Gottlob-Frege-Institut   Gottlob Frege Institute

INFORMATION
Programme and Abstracts

15th SEFI MWG Seminar & 8th Workshop GFC
Wismar, Summer 2010

Special Edition
No. 02/2010

Wismarer Frege-Reihe   Wismar Frege Series

The **Gottlob Frege Centre** was founded 2000-11-07 at Hochschule Wismar. The members support a scientifically based, application orientated, modern and internationally acting education of engineering and business students in the mathematical and natural sciences.
The **Gottlob Frege Institute** attends the didactic research in the announced disciplines since his foundation in 2005.

Further Information to Gottlob Frege Centre and corresponding contact persons are available on our Homepage in World Wide Web:

http://www.hs-wismar.de/frege

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Foreword

I am very glad that Hochschule Wismar will be the host of the 15th Seminar of SEFI Mathematical Workgroup and 8th Workshop "Mathematics for Engineers" in summer 2010.
This common initiative reflects the great and successful work of participating colleagues to make Mathematics in the Educational sector and in the Public more attractive, more popular and more orientated to practical needs. It should be also mentioned that colleagues are confronted with bad knowledge of many study beginners in Mathematics and missing understanding and support in parts of public.
In my opinion both practical skills and theoretical capabilities are important to master the challenges concerning the international market and the future development. Just in a time of knowledge explosion the basics are fundamental because they are the most resistant to quick changes. Absolvers which know these basics have best chances in the competition for attractive and demanding jobs. One of my favourite slogans is

Nothing is more practical than a good theory.

Immanuel Kant was one of the first who stressed this strong relation between theory and practice. In the course of history this slogan was repeated again and again by well-known scientists.

The organisational committee of this conference, the members of Gottlob-Frege Centre and the staff of our university hope with me, that all of you will have a pleasant stay in Wismar and that the conference programme corresponds to your intentions. We wish that you will leave Wismar with new ideas and new thirst for creating attractive mathematical education in your institution.

Dieter Schott
Wismar, June 2010

15th SEFI MWG Seminar and 8th Workshop GFC
Mathematical Education of Engineers
Wismar 20th – 23rd June 2010

The **Gottlob Frege Centre (GFC)** of Hochschule Wismar (University of Wismar) was founded in November 2000 cultivating the Frege heritage. The Centre is especially engaged in strengthening mathematics in the public and in school and university education. It is the university's objective to provide a science-based interdisciplinary and practise-oriented mathematical education using up-to-date teaching methods and means.
The **SEFI (European Society for Engineering Education) Mathematics Working Group (MWG)** was established in 1982. Aims of the Working Group include to provide a forum for the exchange of views and ideas amongst those interested in engineering mathematics, and to promote a fuller understanding of the role of mathematics in the engineering curriculum, and its relevance to industrial needs.
In summer 2010 we will merge **GFC's regular workshop** with the **biannual seminar** of the **SEFI MWG** for enabling and promoting international exchange of expertise. The main topics of the conference will be

- Activation of learners
- What are modelling competencies and how to teach them?
- Use of Technology.

Other contributions related to the mathematical education of engineers are also welcome. Further information can be found at the Seminar Website
http://hermes.et.hs-wismar.de/schott/conference

Program Committee
Burkhard Alpers, HTW Aalen, Germany; *Marie Demlova*, Czech Technical University, Czech Republic; *Carl-Henrik Fant*, Chalmers Technical University, Sweden; *Duncan Lawson*, Coventry University, UK; *Brita Olsson-Lehtonen*, Finland; *Carol Robinson*, Loughborough University, UK; *Dieter Schott*, Hochschule Wismar, Germany; *Daniela Velichova*, Slovak Technical University, Bratislava, Slovakia

Local Organisation
Hochschule Wismar, Gottlob Frege Centre
Dieter Schott, Andreas Kossow, Gabriele Sauerbier, Norbert Grünwald (Rector), *Regina Krause, Daniel Buchholz*
Contact E-Mail: dieter.schott@hs-wismar.de

Schedule

Time	Sunday	Monday
Location		**Computer Centre (26) Multimedia-Room, Pools**
08:00		Registration
08:30		contd.
09:00		Welcome Addresses
09:30		***Invited lecture 1***
10:00		Active Learning
10:30		***Paper presentations I (3)***
11:00		Active and Cooperative Lear-ning
11:30		***Coffee break***
12:00		***Paper presentations II (3)***
12:30		Cognitive and Didactic Aspects
13:00		***Lunch***
13:30		Canteen Building Campus
14:00		***Paper presentations III (4)***
14:30		Support for Students
15:00		contd.
15:10		***Tour of Posters***
16:00		***Coffee break***
16:30		***Software Demos***
17:00		contd.
17:30		contd.
18:00	***City tour***	contd.
18:30	Market Tourist Information	
19:00		***Reception*** Town Hall
19:30	contd.	Finger food
20:00	City tour end	***Concert*** Town Hall
20:30		contd.
21:00		Concert end

Schedule contd.

Time	Tuesday	Wednesday
Location	**Computer Centre (26) Multimedia Room**	**Computer Centre (26) Multimedia Room**
08:00		
08:30		
09:00	***Invited lecture 2***	***Invited lecture 3***
09:30	Math. Education and Industrial Needs	Math. Modelling Competencies
10:00	***Paper presentations IV (3)***	***Paper presentations VII (3)***
10:30	contd.	Modelling
11:00	***Discussion 1 (Groups): Activation / Technology***	***Discussion 2 (Groups): Modelling***
11:30	***Coffee break***	***Coffee break***
12:00	***Discussion 1 (Plenary)***	***Discussion 2 (Plenary)***
12:30	**Change of Venue:** Technology Centre	***Closing Ceremony***
	Alter Holzhafen 19, Town Harbour	***Photo Shooting***
13:00	***Lunch***	***Lunch***
13:30	Foyer Technology Centre	Canteen Building Campus
14:00	***Paper Presentations V+VI (4)***	**Extended Workshop GFC**
14:30	Skills and Requirements	***Paper presentations VIII***
15:00	General Aspects	contd.
15:30	***Photo Shooting***	contd.
16:00	***Excursion*** Town Harbour	***Coffee break***
16:30	Travel with antique Cog	***Paper presentations IX***
17:00	contd.	contd.
17:30	contd.	contd.
18:00	contd.	contd.
18:30	contd.	contd.
19:00	End	End
19:30		
20:00	***Dinner*** Brauhaus am Lohberg	***Dinner*** Restaurant Wismar
20:30	Kleine Hohe Str. 15	Breite Str. 10
21:00	Old Town, near Town Harbour	Altstadt

PROGRAMME
15th SEMINAR SEFI MWG & 8th WORKSHOP GFC
WISMAR (GERMANY), 20 June – 23 June 2010

SUNDAY 2010-06-20

18:00 – 20:00 **Sightseeing Tour** "World Cultural Heritage Wismar"
Meeting point: Market Place, Markt 11, in front of Tourist Information

MONDAY 2010-06-21

Venue: Hochschule Wismar, Computer Centre at Campus (Building No. 26 in Campus plan), Multimedia Room

8:00 **Registration**
9:00 **Welcome Addresses**
Major of Hanseatic Town Wismar**, Dr. Rosemarie Wilcken**
Rector of Hochschule Wismar, **Prof. Dr. Norbert Grünwald**
Chairman of SEFI MWG **Prof. Dr. Burkhard Alpers**
Director of Gottlob Frege Centre **Prof. Dr. Dieter Schott**

Invited Lecture 1
Chair: Burkhard Alpers, Aalen Germany, Chairman SEFI MWG

9:30 **Neil Challis**
Sheffield Hallam University, UK
Learning Mathematics by doing Mathematics

Paper Presentations I: Active and Cooperative Learning
Chair: Sergiy Klymchuk, Auckland, New Zealand

10:30 **Thomas Schramm**
HafenCity University Hamburg, Germany
The impact of Cooperative Learning Scenarios on the applied mathematics education of Geomatics students

10:50 **Donal Healy, Martin Marjoram, Ciaran O'Sullivan, Paul Robinson**
Institute of Technology Tallaght, Dublin, Ireland
Promoting active learning in Mathematics - a 'Problems First' approach

11:10 **Carol L. Robinson**
Mathematics Education Centre, Loughborough University, UK
Using Electronic Voting Systems for Active Learning

11:30 Coffee Break, Foyer Computer Centre

Paper Presentations II: Cognitive and Didactic Aspects
Chair: Carl-Henrik Fant, Gothenburg, Sweden

12:00 **Daniela Velichová**
Slovak University of Technology, Bratislava, Slovakia
Creating Cognitive Connections in Mathematics

12:20 **Susanne Bellmer**
Ostfalia University of Applied Sciences, Wolfenbüttel, Germany
Cognitive layers and students' understanding of mathematics

12:40 **Peter Riegler**
Ostfalia University of Applied Sciences, Wolfenbüttel, Germany
Towards Mathematics Education Research – Does Physics Education Research serve as a Model?

13:00 Lunch, Canteen Building, Campus

Paper Presentations III: Support for Students
Chair: Carol Robinson, Loughborough, UK

14:00 **Michael Carr[1], Eabhnat Ní Fhloinn[2]**
[1]Dublin Institute of Technology, [2]Dublin City University, Ireland
Improving Core Mathematical Skills in Engineering Undergraduates

14:20 **Ciarán Mac an Bhaird,** Ann O'Shea
National University of Ireland Maynooth, Ireland
What type of student avails of Mathematics Support and extra Mathematics Initiatives?

14:40 Kerstin Matter**, Katherine Roegner**
Technische Universität Berlin, Germany
IMPETUS for the Engineering Sciences

15:00 **Håkan Lennerstad**
Blekinge Institute of Technology, Sweden
The periodic system of mathematics: Short Introduction to the Poster

Poster Session: Foyer Computer Centre (Building No. 26)
Chair: Katherine Roegner, Berlin, Germany
15:10 Tour of Posters

1. **Håkan Lennerstad**
Blekinge Institute of Technology, Sweden
The periodic system of mathematics

2. **Jelena Zascerinska**[1], Olaf Bassus[2], **Andreas Ahrens**[2]
[1]University of Latvia, Riga, Latvia, [2]Hochschule Wismar, Germany
Social Dimension of Web2.0 in Engineering Education: Student's View

3. **Péter Körtesi**
University of Miskolc, Hungary
About the Activity CEEPUS Network HU-0028

4. **Raimond Strauß**
Universität Rostock, Germany
Qualitative Methods for Nonlinear Differential Equations – The Solow Model of Long Time Economical Growth

5. Wojciech Mitkowski**, Krzysztof Oprzedkiewicz**
AGH University of Science and Technology, Krakow, Poland
Control Theory – association of mathematics and engineering

6. **Tsvetanka Kovacheva**
Technical University, Varna, Bulgaria
Mathematical Modelling for Teaching Mathematics Using CAS

7. **Ana Donevska - Todorova**
MIT - University, Skopje, Macedonia
Use of Technology for Mathematical Education

16:00 Coffee Break, Foyer Computer Centre

Software Demonstrations: Computer Centre

Room 1:
Chair: Susanne Bellmer, Wolfenbüttel, Germany

16:30 **Donal Healy, Martin Marjoram, Ciaran O'Sullivan, Paul Robinson**
Institute of Technology Tallaght, Dublin, Ireland
Longitudinal Analysis of a Key Skills in Mathematics Initiative

16:50 **Noel Gorman, Martin Marjoram, Donal Healy, Ciaran O'Sullivan, Paul Robinson**
Institute of Technology Tallaght, Dublin, Ireland
The Use of Technology in Mathematics - approaches used and lessons learnt at ITT Dublin

17:10 **Sergei Zuyev**
Chalmers University of Technology, Gothenburg, Sweden
Virtual Learning Environment (VLE) for Probability and Statistics

Room 2:
Chair: Thomas Schramm, Hamburg, Germany

16:30 **Thomas Risse**
Hochschule Bremen, Germany
SAGE, the open source CAS to end up all CASs?

16:50 **Kari Lehtonen**
Helsinki Metropolia University of Applied Sciences, Finland
Technology assisted assessment as a strategic and pedagogical tool in engineering mathematics

Multimediaroom
Chair: Dieter Schott, Wismar, Germany

16:30 **Sandra Costa[1], Isabel Mendes[2], Filomena O. Soares[1], Celina P. Leão[1]**
[1] University of Minho, Guimarães, [2] University of Minho, Braga, Portugal
From differential equations to real-world problems in Control Engineering

16:50 **Peter Junglas**
Private Fachhochschule Diepholz/Vechta, Germany
Simulation programs for teaching quantum mechanics

17:10 **John B. Stav**[1]**,** Trond M. Thorset[1], Kjetil L. Nielsen[1], **Gabrielle Hansen-Nygard**[1]**,** Joan Lu[2], Pascal Pein[2]
[1]Sor-Trondelag University College Trondheim, Norway
[2]University of Huddersfield, UK
Experiences with Use of Open Web-Based Student Response Services in Sciences

17:30 **Thomas Richard**
MAPLESOFT Germany
Physical Simulation using MapleSim

Evening Program

Location: Town Hall, Market Place

19:00 **Official Reception**
Welcome Address: Senator of Hanseatic Town Wismar **Michael Berkhahn**
Meeting with Fingerfood and Drinks

20:00 **Choral Concert at Town Hall**
Chamber Choir “Vocalisti Rostochienses“, Hochschule für Musik und Theater (University for Music and Theatre) Rostock, Conductress Prof. Dagmar Gatz

TUESDAY 2010-06-22

Venue: Hochschule Wismar**,** Computer Centre at Campus (Building 26 in Campus plan), Multimediaroom

Invited Lecture 2
Chair: Dieter Schott, Wismar, Germany, Director GFC

9:00 **Dirk Labuhn**
Airbus Bremen
Mathematical Education and Industrial Needs

Paper Presentations IV: Use of Technology
Chair: Donal Healy, Dublin, Ireland

10:00 **Angela Schwenk,** Norbert Kalus
Beuth Hochschule für Technik, Berlin, Germany
Does CAS at school help freshmen in engineering sciences?

