital assessments on a “home-made” e-learning platform originally designed to renew local teaching traditions?

Competent without competencies? Change of mathematics education at secondary school – the influence on the university entrance level.

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For a long time we reported decreasing mathematical abilities of university freshmen. This is documented amongst others by a long term study at Beuth University over 20 years. The latest results in 2015 are dramatic. Written exams show frequently terrible elementary mistakes we rarely have seen before. At the SEFI Conference at Dublin 2014 we presented examples of these mistakes together with the statistics of its occurrence. Looking for the reasons of these mistakes we considered the role and the side effects of technology in mathematics teaching.

There are still other reasons. In Germany the PISA shock initiated a change of objectives of mathematics education at school. Hence the so-called competence orientated teaching has been implemented. Considering the consequence we analyze the type of mathematical problems of final secondary-school examinations, and demonstrate that it is possible to pass the exam without mathematics.

We can observe the consequences of the mathematics education at school in freshmen at university. As expected, we find a lack in basic skills and a lack in applying rules. In addition we realize that the students changed their approach of problem solving by avoiding formal mathematics, using instead intuitive and creative ad-hoc solutions. This may be sufficient with simple problems but is not transferable to more complex problems. We observe that there is a lack of a systematic approach. We confirm these statements by examples from written exams we got from engineering colleagues.

Mathematics lecturers' views on mathematical modelling: a quest for understanding the gap between research and practice

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This study investigates the views and use of mathematical modelling (MM) in mathematics undergraduate courses in England and Norway from the perspective of lecturers. This includes a characterisation of MM views based on the modelling perspectives developed by Kaiser and Sriraman (2006). Through an online survey we aim to identify the main perspectives held in higher education by mathematics lecturers and the underlying rationale for integrating (or not) MM in undergraduate courses.

MM is widely used in physics, engineering, social and natural sciences. While research indicates that the teaching of MM is important and necessary (Blum and Niss, 1991), in practice MM seldom is a part of the curricula of mathematics degree programmes. Furthermore, when MM is viewed as an important part of students' academic preparation, it is unclear whether it ought to be taught on its own, as a separate course, or incorporated into existing undergraduate courses as a subset of skills to be learnt. It has been widely reported that students find MM difficult (Soon et al, 2011); this adds to the reluctance of many lecturers to introduce MM as a part of their teaching. All of this leads to an even bigger gap between research and teaching of MM. Hence, in this project we ask:

1) What are the conceptions of MM that mathematics lecturers in England and Norway have?
2) To what extent do they use modelling in their teaching, and how?
3) Do they claim that modelling is important in mathematics/mathematics teaching? Why? Why not?
4) If they claim that it is important, but don't use it in their teaching (which we hypothesise to be the case), what are the institutional and practical constraints hindering them?

In order to answer our questions above, the survey asked lecturers about their views on MM, their use of MM professionally and in undergraduate teaching, their aims in using or teaching MM, if they do so, or their reasons for not using it. The responses were elicited in the form of Likert scales, rankings and written statements in comment boxes.

We will present our results at the conference, identify similarities and differences between England and Norway with the aim of elucidating how different conceptions of MM influence the gap between research and practice.

The Future of Online Mathematics Teaching and Assessment

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Maple T.A. is a powerful online testing and assessment system designed especially for technical courses involving mathematics. It provides standard math notation, sophisticated plotting, free-response and open-ended math questions, and intelligent grading of responses, enabling you to take full advantage of automated assessment in your technical courses. In this talk, we demonstrate some of the ways Maple T.A. can be used to truly assess understanding. Examples will include open-ended mathematical questions that may have more than one correct answer, questions that require the student to show multiple steps to arrive at a solution, and the use of adaptive testing to evaluate how much of a problem the student actually understands when they initially give an incorrect response.