10:20 **Karin Landenfeld,** Thomas Preisler, **Wolfgang Renz, Peter Salchow**
Hamburg University of Applied Sciences, Germany
Supporting the Composition of Micro-Modular Content for Mathematical Learning Modules

10:40 **Dieter Schott**
Hochschule Wismar, Germany
Computer Tomography as a Project for Students with focus on Computing

11:00 Coffee Break, Foyer Computer Centre

Discussion Session 1: Activation of Learners and Use of Technology
What kinds of technology use do improve understanding and activate the learner's mind?
Chair: Brita Olsson-Lehtonen, Helsinki, Finland

11:30 Discussion in Groups
12:00 Plenary Discussion

Discussion ends 12:30

Change of Venue
Location: Technology Centre, Alter Holzhafen 19, Town Harbour

13:00 Lunch, Foyer Technology Centre

Paper Presentations V: Skills and Requirements
Chair: Marie Demlova, Prague, Czech Republic

14:00 **Eabhnat Ní Fhloinn**[1] and **Michael Carr**[2]
[1]Dublin City University [2]Dublin Institute of Technology
What Do They Really Need to Know?: Mathematics Requirements for Incoming Engineering Undergraduates

14:20 **Gunther Kurz** et al.,
Hochschule Esslingen, Germany
A never ending story – mathematics skills & deficiencies of first semester students and study success

Paper Presentations VI: General Aspects
Chair: Gabriele Sauerbier, Wismar, Germany

14:40 **A. Garcia, F. Garcia, Gerardo Rodriguez, A. de la Villa**
Carretera de Valencia, Spain
Calculus in one Variable: One Spanish overview according to EAHE

15:00 **Burkhard Alpers[1], Marie Demlova[2]**
[1]HTW Aalen, Germany, [2]Czech Technical University Prague, Czech Republic
The SEFI Math Working Group – Resources and future plans

Presentation ends15:20

15:25 **Photo shooting** in front of Technology Centre

Afternoon Program

Short walk to Town Harbour

Excursion
16:00 – 19:00 Travel with antique Cog "Wissemara"
Snacks and Drinks
Start and End: Wismar, Town Harbour

Seminar Dinner
20:00 Restaurant "Brauhaus am Lohberg"
Location: Kleine Hohe Straße 15, Wismar Old Town, near Town Harbour

WEDNESDAY 2010-06-23

Venue: Computer Centre at Campus Hochschule, Multimedia Room

Invited Lecture 3
Chair: Burkhard Alpers, Aalen, Germany

9:00 **Gabriele Kaiser**
University of Hamburg, Germany
Mathematical modelling competencies: meaning, teaching and assessment

Paper Presentation VII: Modelling
Chair: Daniela Velichova, Bratislava, Slovakia

10:00 **V. Kleiza, O. Purvinis**
Kaunas University of Technology, Lithuania
Modelling by Differential Equations – from Properties of Phenomena to its Investigation

10:20 Norbert Grünwald[1], Gabriele Sauerbier[1]**,** Ajit Narayanan[2]**, Sergiy Klymchuk**[2]**,** Tatyana Zverkova[3]
[1]Wismar University of Technology, Business and Design, Germany
[2]Auckland University of Technology, Auckland, New Zealand
[3]Odessa National University, Odessa, Ukraine
Applications in Unusual Contexts in Engineering Mathematics: Students' Attitudes

10:40 **C.P. Leão**, S.F.C.F. Teixeira
University of Minho, School of Engineering, Guimarães, Portugal
Modelling toward numerical solution of an applied engineering problem

Discussion Session 2: Modelling
Which mathematical modelling competencies are important for engineers and how should they be taught?
Chair: Burkhard Alpers, Aalen ,Germany

11:00 Discussion in Groups

11:30 Coffee Break, Foyer Computer Centre

12:00 Plenary Discussion

Closing Ceremony

12:30 **Gerardo Rodriguez**
Salamanca, Spain
The next SEFI MWG Seminar 2012: Invitation and short Introduction of the host institution
12:45 **Final Addresses**
Burkhard Alpers, Chairman SEFI MWG
Dieter Schott, Host, Director GFC

12:55 **Photo shooting** in front of Computer Centre

13:00 Lunch, Canteen Building at Campus

Extended Workshop GFC 'Mathematics for Engineers'

WEDNESDAY 2010-06-23

Ort: Campus Hochschule Wismar, Rechenzentrum, Multimediaraum

14:00 Eröffnung und Begrüßung
Dieter Schott

Vorträge I:
Leitung: Peter Riegler, Wolfenbüttel

14:05 **Torsten-Karl Strempel**
Hochschule Darmstadt, Germany
Mathematische Modellierung mit Schülern

14:30 **Christa Polaczek**
Fachhochschule Aachen, Germany
Wie viel Vorkurs braucht der Student?

14:55 **Larissa Fradkin**
London South Bank University,UK
Sound Mathematics Ltd., Cambridge, U.K.
Teaching algebra and calculus to engineering freshers via Socratic Dialogue and Eulerian sequencing

15:20 **Edward Tutaj**
Jagellonian University Krakow, Poland
Some statistical materials concerning the teaching of mathematics in Jagellonian University Krakow and Higher Vocational School in Tarnów

15:45 **Karl-Heinz Winkler**
Jadehochschule Wilhelmshaven/Oldenburg/Elsfleth, Germany
Das Lernmaterial in Lehrbüchern zur Ingenieurmathematik und deren Begründung
Instructional material in course books for engineering mathematics and their substantiation

Einladung zum nächsten Workshop „Mathematik für Ingenieure“

16:15 Kaffeepause, Foyer Rechenzentrum

Vorträge II:
Leitung: Christa Polaczek, Aachen

16:35 **Thomas Risse**
Hochschule Bremen, University of Applied Sciences, Bremen, Germany
SAGE - ein CAS auch und besonders für diskrete Mathematik

17:00 **Raimond Strauß**
Universität Rostock, Mathematisches Institut, Rostock, Germany
Qualitative Methoden für nichtlineare Differentialgleichungen – das Solow-Modell des ökonomischen Wachstums auf lange Sicht

17:25 **Peter Junglas**
Private Fachhochschule Diepholz/Vechta, Germany
Transparente Randbedingungen für Simulationsprogramme
Transparent boundary conditions for simulation programs

17:50 **Peter Riegler**
Ostfalia University of Applied Sciences, Wolfenbüttel, Germany
Geschlechtsspezifische Unterschiede in der Rechnergestützten Leistungsermittlung
Gender Differences in Computer Aided Assessment

18:15 **Thomas Schramm**
HafenCity Universität Hamburg, Germany
Möglichkeiten und Unmöglichkeiten des automatischen, mathematischen, summativen und formativen Assessments

18:40 Schlusswort

Workshop Nachsitzung (Abendessen, Dinner)
20:00 Restaurant “Wismar”, Breite Str. 10, Altstadt Wismar

Abstracts 1

Remark: The abstracts sent in for the conference are listed using alphabetic order of (first) authors. Some colleagues had to cancel their planned participation. Nevertheless, the corresponding abstracts are in the list. These authors were marked by a star (*). The titles of the abstracts need not completely coincide with the titles of the corresponding papers or presentations.

15th SEFI MWG Seminar and 6th Workshop GFC, June 2010

A Maths Gateway for Engineering Students: An Update on Maths Support and Education Approaches at Imperial College London.

E. Alpay*, Imperial College London, UK

Recently work has been published on guidelines for the design of a multifaceted computer-based mathematics resource for undergraduate and pre-entry engineering students (see Masouros and Alpay, 2009). Online maths resources, whilst attractive in their flexibility of delivery, have seen variable interest from students and teachers alike. Through student surveys and wide consultations (UK), guidelines have been developed for effectively collating and integrating learning, support, application and diagnostic tools to produce an Engineer's Mathematics Gateway. Specific recommendations include: the development of a shared database of engineering discipline-specific problems and examples; the identification of, and resource development for, troublesome mathematics topics which encompass ideas of threshold concepts and mastery components; the use of motivational and promotional material to raise student interest in mathematics learning in an engineering context; the use of general and lecture-specific concept maps and matrices to identify the needs and relevance of mathematics to engineering topics; and further exploration of the facilitation of peer-based learning through online resources.
In this seminar, an update of the implementation of the design guidelines will be presented, and discussions held on some of the recommendations mentioned above.

Reference:

Masouros, S.D., Alpay, E., 2009, Mathematics and online learning experiences: a gateway site for engineering students , Euro. J. Engineering Education, 34 (November), 1469-5898.

The SEFI Math Working Group – Resources and future plans

Burkhard Alpers, HTW Aalen, Germany
Marie Demlova, University of Prague, Czech Republik

In this contribution, we want to describe the current state of resources provided by the SEFI Math Working Group and discuss plans for future developments. The group's web site offers a math curriculum for engineers which was last revised in 2002. It contains some discussions on current trends (i.e. usage of technology) but mainly consists of structured sets of desired learning outcomes. Possible directions of revision are discussed. The web site also contains a list of topics considered as important by the steering group. The list is explained and plans for a steady development of the list in connection with the biannual SEFI MWG seminars are stated.

Cognitive layers and students' understanding of mathematics

Susanne Bellmer, Ostfalia HAW Wolfenbüttel, Germany

Learning is a complex process. It does not mean just writing on an empty blackboard or substituting old knowledge by new information, but it is connected with cognitive structures. During the learning process cognitive layers are built and new information is integrated within already existing manifold structures. These structures have a strong influence, if and how information is understood.

Up to now most of the existing studies have dealt with physics. But are these structures also important in mathematics? Investigations reveal that these structures do of course exist in mathematics, and they have a very noticeable effect.

In this contribution the application of the concept of cognitive layers to mathematics is presented and various examples are used to show their effects. It is also proposed how this can be taken into account to develop an effective teaching, so that the learning process is facilitated and persistent mistakes can easier be removed.

Improving Core Mathematical Skills in Engineering Undergraduates

Michael Carr[1] and **Eabhnat Ní Fhloinn**[2]
[1]Institute of Technology Dublin, [2]City University Dublin, Ireland

Many undergraduates enter third level with deficiencies in their basic mathematics. Every year a diagnostic test is given to incoming first year students in the Dublin Institute of Technology (DIT). This test consistently reveals problems in many core areas of mathematics. It is difficult to motivate many students to seek help in the Maths Learning Centre to address these problems, and they struggle through several years of engineering carrying a serious handicap of poor core mathematical skills. Some initial testing of final year students showed that students carry these problems with them through their entire undergraduate course.

A pilot project set up a "module" in core mathematics. The course materials was basic but with a very high pass mark of 90%. Students were allowed to repeat this module as often as they liked until they achieve a pass mark. An automated examination for this module has been developed on WebCT and a bank of questions been created. Initially, this project was piloted as part of the third year Ordinary Degree mathematics module in Mechanical Engineering and proved very successful with 88% of the students achieving a mark of more than 90% in this "module".

Given the success of this module the pilot project was extended to five programmes doing Ordinary level degrees in Engineering in the DIT, across three different years.

The Diagnostic test was also given to a large sample of Fourth year students, confirming that many fourth students still struggle with basic maths.

Full results and analysis of this extended pilot will be presented, including the results of an online reflective survey and in depth interviews with a selection of the students.

Alternative:

A large number of engineering undergraduates begin their third-level education with significant deficiencies in their core mathematical skills. Every year, in the Dublin Institute of Technology (DIT), a diagnostic test is given to incoming first-year students, consistently revealing problems in basic mathematics. It is difficult to motivate many students to seek help in the Maths Learning Centre to address these problems. As a result, they struggle through several years of engineering, carrying a serious handicap of poor core mathematical skills, as confirmed by exploratory testing of final year students.

In order to improve these skills in engineering students, a pilot project was set up in which a "module" in core mathematics was developed. The course

material was basic, but a grade of 90% or higher was required to pass the module. Students were allowed to repeat the module as often as they liked until they passed. An automated examination for this module was developed on WebCT, and a bank of questions created for it. Initially, this project was piloted in the third-year Ordinary Degree mathematics module in Mechanical Engineering in the DIT, where it proved very successful.
Subsequently, the pilot project was extended to five Ordinary Degree engineering programmes in the DIT, across three different year-groups. Full results and analysis of this extended pilot will be presented, including the responses to an online, reflective survey and in-depth interviews carried out with a selection of the students involved.

From differential equations to real-world problems in Control Engineering

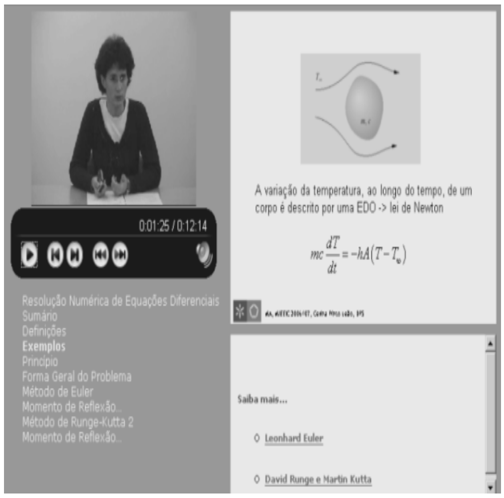
Sandra Costa[1], Isabel Mendes[2], Filomena O. Soares[1], Celina P. Leão[1]
[1]University of Minho, Guimarães, Portugal
[2] University of Minho, Braga, Portugal

In 2009 SimLab [1], a virtual laboratory for the modeling and simulation of real-world problems in process control engineering was developed (Fig. 1). One of the major goals of SimLab is to gather student's attention to how numerical methods in the resolutions of differential equations can be straightly employed in Process Control real-world problems. In fact numerical methods are used in control simulations running in open and closed loop. In this paper, the study performed in order to facilitate the student's acquired knowledge assessment by using SimLab, is described. For that, a list of exercises of multiple choices, focusing elementary concepts of Ordinary Differential Equations, were produced.
Simultaneously, the theoretical pedagogical aspects of the module on differential equations were making accessible in streaming [2] (video with the teacher presentation, added with PowerPoint presentations and complemented with support activities), Fig. 2. These activities were based on problems resolutions to be discussed on face-to-face classes. The degree of satisfaction with this experience was significantly elevated. The students had no difficulties in access these materials, showing a technological knowledge perfectly suited to the requirements of consulting streaming contents. Under the pedagogical point of view, the majority of students strongly agree that this form of content gives them the opportunity to study at times that they consider more convenient and to promote self-evaluation.
At the moment, and following this order of thought, the study of the use of the SimLab as a tool in the students learning process is being carried out. In the Control teaching/learning process, SimLab allows the user to choose the

practical engineering problem and the control type to be implemented. The control problems are modeled by a set of differential equations. SimLab, as a didactic tool, allows testing several numerical methods in the DAE solution, building synergies between the different acquired competencies during the student academic path.