For more information about Maple T.A. visit www.maplesoft.com/mapleta

Teaching modelling and problem solving with a set of realistic problems

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Between courses of mathematics, which mostly engage in the mathematics itself, and traditional engineering courses which are often concerned with already existing models and methods, other more elusive competencies such as mathematical modelling and problem solving may fall between the chairs, especially since they are difficult to teach within the scope of the well-defined.

In the Chalmers software engineering programme and related programmes, we address this with a second-year inquiry-based course in mathematical modelling and problem solving. The course is not a project with a single problem, but is based on a set of about 30 reasonably realistic, highly varied and challenging problems, which are solved in pairs.

We will here reflect on some key aspects of this multi-problem approach:

- By providing a variation among problems which are still large enough to be remembered as cases, we enable students to build a familiarity with the scope of mathematical modelling, and also in other ways develop an ability to handle similar variation in unknown future problems.

- Modelling problems are typically ill-structured, and thus provide an excellent opportunity also to teach problem solving in a way that is relevant to engineers. Also here the variation comes into play, since many classical patterns of problem solving become visible. Based on the students' own first-hand experiences, these patterns are explicitly discussed throughout the course.

- Compared to a project, the set of problems provide a controlled environment with more guidance, and with short feedback loops. This is done with a cognitive apprenticeship approach, making both student and expert/teacher thinking visible. This is adapted to the constraints of a large course, where we provide as much individual group supervision as possible, together with collective feedback, where reflection is an important part.

After taking the course, most students express and demonstrate a fundamental change in their abilities to think and work mathematically, in their understanding of the nature of mathematics and its role in their future profession. They also consider it as one of the most important courses in their education.

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Applied problems and use of technology in basic courses in probability and statistics – a way to enhance understanding and achieve a more positive attitude

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All engineering students at Lund Institute of Technology have a compulsory course in basic probability and statistics. For some students, including those on programmes for mechanical, civil, chemical and environmental engineering, it is their single course on the subject. Several authors have reported problems on these service courses: students may lack motivation, find the theory difficult or boring, others see no applications for the results. To remedy these problems we have, for our service courses, developed course material and a learning environment where students work actively. Two important components in this setting are applied problems and use of technology in various ways.

Beliving that motivated students are better learners than unmotivated, we have during several years developed applied exercises and projects in order to show the students how their knowledge in probabilty and statistical reasoning can be used in other courses, in every day situations or in a future worklife. Furthermore, there is a large number of exercises specific for each student programme; for examples, exercises suitable for environmental engineers, exercises suitable for mechanical engineers and so on.

Mathematical softwares have been used for decades in probability and statistics education in order to analyze and visualize data and for simulations of distributions. In our courses we use Matlab in this traditional way, the amount of computer used at exercises ranging from 15% (most courses) to 100% (the course for future environmental engineers). But nowdays, our courses also include several other uses of technology, for example video clips presenting theory and solutions to exercises, web-based exercises as a complement to ordinary exercises, and web-based tests. We have also developed ’’applets’’, using Matlab scripts, where the students are able to interactively explore the theory.

Our experiences are that active work with applied exercises and projects give a more positive attitude towards the subject. An investigation also showed that the introduction of web-based test increased the result on the final exam and also resulted in a better conceptual understanding.

POSTER PRESENTATIONS

Blended Learning; a specific example

Vilhelm Adolfsson
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Science needs for its theorizing, available, independent measurement data.
In pedagogical/didactical knowledge building, data frequently tend to become dependent on the particular theory; this while the subject of the model building is extremely complex and interdependent.
Lately, brain research and neuroscience has provided a possibility for an emerging, measurement based or evidence based, theory of pedagogy and the possibility to measure dierent learning strategies relative strength; see for an non-specialist overview the article by Ann Lagerstrom [AL] (Swedish), below with an interview with a leading researcher in the field.
The thinking is that practicing leaves a trace in the structure of the brain and so give rise to an alteration/evolution that can be measured; the number of synapses in different parts of the brain.
It has been seen that a first, introductory, instance of mathematics, 'calculus', is rather a skill than a knowledge.
Therefore it becomes essential to have the active participation of the students; which is an example of exercise and promotes the skill. This is somewhat the opposite of a traditional lecture where all to many students are bent on just copying, literally, what is presented on the black-board; leaving the 'thinking' to an occasion with better time and possibilities of reflection.
Now, a way of turning this downward spiral around is what has been termed a ' flipped classroom' where the gatherings or lectures are changed for active thinking and participation. This of course presupposes the possibilities to 'recover', and have access to, relevant teaching enhancements such as e. g. videos of lectures and instructions and alike.
This opens for the possibilities to have self-instructive educational experiences and the so released time bank of the instructor can be used for individual help and instruction; an educational situation with, suggested from studies, superior level of results.
These are just a couple of examples of the problems of the teaching situation; and the former Associate Director for Science in the White House Oce of Science and Technology Policy, Nobel Laureate Carl Wieman argues that if there are ready made aids and devices the teacher is really not needed as a lecturer but is more valuable as a 'private question bank'; the overall aim getting the students engaged and asking questions and acting as scientists.
Our aim is to present various aids and devices and how it is used and appreciated in a specific course, as an example of Blended Learning.

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Using Simple Tests to Identify Students Needing Support in Engineering Mathematics

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Within large first year classes it can be difficult to identify at an early stage those students who are struggling to adapt to studying at a University. In mathematics, many universities adopt a policy of early diagnostic tests to try to identify those struggling with the background material, however this can often identify those who have been away from formal learning for a long time who will not have problems adapting to study within a university environment. In addition, any support provided to students may not be directly related to their studies and such support is often not taken up by those who need it, but instead taken up by those who do not.

This paper presents an approach using simple tests which may be repeated weekly to identify those students who are struggling. To complete the first year mathematics course, a student must pass five such tests covering the basics of algebra, the use of calculators, vectors and matrices, differentiation and calculus. In each test ten multiple choice questions are asked and a student is deemed to have passed the test when they correctly answer all questions at a single attempt. In advance of the tests, students are shown an example test and told that each of the 10 questions will be on the same topic as in the example. They are therefore able to revise the basics before the test, know the topics that will be present in the test and know that they cannot try to be strategic in their approach by avoiding what they perceive to be hard topics. Students who fail to achieve 100% at each attempt, are given feedback on their attempt, encouraged to seek further support during tutorials, and required to take the test again the following week. Experience has shown that at each attempt between 60% and 80% of students pass the test. Within two tests it is therefore possible to narrow down the list of students struggling with the basics to about 10% of the class.

An added benefit is that the tests provide early events for monitoring attendance and those students failing to engage are quickly identified. Personalised emails are sent to each student after each test detailing their test performance, or inviting them to identify problems they are having. The paper concludes by correlating the test results with overall performance in the first year engineering mathematics course.

The Hamburg MintFit Math Test

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As reported in the Dublin SEFI Workshop in 2014 the universities of Hamburg offer their applicants for engineering, natural science or economy studies two online courses that they can use to recap and complement their knowledge of mathematics, which only makes it possible to begin their studies successfully. Accompanying, we developed an online test that gives recommendations to the students about which subjects to revitalise. The test as well as the courses are based on the COSH-standard for mathematics which is widely accepted in Germany.

In this talk, we will focus on the test and report about the conceptual background, the implementation, the evaluation and evolution of the test which is available for all interested pupils, applicants and students and also for teachers.

Project Assignments within Math/Geometry Courses

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Here we deal with different approaches in solving some math/geometry tasks. Two simple examples are presented: *distance from a point to a line* and *distance from a point to a plane*. We list some of the approaches:

One approach supposes the ability to find the derivative of a function of one and several variables, and a necessary and sufficient condition for extrema; another approach is based on the Lemma: the extreme distance of a given point from a curve/plane is realized on a normal of a curve/plane which runs through the given point. Besides, one needs to be acquainted with the equation of a line in parametric form; a third way supposes the knowledge of a scalar product and a definition of a projection of a vector to the axis determined by the vector; tasks without using formulas can be solved constructively, using methods of descriptive geometry, etc.