Fig. 1. Web page for Numerical Methods and Control Simulator, SimLab (www.labsim.dei.uminho.pt)

Fig. 2. Page of the module presented in streaming



References:

[1] Lemos, F.; Leão, C.P.; Soares, F.O., "SimLab: A Virtual Lab for Control Problems. An undergraduate Experience", in VU2008 - Virtual University Proceedings, Bratislava, Slovak Republic, December 2008, 6pp.

[2] Santos, H.; Pereira, T.; Leão, C.P.; Mendes, I.; Soares, F.O., Streaming Contents and RSS Feed in a Pedagogical Environment. Proceedings of the World Conference on Computers in Education IFIP WCCE 2009. Bento Gonçalves, Brasil, July 2009. 8pp.

Nationwide Assessment of First Year Engineering Students in Mathematics in Hungary 2009

Aniko Csakany*,
Budapest University of Technology and Economics, Hungary

Keywords: assessment in Mathematics, engineering students, admission system of higher education, Mathematics education

Professors and lecturers involved in programs in engineering or in natural sciences in Hungary often experience that students entering higher education have a weak background in Mathematics, Physics, and Chemistry in the past few years in Hungary. Lately separated pilot programs were launched by different institutions for assessing the level of knowledge of freshmen starting their studies in these three subjects. In 2008 the Engineering Committee supervised by the Panel of Presidents and Rectors of Hungarian Universities proposed to extend the project to national level. The goal is to assess the background of students starting programs in engineering in Mathematics, Physics, and Chemistry. Universities running programs in natural sciences also joined the project in 2009.
The coordinator of the project in Mathematics was Budapest University of Technology, strongly supported by Eotvos Lorand University. The purpose of the program was to obtain data about the Mathematics knowledge of students that is thought to be essential by professors in higher education. Thousands of students from different institutions took part in the assessment project. The students took the test during the registration week at the beginning of the fall semester of 2009. Based on the results consequences can be drawn about how well secondary education in Mathematics meets the requirements of higher education in Hungary. Conclusions concerning inconsistencies of the admission system of Hungarian higher education also can be obtained.
This paper presents the results and summary of the Mathematics assessment project. The talk highlights the aspects of the assemblage of the proposed Mathematics test, and summarizes the experiences of the project.

Use of Technology for Mathematical Education

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Key words: mathematics, education, software

This paper reflects on the situation in the Republic of Macedonia regarding the mathematical education.
The Macedonian Government project “Computer for every child” is a part from the initiative “Education and Training for Everyone”, based on the National program for the development of the education (2005-2015). For the purpose of this project, a supply of 17,818 personal computers and over 200000 other computational appliances was provided for the primary and secondary schools in Macedonia. The ambition is to achieve 1:1 ratio of computers per pupil in the public schools. This is the largest project in the country's 18 years of existence.
For the needs of actual realization of this project, this research aims to develop tools for educational instructions, trainings, guides for software usage and educational materials in digital and printed form for mathematics.

Implementation of learning outcomes in teaching mathematics

Tatiana Gavalcová*, University of Hradec Králové, Czech Republic

The contribution deals with the problem of implementation of learning outcomes (LO) into the study of programmes with a mathematical content, especially with application of LO as a tool in the teaching/learning of mathematics in informatics programmes. Activities of Bologna process in its 2nd decade are concentrated on a raising of quality in higher education, and several authorities (Declan Kennedy, Volker Gehmlich, the group dealing with the European project Tuning etc.) present a strong argumentation for changes in education approaches: the implementation of LO closely connected with a learner-centred education serves for that purpose as a specific study management. In frame of LO, the contribution deals with the structure and necessary subsequent internal changes in education strategy in mathematics, their impact on activation of learners and the quality of education, and with teachers and learners attitudes as well.

The Use of Technology in Mathematics - approaches used and lessons learnt at ITT Dublin

Noel Gorman, Martin Marjoram, Donal Healy, Ciaran O'Sullivan, Paul Robinson, Institute of Technology Tallaght, Dublin, Ireland

Whilst addressing the mathematical learning needs of students pursuing technical courses is multi-faceted, this paper will describe several uses of technology made by Mathematics staff in ITT Dublin to support students learning of mathematics and it will also address the lessons that have been learnt in how best to use these technologies.
The first example of technology described is the use of the CALMAT mathematics learning environment as a tutorial support tool, as a complete learning environment for different student cohorts and as a mechanism to facilitate the re-engagement of mature students with mathematics. Secondly the implementation of a *Moodle*-based initiative at IT Tallaght called '*Key Skills Testing in Mathematics*', which has the aim of helping students bring mathematical knowledge with them from one semester to the next is explored. Thirdly the use of *MAPLETA* to construct an alternative approach to engage first year marketing students with the mathematical learning is described. Finally the use of an e-book as a part of a preparatory mathematics course is outlined.
In terms of lessons learnt from these uses of technology to support mathematics the following are addressed: the promotion of active learning, the need to use the same technology differently depending on the profile of students being supported and the importance of providing suitable cognitive scaffolding so that students reflect appropriately while using technologies so as to optimise their mathematics learning.

Promoting active learning in Mathematics - a 'Problems First' approach.

Donal Healy, Martin Marjoram, Ciaran O'Sullivan and **Paul Robinson**
ITT Dublin, Ireland

The engagement of students in active learning in mathematics is an ongoing challenge. As a sudden move from a traditional mode of mathematics delivery of a complete module to an enquiry based approach for the module appears daunting, an approach of ongoing incremental change in delivery is under investigation at the ITT Dublin. This paper describes a '*Problems First'* project in which mathematics lecturing staff identify a section or aspect of a Mathematics module which is suitable for modification of approach from a traditional one to one in which the students encounter sets of mathematical problems first. The students do these problems using appropriate materials, aids to reflection and other inputs. This is followed, as needed, by some lecture input to ensure that the necessary learning outcomes have been achieved.

The *'Problems First'* project was implemented on three modules:

1. In the first module, a first year Mathematics module on a pharmaceutical science course, the implementation consisted of an unseen problem being given to small groups of students early in the semester. The students were directed to online preliminary notes and library books and were encouraged to discuss the problem with the lecturer at any time.
2. In the second module a '*Key Skills Testing in Mathematics'* Moodle based testing approach is used to reinforce key mathematical skills needed for a particular semester of engineering and is implemented as part of a Mathematics module for a 3rd year electronic engineering course. An additional reflection sheet was deployed to help students reflect on, and take action on, key areas highlighted for them by their performance in these '*Keyskills'* tests.
3. In the third module, a Mathematics module in the first year of a degree in Mechanical Engineering, for the first 6 weeks of the module problem sheets were given to the students first. These problem sheets were augmented by notes given to the students and by input from the lecturer. As well as the development of the materials to enable this approach to be undertaken, a reflective diary template for the lecturer was developed and maintained for this section of this module.

In this paper the implementation of this 'Problems First' approach in these 3 modules is outlined. Also presented in this paper is the student feedback relating to the facilitation, documentation and learning outcomes of the project as well as any effects on group dynamic during the project**.** Finally the effectiveness of this approach is examined by comparing student performance in continuous assessment and end of semester examination in these modules in January 2010 with the performance data for similar students from previous academic years.

Longitudinal Analysis of a Key Skills in Mathematics Initiative

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The drive towards mass education, and the year on year fall in popularity of technical based subjects in Ireland (and other western countries), has created cohorts of students in many technical courses who are ill-equipped to succeed on those courses. Compounding this problem is the fact that most students in Ireland are now on semesterized courses, which seems to encourage students to learn enough for the regular examinations, without necessarily taking time to reflect on what they have learnt.

At IT Tallaght we have implemented an initiative called Key Skills Testing in Mathematics as a simple and efficient means to encourage knowledge persistence and reflection. Using the Moodle platform, Key Skills consists of;

1. creating many categories of multi-choice question which we believe our cohorts of students MUST be able to do. Each question comes with feedback and reference to a book chapter and an electronic resource.
2. creating tests which draw randomly from particular categories of questions. These tests may be repeated several times over a semester and only a high mark is rewarded with credit.
3. different tests run for different groups and in different semesters, reflecting the Key Skills of previously taught material required for that semester.

The aim is for students to expect Key Skills in each semester, re-inforcing and repeating their learning. We view our project as a simple, structured attempt to embed reflective learning into each mathematics module.

This project has entered its third year in September 2009. We would like to present an analysis of our results so far, looking at performance on Key Skills tests over 5, 4 and 3 consecutive semesters for different groups of students. We will present evidence that students improve over a semester and that, semester on semester, students first attempts in a new semester are better than in previous ones (hinting at long term skills retention).

Simulation programs for teaching quantum mechanics

Peter Junglas, Private FH Diepholz/Vechta, Germany

Fundamentals of quantum mechanics are part of most physics curricula for engineering students. For the teacher this is a quite nontrivial didactical task, since the mathematical tools necessary for a deeper understanding are much too advanced and the phenomena themselves are mind-boggling.
Simulation programs can be useful here by illustrating the behaviour of quantum mechanical systems and allowing a hands-on approach. Several example applets will be presented that solve the two-dimensional Schrödinger equation to help understand notions like uncertainty, the tunnel effect and energy eigenstates.

Mathematical modelling competencies: meaning, teaching and assessment

Gabriele Kaiser, University of Hamburg, Germany

The lecture will start with a description of the state-of-the-art on the meaning and conceptualisation of modelling competencies as well as on the ways of learning and teaching of modelling competencies at different educational levels.
Afterwards, modelling activities, which are adequate to foster modelling competencies, will be described, especially experiences from longer activities such as modelling weeks with students from upper secondary level (age 17-19). Several authentic examples dealt with in these modelling weeks will be discussed, e.g. optimal automatic irrigation of a garden, development of infected ladybugs, optimal chlorination of a swimming pool.
The talk will finish with the description of the results of an evaluation of one recently carried out modelling activities, in which the development of modelling competencies of the students were evaluated based on an adapted version of a well-known questionnaire. The results show the possibility to foster modelling competencies with extended modelling activities and complex modelling examples.

Modelling by Differential Equations – From Properties of Phenomena to its Investigation

V. Kleiza, O. Purvinis, Kaunas University of Technology, Lithuania,

The Panevezys branch of Kaunas University of Technology comprises Business and administration faculty and Faculty of technology. They host students of business administration, civil engineering, electrical engineering, management and mechanical technology. The level of proficiency of different mathematical topics slightly differs for different specialties. But engineers of all specialties will need mathematical knowledge for the solution of practical problems and for research in the fields of mechanics, control, techniques, physics, economics etc. Students of business administration faculty also cover topics of ordinary differential equations that are included in the general course of higher mathematics.

The paper discusses methodological issues of teaching of ordinary differential equations (ODE) to the bachelor and master students of Faculty of technology and bachelor students of Administration and management faculty.

According to our experience of many years, students better understand the theory of ODE if it is illustrated with applications. For building up models we use mechanical and economical problems and solve the inverse problems for ODE as well. Our opinion is that the inverse problems promote better understanding of the very modelling idea. The modelling by mathematical means we present as process including five steps- real-world problem and initial evaluating of its properties, building up a mathematical model, solving the model (for instance, solving ODE), investigation the solution mathematically, formulating the results in the terms of real-world problem.

The paper includes a plan of a typical lecture featuring the above mentioned methodology. Attention is devoted to the explanation of difference between direct problem and the inverse problem and to the correctness of the inverse problem.

Teaching Unusual Applications to Engineering Students: Students' Attitudes

Sergiy Klymchuk*, Ajit Narayanan*, Tatyana Zverkova, Norbert Gruenwald***, Gabriele Sauerbier*****

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**Odessa National University, Ukraine

***HS Wismar, Germany

This paper presents results of two studies on using an innovative pedagogical strategy in teaching mathematical modelling and applications to engineering students. Both studies analyse engineering students' attitudes towards non-traditional for them contexts in teaching/learning of mathematical modelling and applications: environment and business. On the one hand, the contexts are not directly related to engineering. On the other hand, chances are that most of the graduates in engineering will be dealing with mathematical modelling of environmental and business systems in one way or another in their future work. This is because nearly every engineering activity has an impact on the environment and has commercial implications. The first study deals with using differential equations in the environment and ecology. The second study deals with using linear programming for maximizing profit and minimizing expenses for a company. Practice was selected as the basis for the research framework and, it was decided 'to follow conventional wisdom as understood by the people who are stakeholders in the practice' (Zevenbergen & Begg, 1999). The students' mathematical and modelling activities in the class as well as their attitudes were the research objects. Analysis of students' responses to questionnaires, their comments and attitudes towards the innovative approach in teaching are presented in the paper.

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About the Activity CEEPUS Network HU-0028

Péter Körtesi, University of Miskolc, Hungary

CEEPUS is an acronym for "Central European Exchange Program for University Studies". a cooperation form created by the central Eu states Austria, Bulgaria, Hungary, Poland, Slovakia, and Slovenia, and involving by now 15 countries altogether, including Albania, Bosnia-Hercegovina, Croatia, Czech Republic, Macedonia, Montenegro, Romania, Serbia, Prishtina/Kosovo. The main objectives of CEEPUS are to

- contribute to **merging the European Higher Education Area and European Research Area**
- use **regional academic mobility** as a **strategic tool** to implement **Bologna objectives**
- enable cooperation with SEE, the Ukraine and Moldavia

Most of the founding partners of the above mentioned network have been co-operating before in the SEFI- Mathematics Working Group. The making up of the network was due to the SEFI cooperation, but the collaboration has got new dimensions due to the regular visits, possibility offered by the CEEPUS networking in the previous years. We consider a special merit the fact that in

February 2006 our network was awarded the CEEPUS Ministers' Prize for Excellence due to our joint activity. The series of Computer Algebra Driving Licence Summer Universities (2003-2009), which involved more than 180 students and their teachers, was extended beyond the CEEPUS partnership as well. The relative great number of partners is an advantage of our network, as we can offer study exchange for our students in most countries in Central and Eastern Europe, and cover a large area of subjects. The students have been included in co-operation due to this form of activity as well. They participated actively in the preparation of the social program of summer universities and intensive courses. They are involved with the creation of a special students' web page for keeping contact with their colleagues.

We do extended our cooperation to the activities of Leonardo pilot project the European Virtual Laboratory of Mathematics Project No. 2006 - SK/06/B/F/PP - 177436 see web page: http://www.evlm.stuba.sk/. Since last year our partnership includes 3 of the partners of the EVLM project as well, and we wish to extend the dissemination of the results to our larger partnership in CEEPUS cooperation.

The most important activities combined with the CEEPUS network activity are:

- the cooperation in the SEFI- MWG.
- some Socrates projects,
- some Tempus projects,
- bilateral agreements due to the cooperation, and
- many conferences, like the Conference on the History of Mathematics and Teaching of Mathematics, Miskolc 2004, 2006, Tg Mures in 2008, Szeged 2010, (www.uni-miskolc.hu/hmtm), which are important scientific outcomes of our network, and involving many of the students in partnership. We did continue to take part in the SEFI-MWG European Seminar on Mathematics, following to Miskolc, 2000, like in Göteborg, 2002, Vienna, 2004, Oldsbergs, Norway, 2006, Loughborough University, 2008.

Our networking involved in the last 9 years about 950 student and teacher visits, and we did obtain more than 160 extra places for summer university activities. We do plan several joint degree programmes and these en-cotutelle in PhD. We used the partnership to organize events like a computer algebra workshop as a satellite for the SEFI-IGIP Joint Annual Conference, 2007 Miskolc, CAAM in Baia Mare each September. or ICELM Tg-Mures every second year. We plan to continue the joint research activities, reflected by joint publications in journals like Miskolc Mathematical Notes, Carpathian Journal of Mathematics, or Creative Mathematics, and we plan to make up a new Electronic Journal on Teaching of Mathematics in Rousse, based on the CEEPUS cooperation.

Mathematical Modeling for Teaching Mathematics Using CAS

Tsvetanka Kovacheva*, Technical University Varna, Bulgaria

The paper discusses the implementation of the mathematical modeling in solving applied mathematical problems by computer algebra system (CAS). It presents also possibilities of these systems for students of Technical Universities in learning of mathematics. This paper aims to provide the students with some basic modeling skills, which will have application to a wide variety of problems.

A never ending story – mathematics skills & deficiencies of first semester students and study success

Gunther Kurz et al., Hochschule Esslingen, Germany

In Germany two main certificates regulate the admission to fields of study at Universities of Applied Sciences. The general admission certificate (’Abitur certificate’) represents the traditional entry qualification to university studies and a large variety of specialized certificates (’Fachhochschulreife certificates’) admits students to study courses at Universities of Applied Sciences.

The two investigations presented should be seen on the background of (1) politically motivated modifications of the Bologna process (especially in the Bachelor cycle) and (2) the political demand to include tests and/or interviews into the admission process.

Project 1: In winter term of 2008/09 an entry cohort of 670 beginning students in engineering participated in a mathematics test. The test consists of 31 items [calculus (12), trigonometry (8), elementary functions (5) and analytical geometry in a plane (6)]. The results were analysed in detail with respect to (1) the various admission certificates and (2) standard test theoretical criteria (index of difficulty; discriminatory power). The main problem for the introductory mathematics course is the spread of the results over five standard deviations [1].

Project 2: In a long term investigation the study process and success of two entry cohorts in mechanical engineering (139 and 117 students) were and are still monitored [2]. Predictors for graduation are the ’final grade of the admission certificate’, the ’mathematics grade’ in secondary education, the result of a ’mathematics test’ and a field specific competence test ’engineering’. Results of bivariate correlations and the incremental validity of different prediction models [(1) admission grade, (2) admission grade + mathematics; (3) admission grade + mathematics + field specific test] stress the need for a sound base in mathematics in engineering studies.

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Requirements for Mathematical Education for Engineers from an Industrial Point of View

Dirk Labuhn, Airbus, Bremen, Germany

Having delivered up to now more than 6000 aircrafts worldwide, Airbus has a long history in managing the skills and competencies that are required within its different engineering domains. Typical analytical tasks in the aircraft structure are, static stress, fatigue and damage tolerance, vulnerability and thermal analyses, among others. This lecture aims at giving an insight into the skills that are required in the structural analyses domain and to link these requirements to the respective needed understanding of mathematics.

Some of the required modelling skills are taught in Airbus internal trainings, e.g. on company specific add-ons to commercial standard tools and the Airbus way-of working with the tools regarding validation of input quality, data storage rules, quality checks and publishing of results.

Other modelling skills are seen as prerequisite for the job and are expected to be available even for newcomers from universities. The two of the most prominent skills required are as follows: first is the ability to use a method, for example, Finite Element Method (FEM) with a given tool, that is to perform basic tasks such as modelling and meshing the geometry and applying loads to the mesh, and second, is the ability to check results obtained from the tool for their credibility or to make a quick assessment of the impact of changes in the design or in external boundary conditions. "Never trust the tool" is a kind of basic rule that is given to every newcomer in the structure analysis domain, but to facilitate this understanding, the physics behind the tool has to be well understood, e.g. conservation of energy for thermal analysts and of momentum static stress analysts.

Both types of skill require the same competences in the field of engineering mathematics, only to a varying degree. To use a FEM tool, knowledge of

geometry, calculus, algebra and vector analysis is required to a certain extend. In order to check results for their credibility, the same knowledge as for the use of the tool is required but in addition, the physical equations governing the mechanics need to be well understood.
This additional physical understanding of mechanics is the driving factor regarding industrial requirements on engineering mathematical education and it leads to the following questions: “What mathematical skills are required to enable and support the understanding of relevant physical phenomena and second, how can these mathematical skills for engineers be taught in the most efficient way?”

Supporting the Composition of Micro-Modular Content for Mathematical Learning Modules

Karin Landenfeld, Thomas Preisler, Wolfgang Renz and Peter Salchow
Hamburg University of Applied Sciences, Germany

Within several current e-learning platforms support for construction and delivery of micro-modular contents is provided. For mathematical applications, e.g. the Mumie[1] platform provides such functionality in conjunction with an integration tool for composing the contents into modules with learning paths. Similarly, other projects like LON-CAPA[2] and LeActiveMath[3] provide platform-specific tools to compose contents to be delivered by that platform. Learning modules as provided by the current e-learning platforms do not support the individual reuse of micro-modular content and their easy composition for the needs of different lecturers in a satisfactory manner.

In this paper we focus on the need of composition support for adaptive contents. In particular the following requirements which are essential for basic mathematical education in our university of applied sciences are addressed:

- reuse of micro-modular content for different lecturers,
- combination of micro-modules of different content types,
- partial, selective reuse of micro-modular content for courses in different application fields,
- their easy composition to modules and courses and
- export of composed modules and courses to different e-learning platforms, e.g. Moodle[4].

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[1] http://www.mumie.net
[2] http://www.lon-capa.org
[3] http://www.leactivemath.org
[4] http://www.moodle.org

These use cases are not the main focus of the tools provided by the platforms mentioned above. Consequently, a platform independent tool is needed which is in process of development within our current project. It provides

- a central repository of inhomogeneous micro-modular contents,
- an annotation tool for description and configuration of each micro-module using the wiki paradigm for our universities math lecturers' community,
- ergonomic views, browsing and composition including
  - screenshots of applets (e.g. Mumie Mathlets),
  - in-place preview,
- search functionality using meta-data,
- module templates (e.g. containing visualizations, tests, lecture notes) for several base mathematical topics for adoption in different courses and
- access and version control.

The module templates for the above mentioned mathematical base topics ease the fast creation of uniform modules based on the micro-modular contents. Consequently, the aggregation of interrelated content to structured modules helps students to comprehend the topics and raises the quality of mathematical education.

Video Resources for Mathematics Support

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Sigma, Coventry and Loughborough Universities, UK

Mathematics Support Centres are now well established throughout Great Britain and Ireland. Such centres are also starting to be established throughout continental Europe. A key component of mathematics support centres is the resources that are made available to learners who use the centre. There are extensive banks of resources available over the internet from sites such as **math**centre (www.mathcentre.ac.uk) and EVLM (http://www.evlm.stuba.sk/). These resource banks have been built up over a number of years. A recent addition to resources for mathematics support is the use of video-based material: an extensive collection of such material can be found in **math**tutor (www.mathtutor.ac.uk). The video tutorials in **math**tutor are typically 40-50 minutes in length and are best viewed on a PC with a good sized screen. In this paper, we will report on more recent developments in the use of video materials for mathematics support. These resources are much shorter in length (maximum 10 minutes) and are designed to be usable on small portable devices such as mobile phones and MP4 players as well as on PCs and laptops. In addition to presenting some of the resources, this paper will also discuss appropriate distribution mechanism and highlight the success achieved using iTunes and Youtube as well as more traditional academic distribution mechanisms.

Modeling toward numerical solution of an applied engineering problem

Leão, C.P.; Teixeira, S.F.C.F. University of Minho, Guimarães, Portugal

Keywords: modeling, differential equations, human thermal comfort model

Some of the difficulties in the teaching/learning process, namely in the area of the numerical solutions of differential equations, are very well identified. Real life engineering problems can be usually described by sets of differential equations that are mathematical approximations of the physical reality. Normally, this model includes one or more differential equations and a set of initial/boundary conditions. Writing a differential equation model to represent a physical problem, can be a very demanding task to freshmen students. Some difficulties also arise in solving the final mathematical model. This can be facilitated by using some sort of software. The informatics tools allow the connection with real problems and the successive construction of knowledge, independently and in accordance with the flow of the work. Most of all, in such a way, that can improve students' motivation [1].

With a group of students of the MSc in Industrial Engineering Management, an experience has been done on the knowledge application to be gain in Ergonomic Workplace studies area. It was made available to the students a system of differential equations describing the human thermal comfort. They have to solve this model and to simulate it under different conditions. In this work, the students were able to consolidate their knowledge of differential equations at the same time they need to understand the meaning of each component of the human thermal model (environmental conditions, physical proprieties of clothing, contribution of radiation transfer, body metabolism). To obtain the numerical solution of differential equations, the students use and compare different software: commercial (MatLab) and educational (ConfTermal V2, Fig.1). ConfTermal is an educational software, developed at the University of Minho, thus contributing to improving education and providing a complement to the methods used today [2].

Some of the experiences that have come to be performed by the team, to motivate and awareness students to this area are presented in this work. The main difficulties reported by students will be highlighted and they will be used in order to improve this teaching/learning methodology.

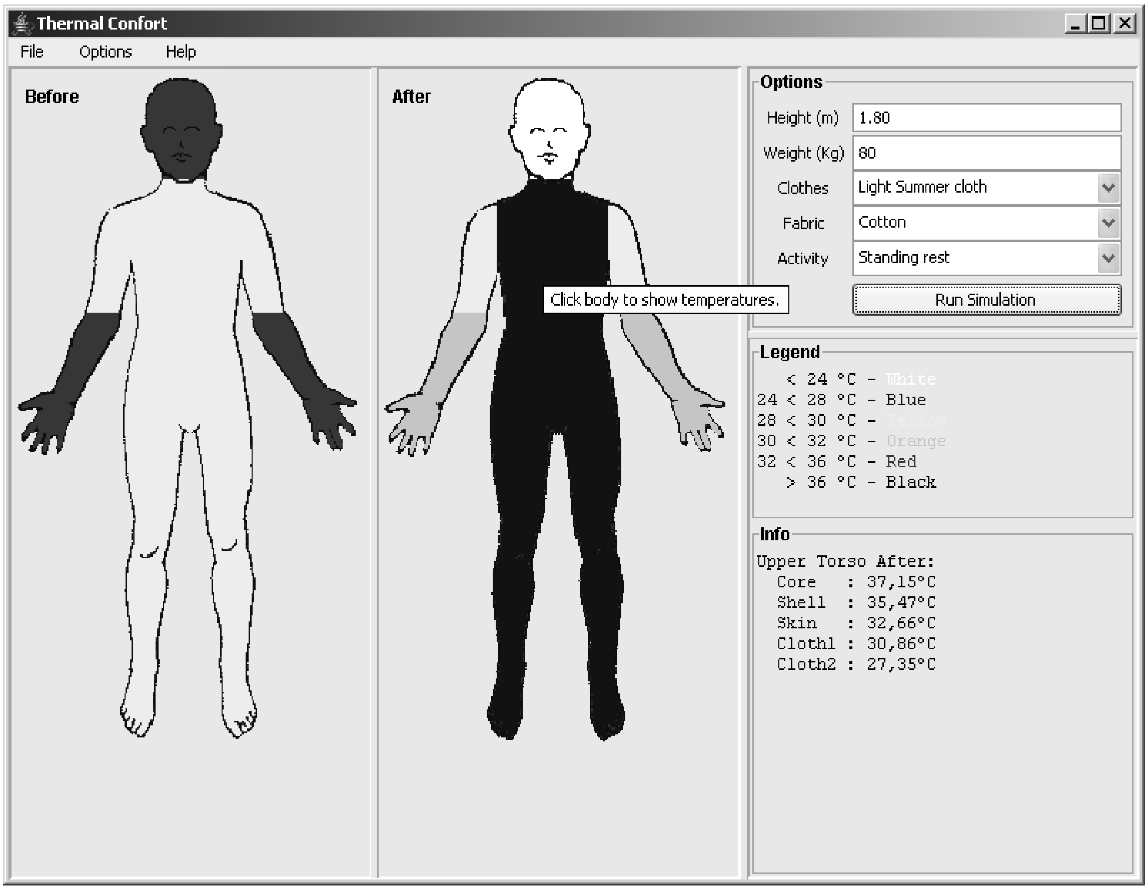

Fig. 1. ConfTermal V2 software main menu

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Technology assisted assessment as a strategic and pedagogical tool in engineering mathematics

Kari Lehtonen, Helsinki Metropolia University of Applied Sciences, Finland

In this presentation, we will first discuss the technology assisted diagnostic testing and assessment systems that have been used in basic mathematics in Helsinki Metropolia University of Applied Sciences (formerly Helsinki Polytechnic Stadia). Also the role of assessment in the learning process will be considered.