Students of the fourth grade of high school should be able to use each of the mentioned approaches to solve *the distance from a point to a line*. This applies also to students in the first year of any technical faculty in solving *the distance from a point to a plane*. However, we know from experience that it is not so. It is partly due to the reason some approaches to solving problems are tightly connected to the areas of mathematics which are dealt with in certain classes in high school, or some courses at the faculties. If there was more time perhaps we could use more of a "horizontal" approach to problems and thus overcome this situation. Some ideas in this regard appeared earlier in [1] and [2].

But, in view of the present curriculum we see a goal could be reached involving project based learning. Demand for different approaches to solving some math/geometry task would shift students from mere use of prepared recipes to understanding the principles of solving the problem by applying a broader idea. As project tasks, various topics could be processed in such a way. In order to help students consider such solutions, we prepared posters where different approaches are presented. The first such poster was presented at the *16th International Conference on Geometry and Graphics* held in Innsbruck, Austria, in 2014. As we then announced we have continued our work the result of which we would like to shown at the 18th SEFI MWG Seminar.

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Design and implement interactive modules of learning mathematics for engineering students

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The teaching and learning mathematics have to be adapted to the new attitude of the engineering students in order to guide them in their own learning process. Today, in higher education, it is common to use support tools e-learning, to increase the interaction between teacher and students, allowing for a more flexible learning.

In order to develop online interactive modules of learning mathematics that can motivate students in their teaching/learning process and increasing the levels of success, it was created e-MAIO (Interactive Learning Modules Online). e-MAIO is a set of interactive online modules of learning mathematics where students can develop an autonomous and collaborative learning, and where they can use the computer to build knowledge, so appealing to its accountability in the individual learning process (Figure1).

Figure 1. e-MAIO project.

Its design was developed with the main objective to capture the various learning styles and respect the form of learning of each student, and to do it, we used a diversification of activities and materials. Students can access to e-MAIO during class, at home or anywhere at anytime. The activities presented are simple and concise with several examples solved so that students become familiar with this type of environment.

This learning modules, supported by Moodle platform have been used in b-learning system for teaching and learning mathematics in electrotechnical engineering of the Institute of Engineering of Coimbra. This project was motivated by the desire to implement some tools for innovative and attractive teaching, but also because we believe that its use leads students to act responsibly in their learning process.

Preparing students in second level education system for Engineering Mathematics

Michael Carr[1], Paul Robinson[2], Ciaran O'Sullivan[2], Martin Marjoram[2], Damian Cox[3] and Cormac Breen[1].

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For many years now we have known about the significant deficiencies in the basic mathematical skills of many engineering undergraduates. Mathematics diagnostic tests in the UK, Ireland and Portugal have shown these shortcomings.

Many third level institutes throughout Europe have introduced high threshold tests in basic maths in the early years of third level Engineering. 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 aimed at students who have left school without a higher Level mathematics qualification, but who wish to start a STEM discipline at college and at honours degree level. Currently, most colleges 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 should form a viable alternative to the 2 year Leaving Certificate qualification for acceptance onto a STEM course for non-traditional students.

This paper will focus on an automated testing component of this module which has been designed in collaboration between third level and Further Education colleges. We discuss the particular implications of this work for Engineering Mathematics at third level.

Assessment of asylum seekers' and immigrants' mathematical competence

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Helsinki Metropolia University of Applied Sciences has established a centre for the demonstration and recognition of asylum seekers' and immigrants' professional competence. The centre will assess the needs of asylum seekers and immigrants for supplementary training, as well as promote their integration into Finnish society and speed up their access to the labour market.

The need for a competence demonstration centre is acute particularly in the Helsinki Metropolitan area, where there are large numbers of immigrants and asylum seekers and the best employment opportunities.