In the future, assessment will be an integral part of the learning process. Future classrooms will embed assessment in instruction in a fundamentally new way. Instructors will be able to monitor their students advancement continuously. If a student is in danger of dropping out, immediate action can be taken. Instructors also get meaningful feedback on how effective their teaching is, and hence will be able to adjust to the needs of the class as a whole and to students as individuals. The present form of assessment of learning outcomes will be replaced by assessment for learning instead of assessment of learning.

The diagnostic testing and assessment system used in Helsinki Metropolia University of Applied Sciences is provided by WebALT Inc., and it has been partly developed in two EU projects. The core of the system is algorithmically generated and checked problems that give also detailed feedback. The system is used administratively to place students in appropriate study groups and also pedagogically to monitor and support the actual learning process in first-semester mathematics courses. Results show that technology clearly promotes learning. However, there are still some problems. It is difficult to get full involvement from both students and teachers to use the system and so far there has been insufficient administrative support.

Secondly, we will give a state-of-art review of learning technology that can be used in teaching mathematics, both in independent self-study and in classes with the teacher. These include learning environments, multimedia, and testing and homework systems.

By proper use of technology, also the new assessment for learning is possible. It is a combination of stealth assessment, performed automatically by the learning system used, automatically graded homework offered by a system that generates a virtually unlimited number of different science problems with meaningful individualized automatic feedback, and advanced real time quiz systems, in which students answer questions by sending SMS messages to a server.

Lastly, we will outline a new comprehensive way to organise the crucial start of engineering mathematics learning with support from advanced learning technology. This will include tight cooperation between admistration, curriculum planning, student support services, teachers, and other stakeholders. Experience has shown, that the proper pedagogical immersion of learning technology will vastly motivate teachers and students and it will lead to better learning results and a more rewarding learning process. Technology supported assessment systems, both online and in classes, will be an essential tool in this process.

The periodic system of mathematics

Håkan Lennerstad, Blekinge Institute of Technology, Sweden

As a large poster, a suggestion for a periodic system of mathematics, displays a selection of the 116 most basic and important functions in engineering mathematics. Almost each other function that appears in engineering is some kind of combination of these 116 functions, using some combination of six ways to combine functions: linear combination, product, ratio, composition, different cases for different x, and convolution.

Each of the 116 functions is assigned a certain square in the table, and the functions are ordered in thirteen families. In the square, the graph of the function is given as a fat red line, highly visible and behind all other symbols. The square also contains symbols for local and global properties, when applicable, which can also be observed geometrically in the graph. Furthermore, the graphs are connected by lines and arrows in a specific colour chosen for each relation between functions, such as derivative or inverse functions. For the basic functions, the table thus presents families, properties and relations.

Families: Natural powers, negative integer powers, singular roots, non-singular roots, logarithms and hyperbolic inverses, exponentials, bounded trigonometric functions, unbounded trigonometric functions, trigonometric inverses, special roots and rational functions, causal functions, impulse "functions".

Local properties: Zero, local minimum and maximum, point of inflection, various types of discontinuities, impulsive singularities, convergent generalized integrals.

Global properties: Continuous, convex, concave, odd/even, increasing/decreasing, injective, surjective, periodic, bounded, solution to a linear differential equation.

Relations: Inverse functions, inverse values, derivative (hence also anti-derivative), translation, dilation, Fourier transform, Laplace transform.

A student that has understood the basic idea and is familiar with the most basic functions, can easily become familiar with many other functions as a course proceeds, since the same notation is used everywhere. An intended use is to simplify dialogue about mathematics. It is very useful in a mathematics classroom.

The table makes it very easy to compare properties between different functions, and to study a certain property by finding new unknown examples. At the same time a student becomes familiar with important functions, since only such functions are present. Huge amounts of mathematical knowledge are presented in an organized way, and a form that is appealing from an esthetical point of view. It has been the subject of an art exhibition in Sweden.

This is a poster that requires a presentation. Copies in a large format will be available.

What type of student avails of Mathematics Support and extra Mathematics Initiatives?

Ciarán Mac an Bhaird and **Ann O'Shea,** National University, Ireland

Mathematics Support Centres and extra mathematics initiatives are principally set up in third level institutions to help 'at-risk' students. The majority of these students are service mathematics students such as Science, Humanity or Engineering students. In this paper we will present our research into student attendance and behaviour which indicates that other factors along with student ability should be taken into consideration. For example, final year students who avail of such services are generally not 'at-risk' but rather students who have done well in their previous assessments and are looking to obtain the highest grades possible in their degrees. We will discuss these findings and their impact on the type of services that we provide.

IMPETUS for the Engineering Sciences

Kerstin Matter, Katherine Roegner,
Technische Universität Berlin, Germany

Since the introduction of the Bachelor degree in Germany, engineering students have even less time for learning mathematics. Required courses in mathematics provide basics, but much reduction in terms of content has occurred. Offering non-required mathematics courses can only partially solve this problem. Engineering students in Germany have precious few credit points for which they can freely choose from elective courses, and here, they are more apt to choose such a course in their own field of studies. The aim of this contribution is to present the IMPETUS model for a non-required course that has mathematics as its core, yet is nonetheless appealing for engineering students. Within this model, students are motivated to take an active role in their own learning process. The knowledge gained in the course (currently statistics and MATLAB) can be immediately applied in a different setting, whereby statistical models are developed and assessed for actual research projects.

What Do They Really Need to Know?: Mathematics Requirements for Incoming Engineering Undergraduates

Eabhnat Ní Fhloinn[1] and **Michael Carr**[2]
[1]Dublin City University [2]Dublin Institute of Technology, Ireland

Engineering programmes in Irish universities have a minimum mathematics requirement for all incoming students. At least 55% in Honour Leaving Certificate mathematics (the final examination after secondary school) is required in order to enter an accredited honours engineering degree programme. However, in recent years, a wide variety of practices have developed to allow students who have not obtained the necessary mathematics grade a second chance to enter into such programmes. These practices range from once-off mathematics examinations offered by individual universities to summer schools or bridging years to allow students an opportunity to improve their mathematical skills, and the initiatives have been of mixed success.
Previous research undertaken in the Dublin Institute of Technology has shown that the greatest predictor of successful completion of first year for an engineering undergraduate is their incoming mathematics level. Therefore, with the aim of establishing the minimum level desirable for new entrants into engineering programmes, we compare the Irish situation to the approach taken in several other European countries with equivalent engineering qualifications. We explore the merits of the various “second-chance” mechanisms and discuss how best to implement and standardise such approaches, with a view to attracting as many students as possible into engineering programmes while maintaining necessary standards.

Control Theory – association of mathematics and engineering

Wojciech Mitkowski, AGH UST Cracow, Poland
Krzysztof Oprzedkiewicz, AGH UST Cracow, HVS Tarnow, Poland

In a presentation we are planning to present main aspects of teaching Control Theory for students of different courses at AGH UST in Cracow and HVS Tarnow.
The Control Theory is area of technical sciences closely associated both with mathematics and engineering practice. This implies, that mathematical skills are absolutely necessary for automation engineer to solve all problems from area of develop, supervise and service of industrial control systems.

In the presentation the following problems will be presented:

- An introduction.
- Areas of mathematics applied in Control Theory: differential equations, algebra (matrix theory, polynomials), functional analysis, interval analysis.
- The methodology of teaching Control Theory: lectures, auditory exercises, laboratories
- A closed – loop control system and steps of their develop:
  - A mathematical model of the control plant,
  - A synthesis of the control system,
  - Simulations: MATLAB/SIMULINK,
  - Practical implementation.
- An example of real automation task solving by students during Control Theory course.
- Conclusions.

Physikalische Modellierung mit MapleSim
(Physical Modelling using MapleSim)

Thomas Richard, Maplesoft, Germany

Wir stellen die aktuelle Version der Modellierungs- und Simulationsumgebung MapleSim vor. Sie erlaubt das Modellieren technischer Systeme, die aus unterschiedlichen physikalischen Gebieten („Domains“) zusammengesetzt sein können. Dazu zählen Mechanik (rotatorisch und translatorisch) und Mehrkörpermechanik, Elektrotechnik und Elektronik, Thermodynamik, Hydraulik und Signalfluss. Diese Domains basieren überwiegend auf der Modelica Standard Library. Es werden sowohl akausale als auch kausale Beschreibungen unterstützt, womit sich die Software ebenso für den Anlagen- wie für den Regler-Entwurf eignet. Der Anwender setzt sein Modell aus vorhandenen oder selbstdefinierten Komponenten zu einem Blockdiagramm zusammen, gibt Parameter und die zu beobachtenden Größen („Probes“) vor und startet die Simulation. Dabei stellt die Software ein voll parametrisiertes System aus differential-algebraischen Gleichungen auf, das symbolisch vereinfacht und anschließend numerisch gelöst wird. Die Ergebnisse stehen in Form von 2D-Plots, 3D-Animationen sowie numerischen Datenlisten zur Verfügung. Für das Postprocessing stehen Templates zur Analyse der Gleichungen, Code-Generierung für C, Parameter-Optimierung, Monte-Carlo-Simulation und viele andere Aufgaben bereit. Optionale Toolboxen ermöglichen den Export nach Simulink und LabVIEW inkl. VeriStand sowie die Reifenmodellierung und eine vertiefte Analyse und Optimierung von Reglern.

Towards Mathematics Education Research – Does Physics Education Research serve as a model?

Peter Riegler, Ostfalia University of Applied Sciences, Wolfenbüttel, Germany

Up until the late 1900s Mathematics and Physics had shared a long common path of their histories. Mathematics continues to be of paramount importance to Physics also after the "big divorce" while Mathematics has created new scientific insights by separating itself from its physics roots. Given this split up it appears quite natural that the mathematical and physical strands of Education Research are basically separated. Yet concerning educational practice, both scientific fields share the top rank on the list of subjects students typically most dislike.

Physics Education Research (PER) has evolved to a consistent, coherent and noticeable subfield of academic Physics over the past three decades. Major successes encompass theoretical (e.g., how do students learn physics?) and applied aspects (e.g., how do we measure the effectiveness of physics instruction?). Interestingly, despite its importance to Physics Mathematics has played a minor role in PER, so far. From this, however, it cannot be concluded that Physics cannot provide support to its twin sister Mathematics when it comes to Education Research.

In this talk I will argue that quite on the contrary PER can serve as a model for the emergence of a strongly coherent Mathematics Educational Research (MER), in particular when it comes to education at university level. After reviewing the main findings of PER I will discuss how methodology developed by this field could be advantageously used by MER. I will discuss which questions should be addressed by MER as a consequence of hitherto PER results. I will also cover the implications of the reform of Physics instruction triggered by PER on teaching Mathematics and support the argumentation by results of ongoing research.

SAGE, the open source CAS to end up all CASs?

Thomas Risse, Hochschule Bremen, Germany

SAGE, the "Software for Algebra and Geometry Experimentation", is a full grown open source computer algebra system. It comprises and allows access to well known specialized open source computer algebra systems like GAP, MAXIMA, PARI, R, SINGULAR etc. and other optional ones.

SAGE is highly practical to support education in mathematics in every situation and on every level: comprising the CASs listed above it is powerful enough to support solving problems in many areas, let alone all engineering related branches of mathematics. At the same time SAGE offers a terrific web

interface that allows for easy utilization of this competitive alternative to the three big Ms: Mathematica, Maple and MATLAB.
The presentation demonstrates some of the feature of SAGE and substantiates SAGEs benefits not only for research but all the more for the education in mathematics.

Using Electronic Voting Systems for Active Learning

C. L. Robinson, Loughborough University, UK

In recent years concerns have been expressed about the level of student engagement in the learning of mathematics at university. There can be a wide variation in the level of prior knowledge of students and many students do not appreciate the importance of mathematics for their course. Often they are taught in large classes and poor attendance at lectures and tutorials is not uncommon. Universities are finding that they have to look at ways of addressing the issues of how to motivate and assist such students in their learning of mathematics.
The focus of this presentation will be the use of Electronic Voting Systems (EVS) to engage engineering students in the learning of mathematics. Some academic staff members from the Mathematics Education Centre at Loughborough University have been using EVS since 2007/2008 year to teach mathematics to undergraduate students from Mechanical, Automotive and Aeronautical Engineering departments. A study was designed to investigate the views of staff and affected students about the use of EVS in Mathematics classes. At the end of the first year of use, staff generally perceived EVS as an effective teaching tool. However there remained many unanswered questions for staff. In particular, how do we ascertain the types of questions which better engage students and which facilitate deeper learning?
This presentation will discuss findings from the literature and present different pedagogic approaches which can be adopted when using EVS. It will discuss the setting up of a University-wide EVS staff interest group at Loughborough University and some of the issues addressed. Finally it will highlight resources which have been developed for using EVS to teach engineering mathematics. These have been developed following mini-project funding from the sigma-cetl and include a website with over 300 multiple choice questions and links to question banks developed elsewhere.

Calculus in one Variable: One Spanish overview according to EAHE

Rodriguez, G -Garcia, A- Garcia, F – de la Villa, A - Spain

The adaptation to the European Area of Higher Education (EAHE) implies a new model of teaching and learning with active methodologies and learning based on competences. The deadline to introduce the new curriculum is the academic year 2010-2011. Then we have to discuss different approaches for such introduction.

In this paper we present the results of several different experiences of Calculus I courses for engineering in the EAHE structure. Aspects such the feeling of students and the comparison of grades will be analyzed.

We have designed our courses bearing in mind the following considerations:

1. Teachers and students: The statements involved in the educative process have to change, in deep, the attitude concerning the mathematical courses according to EAHE. The teachers need more effort to control the students` work and to prepare a good and realistic design of the course. The initial premise for students includes a necessary daily work (in the old model, the students` work is concentrated in the last period of semesters). After that, we have to encourage them for following all the designed activities in the course.
2. The materials. The teachers have to design a good and selected material. This material might include: A text book, taken for guide in the course, tests for auto-evaluation, worksheets and projects (for working in groups).
3. The technology. CAS (like Derive, Maxima, Mathematica, etc), Learning Management Systems (Moodle) and other portals are used.
4. The learning. The face-to-face learning, e and b-learning will be mixed and selected according to the needs and the possibilities of teachers, students, bureaucracy, etc.
5. The assessments. Taking into account the daily work of students, we have to be consequent and to be able to prepare a "continuous evaluation". Then the one minute papers, question marks, the projects, the periodic exams (one per month approximately) and the final exam will be taken into account for the final grade.

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Computer Tomography as a Project for Students

Dieter Schott, Hochschule Wismar, Germany

Computerized Tomography is a very popular subject which most of the people are confronted to during the process of medical diagnoses. Many people are surprised to learn that a lot of mathematics is behind the corresponding image reconstruction process.
It is shown that a teaching project with students about this subject is very efficient because a lot of important teaching aims can be supported including the main topics of the seminar:

- **Activation of learners** (subject of practical relevance, team work, competition between different groups, own initiatives and creativity, simulation experiments, presentation and evaluation of results),
- Teaching **modelling competencies** (discussion of suitable modelling assumptions),
- **Use of Technology** (computer software MATLAB, own routines, own user inter-face),
- **Project based teaching** of mathematics (discussion of different solution approaches,
- **Interdisciplinary character** (physics, mathematics, computer science, modelling, simulation, methodology of science, economy),
- **Flexibility** of the subject (adaptation to students level, distribution of tasks),
- Training of **problem solving**.

Discussing the tasks and problems within the project there are the following conclusions:

- **Mathematics** is needed everywhere.

- **Complex problems** often contain a lot of stumbling blocks.
- Without **good modelling** and without **good mathematics** nothing is going at all.
- **Practical problems** are solved with modern mathematical methods using **computers**.
- The education of engineers without **solid mathematical basics** is disastrous.

The impact of Cooperative Learning Scenarios on the applied mathematics education of Geomatics students

Thomas Schramm, HafenCity University Hamburg, Germany

Geomatics students need a profound knowledge in mathematics to master their studies and to be prepared for their life as engineer. The best way to understand this necessity is to apply the mathematical methods and techniques in scientifically sound projects. We offer summer camps in Spain to work in international student teams on surveying projects in archeological sites in Spain. The students apply laser scanning, photogrammetry and other high tech surveying methods. The resulting data must be assessed, evaluated and visualized using the methods learned before. Because of the scientific relevance of the results, the students are highly motivated. Cooperative Learning (CL) as a learning or teaching strategy is a part of Civic Education and successfully applied at schools and universities. The idea is that students of different levels of ability learn and act together in a group to achieve a common goal and improve thereby their understanding of a subject. We show that the categories of CL can be used to describe our projects and help to improve the learning and teaching processes.

Does CAS at school help freshmen in engineering sciences?

Angela Schwenk, Norbert Kalus
Beuth Hochschule für Technik Berlin, Germany

We know for a long time that students have many difficulties concerning the basic skills in mathematics. But during the last years students show new kind of mathematical mistakes: They lack the recognition of patterns and structures within mathematical expressions. The presentation will show examples.
Furthermore, during the last years there is also a change of paradigm of teaching mathematics at German schools due to bad PISA results. The focus is now on modeling and solving problems of the real world. CAS is often used. Even the final math exams of secondary schools are written with the help of CAS calculators. As a consequence practise in applying rules (for differentiation, integration etc.) is missing.

The theses of the talk are:
The lack in basic skills is caused by using calculators too early.
The lack in applying rules is caused by using CAS too early and too much.
What is to do?
First aid: The Beuth University of Applied Sciences introduced an online bridging course in addition to the existing bridging course in compact form.
We hope for a fruitful discussion.

Experiences with Use of Open Web-Based Student Response Services in Sciences

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Sør-Trøndelag University College, Trondheim, Norway
Lu Joan and Pein Pascal
School of Computing, University of Huddersfield, Huddersfield, UK

New mobile technology is going to change the nature of teaching, learning and social interaction. Students and teachers may integrate technology and learning both in and out of the classroom, due to portability of mobile devices and their ability to connect to Internet almost anywhere. They are ideal as a store of reference materials, learning experiences, and general-use tools for fieldwork.

Student Response Services (SRS) dedicated to mobile learning frameworks, consists of two main components: the handheld units, which the students use to submit a response during a voting session; and a control interface that is connected to a server. The handheld units use a wireless Internet connection to communicate with the server. The server has three main tasks:

- Set up the handheld units prior to the vote by using the control interface to upload the desired voting interface to each unit (i.e. buttons “A”, “B”, “C” etc. corresponding to the selected vote type)
- Collect the response from each handheld unit
- Processes the data to create graphical representations on the fly showing how the students voted.

The system is designed to collect student responses through a handheld device, such as for instance iPod Touch or iPhone. Initially, teacher open a voting session with minimum operation, then student responses a vote sequentially with a simple press on the button.

The system solution is web based and generic, whereby it may be utilized in all kind of process and product oriented instruction and training activities. It works on modern mobile devices that may read a HTML page. The SRS are constructed for use in vocational education and training, and in higher education courses. This is achieved through easy and flexible integration with interactive touch screen blackboards by utilizing Flash in combination with AIR and FLEX technology. The European Commission cofounds the R&D during 2008-10 as a pilot project under the KA3 ICT program.

The new active collaborative learning approach let students set the in-class terms for discussion in order to get a clearer view of their instant knowledge and perception. The new tool is flexible and intuitive to use, it easily displays complex interrelationships between topics, including most relevant or marginal choices, or what is most difficult to understand. It connects the teacher and student in a new way that it is impossible to do so quickly by using traditional methods. The tools were during the school year 2009/2010 tested and validated in vocational education in industry in Norway, UK, Sweden, Hungary, Romania, Slovenia and Slovakia, as well as in 7 physics courses and 2 courses in mathematics in Norway. The evaluations show excellent feedback from students and teachers.

A state of the art SRS solution will be demonstrated onsite during the SEFI seminar by distributing 30 iPods to the audience. The presentation will include the experiences obtained by using the new SRS for next generation wireless mobile handheld devices. The services are based up on XML-based standards and web authoring facilities for the contents available on web pages, by providing XML-based universal notation and interface including visualization of scientific and engineering drawings and graphs. The search facilities retrieve the postulates of the instructor through a service-oriented architecture that integrates semantic web into the system for retrieval of information from the knowledge base system. Closed solutions like the iTunes Store are not used, and the decision process solution system is open, flexible to achieve maximum interoperability.

During the testing period we experienced in interviews with the students, that they reported:

- It become more fun to participate in the science courses
- Their engagement is increasing
- They become more motivated to participate in the learning process in the classroom
- The students are very positive towards using the new technology, and most students want to implement the SRS in all courses as fast as possible
- The use of SRS is integrated into the training in such a way that they don’t feel it steel to much time from the lecture, since the control interface is designed in such a way that it is easy to merge it into the story telling of the teacher
- The SRS system solution for mobile devices is very flexible, whereby the students have suggested several new ways of using them into the training process

Our preliminary results show a clear positive picture for the SRS technologies impact during classroom-based training. These results are in accordance with recent reviews of the literature of the effects of using hardware based SRS.

A full paper will points out and discusses recent developments that bring mobile learning to the next level by using open web-based solutions for cheap Smartphones in education of engineers, keeping in mind the pedagogical challenges in the new learning environment. Mobile devices can be used almost anywhere, they are perfect platforms for situated and context based learning activities, where real life is used to provide stimuli and activity for learning.

Qualitative methods for nonlinear differential equations – the Solow model of long time economical growth

Raimond Strauß, University of Rostock, Germany

Many basic mathematical subjects and procedures of great relevance for the engineering practice are not even included in mathematics schedules of universities. The use of computers actually requires a more “higher mathematics”-knowledge than in the past. This will be demonstrated for nonlinear differential equations. We present simple qualitative methods to determine the essential solution behaviour of nonlinear equations, although we are not able to determine all solutions. This will be applied to the Solow model and other models.

Creating Cognitive Connections in Mathematics

Daniela Velichová
Slovak University of Technology, Bratislava, Slovakia

Research in cognitive psychology indicates that our brains store knowledge using both words and images. Instruction that targets and engages both of these systems of representation has been shown to significantly increase students' comprehension and retention. Explicitly engaging students in the creation and usage of non-linguistic representations has even been shown to stimulate and increase activity in the brain. This leads to creating cognitive connection that reinforce the knowledge and understanding of basic concepts. Manipulatives are concrete or symbolic artefacts that students interact with while learning new topics. They are powerful instructional aids because they enable active, hands-on exploration of abstract concepts. Research has shown that computer-based manipulatives are even more effective than ones involving physical objects, in part because they can dynamically link together multiple representations of the investigated concepts. At the beginning of the 3rd millennium we are facing a dramatic change in the basic nature of teaching and learning strategies caused by the massive usage of new technology. We can benefit from this development in general, and in mathematics especially, as currently available dynamic and visual learning environments could affect our perspective in terms of the content and comprehension of mathematics education. Extensive usage of new ICT has enlarged the pool of cognitive tools and possibilities of their application in teaching and learning processes.
Cognitive tools have their irreplaceable position in the didactics and educational theory and there exist a lot of ideas on how we can understand their role in education. These allow users to explore mathematical concepts dynamically and have been increasingly discussed in the recent years, as can be seen e.g. in the paper by Luis Moreno-Armella, Stephen J. Hegedus, and James J. Kaput: From static to dynamic mathematics: Historical and representational perspectives, published in Educational Studies in Mathematics, Vol. 68, where an historical overview of symbolization in mathematics is presented, which can be considered as the evolution of cognitive tools. They identify five stages of the evolution of symbolization *“from static, inert inscriptions to dynamic objects or diagrams that are constructible, manipulable and interactive”* (p. 103).
This paper brings information about dynamic multiplatform mathematical software GeoGebra produced by Markus Hohenwarter in 2002 for learning and teaching mathematics available in 45 languages for all interested users via

free download on web. GeoGebra enables production of self-standing dynamic worksheets as interactive java applets embedded in html pages presenting dynamic constructions and calculations interactively on the web, enhancing thus available powerful electronic tools suitable for production of instructional materials in maths education provided on-line. The dynamic worksheets prepared in the GeoGebra provide users to create dynamic mathematical objects and to interact with these objects. If we assume that these mathematical objects are the real objects of this platform, although the platform itself is virtual in nature, then the continuous interaction between these objects and users could be considered as a continuous dynamic interaction. Similarly, the GeoGebra can be considered as a haptic device detecting the movements of the slider and adjustable objects described in this platform. Several possibilities will be presented on how this useful utility might be used in e-learning solutions as a dynamic interactive platform for activation of students in creating cognitive connections.

Motivation of Mathematics for Engineers by Animation and Visualization using CAS

Thomas Westermann*
University of Applied Sciences, Karlsruhe, Germany

The turbulent development of computer software in mathematics requires an extension of the education of engineers. Hence, not only praxis-oriented knowledge must be supported but also the mechanics to successfully use these systems. The computer algebra systems (CAS) have improved the mathematical work of engineers. The systems are used for numerical computations as well as for algebraic manipulations of equations. Moreover, the powerful graphical capabilities and the easy use of the graphics are applied to display complicated functions and technical results. The techniques in hand calculations are trusted into the background in favor of the systematic approach in mathematics and of the exciting modeling of realistic systems. This new, exciting aspect has been taken up and the CAS Maple was included in the education of engineers. Mathematical concepts are motivated in a clear and vivid manner by the use of the visualization and animation capabilities of Maple.

This new, exciting aspect has been taken up and the CAS Maple was included in the mathematical education of engineers. Mathematical concepts are motivated in a clear and vivid manner by the use of the visualization and animation capabilities of Maple. But not only for the basic mathematical concepts CAS can be applied but also for studying numerics. It is shown how computer algebra can be used do develop numerical algorithms, visualize the algorithms as well as the results in a vivid manner.

In this paper the principal concept and the application of Maple in engineering education will be demonstrated in various examples:

- Basic principles like differentiation and integration are motivated via animations.
- Lengthy and abstract topics like the convergence of Fourier series to a given function are discussed.
- The visualization of the wave equation in case of a vibrating string is performed.
- Finally, the oscillations of an idealized skyscraper are computed to visualize the meaning of eigenvalues and eigenvectors.

For each of these examples an electronic version (worksheet) is used interactively that can be changed during the presentation if it is required from the audience.

Social Dimension of Web 2.0 in Engineering Education: Students' View

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Contemporary engineers need to become more cognizant and more responsive to the emerging needs of the market for engineering and technology services. Social dimension of Web 2.0 which penetrates our society more thoroughly with the availability of broadband services has the potential to contribute decisively to the sustainable development of engineering education. However, the success of the social dimension of Web 2.0 in engineering education requires student engineers' view on needs in the social dimension of Web 2.0 to be considered. Analysis of needs in the social dimension of Web 2.0 by engineering students is significant to contribute to the efficient incorporation of the social dimension of Web 2.0 in the curriculum of engineering science. The study was conducted in the frame of the Fifth Baltic Summer School *Technical Informatics and Information Technology* at the Institute of Computer Science of the Tartu University, August 7-22, 2009, Tartu, Estonia. The results of the empirical study reveal that the student engineers' view on needs in the social dimension of Web 2.0 has changed after the efficient incorporation of the social dimension of Web 2.0 in the curriculum of

engineering science. The conclusions suggest the following hypothesis for further studies: in order to develop the use of the social dimension of Web 2.0 by student engineers it is necessary to promote student engineers' use of the social dimension of Web 2.0 for organizational and professional purposes, as well as to create a favourable learning environment which supports learners' needs in a multicultural environment.

Virtual Learning Environment (VLE) for Probability and Statistics

Sergei Zuyev, Chalmers University of Technology, Gothenburg, Sweden

Chalmers University of Technology is reputed for the level of its graduates in Engineering. However, modern technological challenges and ubiquitous use of computers call for changes in the way Probability and Statistics is taught at the university.