The competence demonstration centre's operations will initially be mostly linked to the studies of technology. This is because currently the majority of asylum seekers are men aged 20 to 29 years, many of whom possess training and work experience in the field of technology and a good potential for continuing their higher education studies or finding work once their competence has been recognised. Metropolia's engineering training is the largest and most international in Finland, which gives the UAS the resources to assess foreign engineering degrees and to arrange demonstration examinations for recognising competence.

The competence assessment will first focus on mathematical competence, digital fluency and English competence. The mathematical competence will be assessed using a test comprising of 30-40 mathematics problems. The pilot test will be a traditional written test, but subsequent tests will be STACK-based tests on computers. The problems will represent difficulty levels from secondary schools to basic engineering studies. The pilot test will be in English and Arabic. We hope that competence assessment will help to determine the needs for subsequent supplementary training before entering e.g. proper engineering studies.

The pilot assessment takes place 20.-21.4.2016 at Metropolia. The pilot group consists of roughly 50 asylum seekers who seem to have a good potential for engineering studies. A substantial proportion of asylum seekers state that they have a university degree, from bachelor to doctorate. They have no diplomas to present. 90% of asylum seekers speak Arabic. English competence is variable.

An exploratory approach to engineering mathematics using GeoGebra

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For students aiming for a Bachelor degree in Engineering, the first course in university mathematics can be perceived as anything from a fun and useful tool for technology to a challenging obstacle of incomprehensible gibberish. From a learning perspective, we want as many students as possible to start seeing the structure behind the mathematical formulas and start asking questions like "But what happens if…". For the autumn semester of 2015, a group of lecturers with previous experiences in web-based education and flipped classroom techniques and research interests in learning using dynamic mathematics software set out to form an updated teaching environment for the beginner's course in mathematics for all the students at the three-year engineering programs at Karlstad University. Our goals were to increase the awareness among the students about the actual relevance of mathematics for the engineering programs, to stimulate in-depth learning, and to find efficient ways of communicating mathematical knowledge.

We want to share our reasoning, the practicalities, and the outcomes of our course development project where we

- developed a series of video presentations of course material, and combined flipped classroom teaching with traditional style lectures and lessons,
- used dynamic software for visualization to support the students' mathematical understanding,
- developed task sequences, where students used GeoGebra to investigate mathematical relations, make conjectures, and verify them,
- used the developed task sequences as part of the course examination,
- discussed the changes and future work both with students and with colleagues.

The selection factors of deep versus superficial mathematics learning strategy

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Learning to study is a key factor for student success.

Each student's population due to the different learning traditions and different living environment are expressed by indicators with different intensity.

The goal of the article is to present the research in order to find out what internal and external factors lead to choice of deep or superficial mathematics learning strategies.

The following methods of research were used:

- Analysis of scientific literature, which helped to clarify the deep and superficial differences in learning strategies
- The analysis of students papers in mathematics examination that had helped to assess the extent of superficial learning
- Questionnaire. Questions were focused on the deep and superficial learning indicators. These indicators were grouped into external and internal factors underlying students' educational success. As the answers of the first year and the second year students had distinguished, the second-year students were further questioned in order to find out the most recurrent factors determining the choice
- Descriptive statistics.

The article consists of three parts. Deep and superficial learning indicators are discussed in the first part; Analysis of mathematics examination results are discussed in the second part and the results of the questionnaires and the factors determining the choice of learning strategies are summarized in the third part.

An Investigation to determine if First Year Engineering Undergraduate Students suffer from Mathematics Anxiety

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In recent years there has been a growing concern about the anxiety experienced by school children when learning mathematics. Mathematics Anxiety has been defined as "a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in ordinary life and academic situations". The implications of children suffering with Mathematics Anxiety can be avoidance of situations where mathematics is required. It can also lead to perfectly capable children not wishing to pursue careers in disciplines that depend upon the application of mathematics. This has consequences for all areas of engineering.

The research question for this investigation was to determine if there was any evidence to suggest that students who chose to study engineering were not anxious about mathematics. The implications of this question are that if the skills shortage in engineering is going to be addressed, the engineering community needs to work with schools in order overcome mathematics anxiety and hence encourage children to consider careers in engineering.

This investigation involved a cohort of 380 first year undergraduate engineering students completing an on-line questionnaire. Of this cohort 41 responded, representing approximately 11% of the population. The analysis of the results show that amongst the students who responded there was little evidence of anxiousness concerning mathematics. This is not surprising since most of them had studied mathematics at an advanced level prior to coming to university. Also, the students had not had any formal assessments prior to completing the questionnaire and therefore would feel secure based on their a-priori achievements in mathematics. Once the end of module assessment has been carried out the results will be compared to the responses given in the questionnaire. The questionnaire will be issued again during the advanced second module on engineering mathematics and a comparison made to determine if there has been a change in attitudes once the students had experienced more challenging mathematics and could not rely upon prior knowledge.

Malware propagation models: A challenge for engineering students

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The smart phones, tablets and laptops are important part of our daily life. Students are everyday and every moment using their mobile phones. Sometimes it is difficult that they disconnect from those devices and pay attention to teachers and lecturers. Mathematical classes need a special attention to get the explanations and not to spend too much time looking for understanding basic concepts.

We have proposed our undergraduate engineering students a Realistic Mathematics Education (RME) based on Internet of Things (IoT) and malware propagation.

Engineering students have to handle a lot of simulation problems using numerical methods: magnetic shield, airflow around an obstruction, car deforms in a crash, etc. Differential Equations and Partial Differential Equations are topics that will be part of their life for finding solutions to many problems. They learn mathematics solving real problems with the help of the already acquired competences and skills. We have proposed the students the adaptation of the mathematical competences to the engineering context: modeling mathematically the dissemination of any virus (biological o computational); thinking mathematically on their mobile devices; handling mathematical symbols and formalism, and solving mathematical problems using the needed tools.

The progressive implementation of the IoT makes the malware a real threat. We are all connected. We found the malware as one of the most important security threats against mobile devices. Mobile devices play an important role in the development, management, monitoring, and control of the critical infrastructures. Critical infrastructure sectors include energy, public health, telecommunications, transportation, nuclear safety, emergency services, industry, etc. They are essential for the maintenance of the basic social requirements, and are managed by information and telecommunication technologies.

From the simulations shown in some films or videos published in YouTube, students could understand how the virus spread works. There are several simulations available at the Internet and also some developments at Wolfram Community for example.

From the classical model of Kermack and McKendrick to the Random Constant-Spread Model that describes the outbreak of the code-red worm in 2001, students can work on the model expressing the equations whose solutions will be found using different technological tools. They will describe the behavior of the phenomenon and determine the efficiency of the mathematical model developed. We proposed the students this process to acquire the competences related to Differential Equations, and we made a statistical analysis from their answers to a reliable survey.

The Spanish identity card and real life applications as a realistic way to learn mathematics and software development

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We have proposed our first course undergraduate engineering students to leave their mobile phones at home, or to switch them off during classes' time, but we found that sometime it is very difficult, as they need to be connected all the time.

We are a group of lecturers and professors from different departments at the University of Salamanca that wanted to get well prepared engineers using real life applications based on the use of the mobile devices and laptops.

Computer Science engineering students have to assist to some programming courses from the first day at the university. They should develop a program for Fibonacci series or for getting the letter for our Spanish identity card (modular arithmetic), or any other algorithm that has a real application.

In mathematics classes, we have proposed the students to think mathematically using their mobile devices. The first proposal from their side was to use twitter to have the daily information, but at the end only one student was the responsible for feeding the application. They tried to find Apps for mathematics classes and some of them found some interesting ones, like the one for Cesar cipher. We make students to answer some google surveys using their mobile phones (they find easier and quicker than to go into the online platform). It is very difficult for students to think mathematically using their mobile phones. In fact, it is know that they are native ICT users, but they find difficult to add a question in a forum in the learning management system for example.