The novel approach consists in shifting the weight from formal lectures towards self-practise and self-studying with the help of the VLE aided with statistical routines of Matlab computer package. The VLE developed at the Department of Statistics and Modelling Science of the University of Strathclyde, UK, and at Chalmers provides students with a unified teaching environment containing randomly generated questions (quizzes) on every subject of the course (currently, about 500), extensive system of hints and answers, links to the class text and other support materials: statistical tables, demonstrations, help files. Since it is web-based, the VLE is accessible from anywhere anytime, it does not depend on the operating system used, it has infinite number of variations of the study questions, so it provides students with valuable resource to practise beyond the assisted lab times. The experience gained after over 5 years of using the VLE at Strathclyde University shows many advantages of this approach to learning and enjoyed full support of the student community.

A great feature of the VLE is that it also provides the class organises with extensive tools for monitoring each student's activity on the VLE which allows for immediate intervention with individualised help should there be a need. The VLE can also be used for final examination: the students by the end of the course become very familiar with its environment and this helps to ease the examination stress. Since marking is done automatically, VLE saves a huge amount of staff time leaving them to scrutinise only boundary case submissions and appeals.

The talk will also present the gained students' feedback on their experience with the VLE and future development plans.

Abstracts 2

Extended Workshop GFC, June 2010

Teaching algebra and calculus to engineering freshers via Socratic Dialogue and Eulerian sequencing

Larissa Fradkin,
London South Bank University, Sound Mathematics Ltd., Cambridge, U.K

Modern undergraduates join science and engineering courses with poorer mathematical background than in the past. University tutors spend more and more time delivering remedial teaching classes. When doing so, most rely on traditional methods of delivery. However, such methods presuppose that the learners have a good memory and a considerable time to practice. These suppositions are particularly unrealistic when dealing with large groups of undergraduates who are so-called ordinary learners, that is, have limited mathematics background, limited memory, limited proficiency in explanatory reasoning, limited interest in the subject and on top of that, limited time to cover a large amount of material and limited study skills, all aggravated by a limited contact with teachers. Yet, these disadvantages can be overcome when dealing with adult. Our aim is to present evidence that they can achieve relatively deep learning of mathematics – and remarkably quickly – through a friendly (sometimes humorous) teacher-guided (Socratic) dialogue, which aims on the one hand, at uncovering learner difficulties and on the other hand, at frequent reinforcement of basic mathematical abstractions through Eulerian sequencing. The latter is a name for verbalisation, a systematic approach to mathematics as a language that allows students to analyse (sequence) given mathematical expressions and thus find the relevant solution algorithm (sequence of solution steps). This way learners can be taught to generate self-explanations, that is, argue why various steps are to be taken and not just what the steps are. This is important, because it has been found that the amount learned is proportional to the number of self-explanations generated. We report common student misconceptions and also progress in developing a Cognitive Tutor e-PACT (electronic Personal Algebra and Calculus Tutor) based on the above ideas.

Transparent boundary conditions for simulation programs

Peter Junglas, Private Fachhochschule Diepholz/Vechta, Germany

Simulation programs for the visualisation of wave phenomena have to cope with the problem of boundary conditions: A wave that reaches the boundary gets reflected, which soon leads to a very complicated and unintuitive wave pattern. The obvious remedy - to increase the grid – is prohibited by the large increase of computing time.

A better solution are "transparent boundary conditions", which use clever tricks to get rid of outgoing waves. How they work for the wave and Schrödinger equation and can be put to good use in concrete teaching situations will be shown by several examples.

Wie viel Vorkurs braucht der Student?

Christa Polaczek, Fachhochschule Aachen, Germany

Seit vielen Jahren werden an Hochschulen Mathematik-Vorkurse angeboten, die die Fähigkeiten und Fertigkeiten in der Elementarmathematik reaktivieren und gegebenenfalls ausbauen sollen. An der FH Aachen werden seit 15 Jahren für die Studiengänge des Maschinenbaus Vorkurse durchgeführt. Der Vortag berichtet über den Ausbau dieser Kurse und die Evaluationen sowohl in Hinblick auf den Lernzuwachs während der Kurse als auch auf den Studienerfolg.

Gender Differences in Computer Aided Assessment

Peter Riegler

Ostfalia University of Applied Sciences, Wolfenbüttel, Germany

Very early in the young history of computer aided assessment researchers found a particular positive influence on the learning gains of females. While these findings have been confirmed several times the underlying reasons still remain unclear. Here, I will report on another observable gender difference in computer aided assessment by investigating the temporal work style of males and females.

As a side issue I will address how to model this work style statistically and give some *ab initio* theoretical grounding for the observed data.

SAGE - ein CAS auch und besonders für diskrete Mathematik

Thomas Risse, Hochschule Bremen, Germany

SAGE, die "Software for Algebra and Geometry Experimentation", ist ein ausgewachsenes open source computer algebra system, CAS, das spezialisierte open source CASs wie GAP, MAXIMA, PARI, R, SINGULAR etc. unter einer gemeinsamen, integrierten Oberfläche zur Verfügung stellt und damit zu einer überzeugenden Alternative etwa zu den drei großen Ms, Mathematica, Maple und MATLAB wird.
SAGEs Funktionsumfang deckt viele Bereiche der Mathematik wie lineare Algebra, Analysis, Numerik, Differentialgleichungen usw. ab, so dass es alle Anforderungen an die Unterstützung der Mathematik-Ausbildung (über-) erfüllt.
SAGEs besonderen Stärken liegen aber vielleicht eher in der diskreten Mathematik; so bietet es mit Gruppen, Monoiden, Polynom- und Potenzreihen-Ringen jede Menge Algebra, darüber hinaus Kombinatorik, Kodierung, Modulformen, usw. bis hin zu (hyper-) elliptischen Kurven, Hecke Algebren oder Homologie.
Am Beispiel Fehler korrigierender Codes wird demonstriert, wie man mit SAGE diskrete Mathematik treibt, und damit zu belegen versucht, dass SAGE gleichermaßen Lehre und Forschung auch in diskreter Mathematik unterstützt.

Möglichkeiten und Unmöglichkeiten des automatischen, mathematischen, summativen und formativen Assessments

Thomas Schramm, Hafencity Universität Hamburg, Germany

eAssessments und *ePractice* sind in aller Munde, werden aber noch relativ wenig eingesetzt. Es gibt hohe Erwartungen und demgemäß Enttäuschungen, aber auch Überraschungen.
Wir wollen Strategien vorstellen, die einen möglichen sinnvollen Einsatz am Beispiel Maple T.A. aufzeigen und möchten vor einigen Fallen warnen, in die man tappen könnte.

Einfache qualitative Methoden für gewöhnliche Differentialgleichungen

Raimond Strauß, University of Rostock, Germany

Wenn man die weiter wachsende Bedeutung der Computer betrachtet, wird klar, dass Einsichten in strukturelle Eigenschaften von Lösungen gewöhnlicher Differentialgleichungen eine wichtige Ergänzung zu den in den Vorlesungen behandelten analytischen und numerischen Verfahren sind. Ziel des Vortrages ist es, die einfachen qualitativen Methoden für Differentialgleichungen zu benennen, die man ohne allzu großen Aufwand in die Vorlesungen zur Mathematik für Ingenieure aufnehmen kann. Es wird unter anderem ein ökonomisches Modell als Beispiel gewählt, das besonders für Wirtschaftsingenieure geeignet ist.

Mathematische Modellierung mit Schülern

Torsten-Karl Strempel, Hochschule Darmstadt, Germany

Seit mehr als 15 Jahren richtet die Technische Universität Kaiserslautern teilweise in Kooperation mit dem Zentrum für Mathematik die sog. Schülermodellierungswoche aus. War das Konzept einer Veranstaltung zur mathematischen Modellierung mit Schülern zunächst ein Wagnis, so hat es sich inzwischen etabliert, wurde in verschiedenen Formen erweitert und fand Eingang in Lehr- und Studienpläne. Somit ist die Motivation von Schülern durch reale Aufgabenstellungen, praxisrelevante Lösungen und eigenverantwortliches Arbeiten ein Standardbaustein in der mathematisch-naturwissenschaftlichen Ausbildung geworden.

Der viel diskutierte Fachkräftemangel und die sinkende Zahl qualifizierter Studienanfänger erfordern eine frühzeitige Motivation in der Schule. Das Konzept des mathematischen Modellierens wurde inzwischen auf verschiedene Jahrgangsstufen erweitert, die TU Kaiserslautern bietet Modellierungstage vor Ort an und das Zentrum für Mathematik hat gemeinsam mit Lehrern mathematische Modellierung in der Schule begleitet.

Die Schülermodellierungswochen, die Herbstschule Angewandte Mathematik und weitere Veranstaltungen an der Schnittstelle Schule Hochschule geben einen Einblick sowohl in die wissenschaftliche Arbeit, als auch die Anwendung mathematischer Forschung und helfen vielen Schülern bei der Entscheidung für einen Studiengang.

Der Vortrag fasst die Entwicklung der mathematischen Modellierung mit Schülern aus den vergangenen Jahren zusammen und gibt Hinweise zur Durchführung eigener Veranstaltungen.

Instructional material in course books for engineering mathematics and their substantiation

Karl-Heinz Winkler
Jadehochschule Wilhelmshaven/Oldenburg/Elsfleth, Germany

Mathematics in engineering studies is usually conveyed by seminarian lectures alongside partly provided pertaining tutorials. The education is thereby supported by a wide choice of course books. Those books frequently claim to be proper for self-education and offer, besides the content of teaching, (an assortment) of exercises for learning as well as for acquirement and examination.

Course books convey, e.g. by introduction and foreword, a certain image of mathematics in general and engineering mathematics in special. Through that, the content and the selection of instructional tasks is justified and motivated at least implicitly. In many ways remarks (in those books) show characteristics of syllabuses.

This presentation introduces the curricula of course books, critically examines them and develops criteria for scientific assessment of the selected instructional material. All this should moreover be measured by aspired learning processes and formulated educational objectives and evaluated on basis of recent achievements concerning the design of instructional tasks.

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Gottlob Frege Centre (GFC) at Hochschule Wismar

Foundation: 2000 – 11 – 07
Cooperation: UICEE *Satellite Centre* for Engineering Science and Design (2001-2006), SEFI Mathematical Workgroup (since 2008)
Directors: Prof. Dr. rer. nat. Norbert Grünwald (Rector), Prof. Dr. rer. nat. habil. Dieter Schott
Secretary: Dr. rer. nat. Gabriele Sauerbier
Members: Mathematicians and Computer Scientists of Hochschule Wismar
Homepage: http://www.hs-wismar.de/frege

Promoted Projects

- International Quality Network (DAAD 01-04)
- Learning Region (EGOS, BMBF 02-06)
- LIMES (Learning Centre Mathematics for First Semester Students)

Aims and Tasks

- Mathematical (and scientific) Education is to
  - *strengthen* (scientific base, practical applications)
  - *modernise* (contents, teaching forms, aids)
  - *internationalise* (cooperation, exchange of teaching material, professors and students)
- Mathematics (and Natural Sciences) as well as the heritage of *Gottlob Frege* (Wismar 1848 – Bad Kleinen 1925) is to
  - *popularise* (events, colloquia, competitions)

Additional Teaching Offers

- Entrance tests in Mathematics (registration and evaluation of entrance levels)
- Online courses in Mathematics (bridging course, course for advanced students)
- Promotion of pupils (events for school classes, programmes for gifted pupils, cooperation with special schools)
- LIMES (see promoted projects)

Invitation of Guest Professors

- Problem collections, thematic books for pupils and students
- MATLAB courses for Master students
- Mathematical lectures (in English)

Supervision of Guest Students

- Development of Web Courses, Research Projects, Diploma Theses in mathematical subjects

Contributions to Mathematical Teaching

- Cooperation with mathematical teaching groups
- Organisation of yearly *Workshops* „Mathematics for Engineers“
- Organisation of *Symposia* „Modern Mathematical Education for Engineers“ in the framework of DMV (German Union of Mathematicians)
- Edition of Wismar Frege Series ISSN 1862-1767 (since 2005)

Gottlob Frege Institute (since 2005)

- Free Membership for interested Colleagues working in mathematical didactics at university level
- Research, publications, courses, teaching material, studies

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Gabriele Sauerbier

LIMES – a Project for Freshmen Engineering Students at Wismar University

LIMES stands for 'Learning and Information Centre Mathematics for Engineering Students'. It is a Centre at Wismar University. The freshmen students at the Faculty of Engineering are the target group. The project has three parts, an online provided self test, a refresher course and weekly optional consultations in Mathematics. Mathematically talented higher semester engineering students work as tutors for the first semester students. With the support of Wismar University Foundation the LIMES project was launched in summer semester 2007 and works very successfully. In the following the project will be presented in detail.

Introduction

Since 10 years the Department of Mechanical Engineering at Wismar University arranged a Diagnostic Test Mathematics with first Semester Engineering Students. Later the Gottlob Frege Centre adapted and expanded the test for all first Semester Engineering Students of Wismar University. The results were alarming: 50% of our Freshman Engineering Students are not able to solve simple mathematical tasks of School Mathematics. On of the varied reasons is a longer break between visit of school and start of study at University. So Gottlob Frege Centre discussed and improved the idea of a Refresher Course Mathematics for our freshmen students in Engineering Subjects.

Idea

The most important goal of our Faculty of Engineering Sciences is to reduce the number of college dropouts. Gottlob Frege Centre stressed the importance Mathematics Education for Engineering students. Gottlob Frege Centre started in June 2007 the long and well prepared Project LIMES *Lern und Informationszentrum Mathematik für Erstsemesterstudenten*. We convinced Wismar University Foundation of this idea and obtained financial support. This was the first project supported by Wismar University Foundation. In the maintime the project is part of the Goal Agreements between Faculty of Engineering Education and Wismar University.

The project

The project has three parts: an online self test Mathematics, a Refresher Course, and weekly consultations in Mathematics during the first Study Year. Additionally our lecturers in Mathematics require weekly homework from first semester students. The consistent combination of these arrangements led to the first successes.

The actual online self test contains Simplifications (5 min), Fractions (5 min), Powers and Logarithms (15 min) Equations (40 min), Calculations for right Triangles (5 min), Word Problems (20 min).