We have analyzed in this paper both things: how students use their mobile phones and also how they develop programs related to those real life mathematics applications. Furthermore, students learn mathematics developing some algorithms using different programming languages and making sure that the syntax is correct. In other case the source code will not run.

Flipped classroom in interdisciplinary course

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For master students of the process technology and energy technology we offer a course on simulation of transport processes. Two aims are focused:

The students should learn or repeat the basics in using a simulation tools.

They should learn to combine specialized knowledge with mathematical concepts to simulate a technical process.

In the first part of the course the students collect first experiences in programming by modeling a Rankine cycle using Matlab. Hereby they discuss the quality of the presented mathematical model and possible improvements. The students are accompanied by the lecturers of the lecture "Transport processes" (master studies) and “Mathematics for Engineers” (bachelor studies). While working on the computer learners can discuss their questions, programming ideas and difficulties with each other and the trainers and they receive immediate feedbacks. The second part of the course is focuses on simple heat transfer processes described by ODE or PDE models. Therefore some mathematical concepts (e.g. linear equation systems) are needed, but they have learned it about three years ago.

Up to now the mathematical models of the technical processes and the repetition of the mathematical basics were presented as talks during the lectures with little time remained for the discussion. But the students need enough time to reconsider the introduced topics. We have seen, that this process needs more time then scheduled, e.g. to understand the way to describe the first derivative of a function on a interval by a system of linear equation system.

Now we are working on a didactic reorganization (flipped classroom) of our course, so that the students will have enough time, to repeat subjects needed in our course. Therefore on-line learning modules and formative on-line tests have to be finished to prepare the single sessions. Thus questions can be discussed quite early and it remains more time to discuss, e.g. improvements of the models. By using the flipped classroom concept the students will be motivated to work more independently and they may reach a better understanding by using the digital learning materials as starting point for the considerations. Thus we will generate a more active participation in the teaching and learning events and better learner’s results can be achieved.

Enhancing the Ability to Identify and Use Mathematical Concepts

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The paper deals with the results of project work integration into regular teaching of "Basics of Numerical Mathematics" in bachelor studies with common conception of course, based on traditional lectures and exercises aided by CAS *Mathematica*. The pedagogical experiment took place at the Faculty of Mechanical Engineering STU in Bratislava and it summarizes the outputs obtained during two school years 2013/2014 and 2014/2015. Its realization proceeded on experience obtained in pre-experimental observations, applied on special group of students retaking the course in previous school year (discussed in last SEFI seminar).

Usually, in project method, the tasks for students are formulated in the form of complex, time demanding technical or other assignments. In order to affect the students' ability of identification and usage of numerical methods we turned this approach, and asked students to find suitable technical problem for given numerical method. This allows us to monitor students' ability to recognize the mathematical concept and identify suitable technical problem; to formulate goal of the task from technical and from numerical point of view; to solve the problem using available numerical methods, compare results, and to formulate and discuss a solution and interpret it in technical application.

The paper will present the experiment summary, results, conclusions and polemics; and it will also discuss further plans dealing with ways of integration of technical applications into teaching numerical methods at bachelor studies.

Model of passing mathematics course at the university

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Engineering students struggle to understand mathematics. In this article there are discussed the effects of mini-tests given in a period of each week during one semester of the course of mathematics. A model of students failing and/or passing the assignments is presented.

MECD : The Manchester Engineering Campus Development : with an angle for Mathematics

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The University of Manchester is currently planning a major new building development that will house the four schools of Engineering and which will act as a focus for the teaching and research activities for these schools.

The vision for the Manchester Engineering Campus Development (MECD) involves floor-space of 76 000 square metres spread across 8 floors. With completion expected in 2020, it will be home to 1300 staff and 7000 students.