The Refresher Course takes one week and contains a daily 60 Minutes Lecture plus three tutorials. Each day 1 Topic from School Mathematics is repeated. The lecture is given by a University Teacher. The tutorials are organized in groups with at most 20 students and with our Higher Semester Engineering Students as Tutors.

The weekly consultations are arranged with Higher Semester Engineering Students as Tutors.

Feedback of Students

By now 417 first semester engineering students visited the refresher course. Gottlob Frege Centre asked for a little Evaluation with the following questionnaire.

Question 1:
I would take part again in such a course.
Yes No
Question 2
The topics were
Just right to simple to difficult.
Question 3
The Lecture and Tutorial Time was
Just right to short to long.
Question 4
What was good?
Question 5
Have you hints to improve the course?

In the years 2008 and 2009 with all together 317 course participants we got feedback from 264 students, 262 would visit such course again. 225 said that the topics were just right. Only 23 students wished a higher level, 80 students remarked that the course time could be longer.

Perspective

The project has a high prestige among our students. Very often our Higher Semester Students apply for a Tutor position.

The students asked us to extend the project idea for other subjects as Technical Mechanics and Physics.

In these days Gottlob Frege Centre of Wismar University prepares the 4th Refresher Course.

Begabtenförderung Mathematik e. V.

Anschrift: Kyffhäuserstraße 20, 85579 Neubiberg

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Finanzierung: Der Verein finanziert sich aus Mitgliedsbeiträgen (36€ Einzelpersonen und Gymnasien, 15€ für Schüler und Studenten bzw. 310€ für Körperschaften) und aus Spenden. Vereinsmitglieder erhalten kostenlos die „Mathematikinformation“ und die „Mitteilungen“.

Arbeitsbereich: Begabtenförderung Mathematik e. V. agiert im deutschsprachigen Raum Mitteleuropas.

Der Verein wurde 1998 an der Ludwig-Maximilians-Universität München von Hochschullehrern, Gymnasiallehrern und Eltern gegründet.

Zielsetzungen:

- Förderung der gehobenen Mitte der Gymnasiasten auch hinsichtlich eines Mathematik anwendenden Studiums.
- Weiterentwicklung des Mathematikunterrichts.
- Hochbegabtenförderung in Mathematik.
- Hebung des Unterrichtserfolgs.
- Hebung des Stellenwerts der Mathematik in der Gesellschaft.
- Kooperation der Gymnasien mit Hochschulen, Universitäten und Wirtschaft.

Tätigkeit des Vereins:

- Die Herausgabe der Zeitschrift „Mathematikinformation“ (siehe Seite 6).
- Der Verein bietet Fortbildungsseminare für interessierte Lehrer/innen an.
- Der Verein veranstaltet Schülerseminare auch gemeinsam mit anderen Organisationen zur Hebung von Fähigkeiten und Wissen.
- Bildungspolitiker, Schulbehörden, Lehrer, Eltern und Schüler sind für derartige Fördermaßnahmen zu gewinnen. Der Verein unterstützt in diesem Zusammenhang die in Bayern, Baden-Württemberg und dem Saarland eingeführten Intensivierungsstunden zur Förderung von an Mathematik Interessierten.
- Der Verein bietet Gymnasien, denen die staatliche Förderung fehlt, die Finanzierung von wöchentlich 2-stündigen Schülerseminaren an, soweit hierfür Finanzen vorhanden sind.
- Einbringen der Erfahrungen der Industrie und Wirtschaft.
- Einmal jährlich findet in Zusammenarbeit mit den Mathematikern einer Universität und auch anderen ein „Forum für Begabungsförderung in Mathematik“ unter den folgenden Gesichtspunkten statt:
    1. Information der Lehrerschaft über mathematische Entwicklungen und Anwendungen.
    2. Lehrer/innen haben die Gelegenheit, in Kurzvorträgen, Postern und Arbeitsgemeinschaften ihre eigenen Ideen zur Weiterentwicklung der Mathematik am Gymnasium und der Grundschule zu äußern.
- Herausgabe der Zeitschrift „Mitteilungen“ zur Information der Vereinsmitglieder.

Zeitschrift „Mathematikinformation“

Sitz: Kyffhäuserstraße 20, 85579 Neubiberg, ISSN:1612-9156

Beitrittserklärung
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freut sich über eine Zusammenarbeit mit dem

Gottlob-Frege-Zentrum

der Hochschule Wismar.

Der Verein bittet die deutschen Teilnehmer der Konferenz durch Mitgliedschaft, Abonnement oder Spenden die

ZIELE ZU EINEM BESSEREM GYMNASIUM

nach Kräften zu unterstützen.

Dr. Karlhorst Meyer, Vorsitzender

Gottlob Frege: Course of Life

Quoted from ‘Frege’s Life and Work: Chronology and Bibliography’ by Christian Thiel and Michael Beaney

1848 Birth of Friedrich Ludwig *Gottlob* Frege on 8 November in Wismar, Mecklenburg-Schwerin, on the Baltic coast. His father, Karl Alexander Frege (born 3 August 1809), was principal of a private girls’ school, and his mother, Auguste Wilhelmine Sophia Frege, maiden name Bialloblotzky (born 12 January 1815), was a teacher at the school. They had been married since 18 July 1846 (possibly 18 July 1844), and lived at 2 Böttcherstraße (in a house that was destroyed towards the end of the Second World War, a century later). On 11 December Frege was baptised into the Lutheran church (in which he remained for the rest of his life).

1864 Gottlob Frege entered the *Gymnasium* (the grammar or high school) in Wismar. Frege appears to have received an average education in geometry and arithmetic, but was not introduced to the differential and integral calculus.

1869 Gottlob Frege passed his *Abitur* (school graduation examination) in the spring and immediately entered the University of Jena.

Frege spent four semesters at Jena, taking courses in mathematics, physics, chemistry, and philosophy. His teachers were Hermann Schäffer (geometry, physics, algebraic analysis), Ernst Abbe (physics, theory of functions), Anton Geuther (chemistry), Carl Snell (geometry, analytic mechanics, physics), and Kuno Fischer (Kant). Of these, Abbe (born 23 January 1840) was to play by far the largest role in Frege’s life, becoming his mentor and later supporting him financially through a research fund he set up in 1886 (the *Ministerialfonds für* *wissenschaftliche Zwecke*), and then the Carl-Zeiss-Foundation, which he established in 1889. Alongside his teaching duties, which gradually took second place, Abbe worked closely with Carl Zeiss (1816-1888) in the highly successful and lucrative optics industry in Jena. Frege's research was in effect partly funded by the profits from this industry.

1871 On the advice of Abbe, Gottlob Frege transferred to the University of Göttingen, where he spent five semesters (from summer semester 1871 to summer semester 1873), taking courses in mathematics, physics, and philosophy of religion. His teachers were Alfred Clebsch (analytic geometry), Ernst Schering (functions of complex variables), Hermann Lotze (philosophy of religion), Wilhelm Weber (experimental physics), and Carl Riecke (physics).

1873 Gottlob Frege submitted his doctoral dissertation, 'On a Geometrical Representation of Imaginary Forms in the Plane', in the summer, and had his viva on 8 August, examined by Schering in mathematics and Weber in physics. Frege asked to be excused from the public lecture that was normally required, on the grounds of lack of practice in spoken Latin; and the request seems to have been granted. He was awarded his doctorate on 12 December.

1874 With Snell in poor health at Jena, Frege was encouraged to apply for the post of *Privatdozent* (an unsalaried lectureship) in mathematics. To do this he needed to write his *Habilitationsschrift*, which he submitted in March, on 'Methods of Calculation based on an Extension of the Concept of Magnitude'. Abbe reported favourably on it on 30 March, talking of the "real originality and unusually inventive power" that it showed. Frege was examined on it on 18 April, by Abbe and various other members of the Faculty, including the Dean, Ernst Haeckel, and was recommended for the post. He gave the required public disputation on 16 May and trial lecture on 18 May, and joined the teaching staff at Jena (where he remained until he retired in 1918).

1879 Publication of *Begriffsschrift* in January, perhaps the single most important event in the development of modern logic. By extending the use of function-argument analysis in mathematics to logic, and introducing quantifier notation, Frege constructed the first system of predicate logic. He also offered an axiomatization of propositional logic, and showed how the two traditional parts of logic – syllogistic theory and propositional logic – could be integrated into one logical system.

The book's publication, however, enabled Abbe, supported by the philosopher Rudolf Eucken (1846-1926), to recommend Frege's promotion to *ausserordentlicher Professor* (equivalent in status to an associate professor, but with only a small salary), which was granted in July. Frege had good relations with Eucken, who had come to Jena in 1874, and who had some influence on Frege's work.

1884 Publication of *Die Grundlagen der Arithmetik*. In this book Frege criticised previous views of arithmetic and outlined his own logicist view – that arithmetic is reducible to logic, or as he expressed it here, is a system of analytic a priori truths. He argued that number statements should be seen as containing assertions about concepts, defined numbers in terms of extensions of concepts, and derived what we now know as the Dedekind-Peano axioms of arithmetic.

1887 Frege married *Margarete* Katharina Sophia Anna Lieseberg (born 15 February 1856) on 14 March, in Grevesmühlen, near Wismar, where her family lived. Her father, Heinrich Lieseberg, was a lawyer. On 1 July the newly-married couple moved into their new house at 29 Forstweg (now Ibrahimstraße) in Jena.

1891 Publication of ‘Function and Concept’, which was given as a lecture to the *Jenaische Gesellschaft für Medicin und Naturwissenschaft* (in which Frege was an active member) on 9 January. Frege here explained his key notion of a function, and distinguished for the first time between *Sinn* and *Bedeutung*.

1892 Publication of ‘On *Sinn* and *Bedeutung*’ and ‘On Concept and Object’, two of Frege’s most famous papers and seminal texts in the development of modern analytic philosophy and philosophy of language. In the former Frege gave his fullest account of the distinction between *Sinn* and *Bedeutung*, and in the latter he emphasized the essential difference between objects and concepts.

1893 Publication of Volume 1 of Frege’s *magnum opus*, the *Grundgesetze der Arithmetik*. In this work he set out to demonstrate formally his logicist reduction of arithmetic to logic, using a revised version of his Begriffsschrift.

1895 Publication of ‘A Critical Elucidation of some Points in E. Schröder, *Vorlesungen über die Algebra der Logik*’, a critique of the work of the most important representative of the Boolean tradition in Germany. Schröder had reviewed Frege’s *Begriffsschrift* .

In September Frege met Hilbert at the 67th Convention of German Scientists and Doctors in Lübeck, where Frege gave a talk on Peano’s logical notation (subsequently published in 1897). Frege wrote to Hilbert on 1 October, and they became engaged in a dispute over the foundations of geometry.

1896 Frege was promoted to the post of *ordentlicher Honorarprofessor* (equivalent in status to a full professor, but an honorary post).

1897 Publication of ‘On Mr. Peano’s Conceptual Notation and My Own’, comparing Peano’s notation with his own – discussing generality, among other things.

1899 Publication of ‘On Mr. H. Schubert’s Numbers’, a satirical critique of an account of the foundations of arithmetic provided by Hermann Schubert (1848-1911) in the first volume of an encyclopedia on the mathematical sciences published in 1898.

1902 Letter from Russell to Frege, dated 16 June, informing him of the contradiction in his logical system. The paradox devastated Frege, and despite an initial attempt to resolve it, Frege eventually felt forced to abandon his logicist project, although he continued to work on logic and related issues in the philosophy of thought and language. A detailed correspondence between Frege and Russell followed, not only about the paradox and possible responses to it, but also about their conceptions of sense, *Bedeutung*, proposition, thought, truth, and so on. The correspondence fizzled out towards the end of 1904, although later letters were written.

1903 Publication of Volume II of the *Grundgesetze*, including a hastily written appendix seeking to respond to Russell’s paradox.

Publication of the first of Frege’s essays (in two parts) on Hilbert’s work, ‘On the Foundations of Geometry: First Series’.

Publication of Russell’s *The Principles of Mathematics*, with a long appendix (22 pages) on ‘The Logical and Arithmetical Doctrines of

Frege', the first substantial account of Frege's philosophy to appear in print.

1906 Publication of the second and much longer of Frege's essays (in three parts) on Hilbert's work, 'On the Foundations of Geometry: Second Series'. This was in response to a (qualified) defence of Hilbert's views by Alwin Korselt (1864-1947), published in the same journal – the *Jahresbericht der Deutschen Mathematiker-Vereinigung* – in 1903.

1907 Frege was awarded the prestigious title of '*Hofrat*'.

1910 Rudolf Carnap attended Frege's course on the Begriffsschrift in the winter semester 1910/11.

1911 Ludwig Wittgenstein visited Frege for the first time in the late summer, Wittgenstein having sent some objections to his views. Wittgenstein later reported that Frege "wiped the floor with me" (quoted by Geach 1961, 130). But Frege encouraged him to come again, and recommended that he study with Russell. Wittgenstein visited Frege at least two more times – in autumn 1912 and autumn 1913. 1911 also marked the start of correspondence between Frege and Wittgenstein, which continued until 1920, although only some of this has survived (Frege 1989). (On the relationship between Frege and Wittgenstein, see Reck 2002.)

The neo-Kantian Bruno Bauch succeeded Otto Liebmann as Professor of Philosophy at Jena. Bauch was interested in Frege's work, and later encouraged Frege to write the three essays of his *Logical Investigations*, which were published in the journal Bauch founded, the *Beiträge zur Philosophie des deutschen Idealismus*.

1913 Carnap attended Frege's course on 'Begriffsschrift II' in the summer semester.

1914 Carnap attended Frege's course on 'Logic in Mathematics'

1918 Frege retired from the University of Jena on 8 December, and moved to Bad Kleinen, near Wismar. The sale of his house in Jena, and a gift of money from Wittgenstein, enabled Frege to buy a house in Bad Kleinen.

Publication of 'Thought' and 'Negation', the first two essays of his *Logical Investigations*.

1923 Publication of 'Compound Thoughts', the last of his three *Logical Investigations*.

1924 In diary remarks written during March to May, Frege expressed some virulent right-wing and anti-Semitic views, which arguably conflict with the political (national-liberal) and religious beliefs that he seemed to have held for most of his life.

1925 Death of Frege on 26 July at the age of 77. Buried on 29 July in Wismar.

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