MECD will house the following four schools of Engineering : Chemical Engineering and Analytic Science : Electrical and Electronic Engineering : Materials : Mechanical, Aerospace and Civil Engineering. In addition, the Science and Engineering Foundation Office (with students on the Foundation Year progressing to the four Engineering Schools and to other schools in the Faculty) will be located within MECD.

One common factor possessed by all these schools is the requirement for high-quality mathematics teaching and the consequent role of the school of mathematics. The needs of the school of mathematics in teaching to these schools forms a key part of the design process in this new development.

The committee being consulted on matters to do with teaching consists of MECD project staff, technical staff (e.g. audio-visual) the Directors of Studies of the Engineering Schools (including the director of Foundation Studies) and the Director of Service Teaching in the School of mathematics. This committee considers such matters as lecture theatres, small group teaching and consultation rooms, computer clusters, study spaces and, of course, multi-function rooms. It considers such aspects as suitability for small/medium group mathematics tutorials as well as specialist engineering project group meetings. It considers constraints on the wifi-networks and projection systems relevant for the needs of mathematical software as well as the needs of engineers on their mainstream courses.

Once complete, MECD will be an inspiring home for the engineering students for their studies including the study of mathematics.

Using online-assessment to improve learner-centered teaching

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Students often attend lectures unprepared. That is why they don’t notice the lack of understanding the subject. Also the lecturer can’t distinguish between real problems and just bad preparation. Students have therefore problems in following the topics building up on previous ones. This leads to serious and difficult to close knowledge gaps.

It makes it important to recognize such gaps in an early stage, so they can still be closed. Therefore e-learning tools can be used in a formative way for students and lecturers. In the classic way they are used to help student to identify understanding problems. But the results are also helpful for the lecturer for the preparation of the following lecture. He/She gets an overview of the progress of the course and the content can be based on the understanding level of the students. The tools can also be used to transfer parts of the learning outside of the class room.

Using these methods, the students take an active part in the lecture and improve their understanding. The authors use these methods on a regular basis during their courses and wish to share their experiences, including first evaluation results.

TeStED – Transitioning without A2 level mathematics

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The research presented is part of a project to develop a learning resource for students entering STEM degrees. The study aims to address the mathematical difficulties that many students present transitioning into the first year of their Engineering course. To this end data were collected to identify how preferred learning styles, maths anxiety and the specific learning difference of dyslexia relate to outcomes on a mathematics diagnostic test.

In the UK there has been a perceived decline in the mathematical preparedness of students entering STEM degrees. Numerous reports have addressed this issue (for example, Hawkes and Savage, 2000; Marr and Grove, 2010). Lawson (1995) focussed on the mathematical qualification of students entering STEM degrees and found that there was little difference between students' overall end-of-year performance when presenting a BTEC or a failed A-level qualification (i.e. at grade N or U) upon entry. In the mathematical context, the study also found that algebra skills, in particular, were weak for all students.

For this study, students' gaps in knowledge were not thought of as evidence of students' inability to learn mathematics. Rather the research team regarded gaps in knowledge as an outcome of the kind of teaching and learning experienced by students pre-university. This could relate to availability of suitable resources, course content, appropriate teaching methods or students' choice of course.

To develop a learning resource that could address the various issues presented by students the research team, consisting of a mathematician and two mathematics educators, collected data from (a) a diagnostic test that students took upon entry to the university, (b) a questionnaire about students' mathematical background and learning preferences, (c) a screening test for dyslexia and (d) a screening test for mathematical anxiety. All students surveyed were enrolled for an engineering degree and in their first year of study. The results presented relate to the following research questions:

- How are the study participants characterised in terms of the data collected?
- What trends can we identify relating data collected on the survey and screening tests to the diagnostic test outcomes?
- What trends can we identify relating data collected on the survey and screening tests to students' choice of mathematics qualification pre-university?

We present results to date using statistical analyses of the data.