Corporación Universitaria para el Desarrollo de Internet A.C.
Internet 2 - México

Noemí V. Mendoza Díaz Ph.D.

Temas de enseñanza de las matemáticas para ingeniería

29 de Junio del 2010

Engineering Mathematics

- Europa (*Burkhard Alpers-SEFI Working Group on Mathematics and Engineering Education*)
- Oceanía (*Australian Mathematical Sciences Institute*)
- EE.UU. (*Richard Lesh-Model Eliciting Activities*)

Europa

- Activation of learners : How can we ensure that the students are more actively involved in the learning process than in the usual lecture ?
- Use of technology : How can we use technology (CAS, pocket calculator, web, etc.) in the teaching and assessment process in a pedagogically sound manner ?
- Modelling competences and their teaching: What are desirable modelling competences and who (mathematicians, engineers) teaches them how ?

Europa (cont…)

- Assessment: Which forms of assessment are used, what are their advantages and disadvantages, and which learning goals are induced by certain forms of assessment ?
- Content and learning outcomes: What should be the contents and the learning outcomes of the mathematical education of engineers ?
- Mathematics at the workplace: What kind of mathematical qualifications do engineers need in their professional life ?
- Higher level learning goals: What are higher level learning goals (e.g. deeper understanding) and how can they be achieved ?

Europa (cont…)

- Mathematical needs in continuing engineering education: What kind of mathematical education do professional engineers need in addition to the one they obtained during their university studies ?
- Integration of mathematics and engineering subject education: How can we integrate the mathematics education and the education in engineering subjects to avoid mathematics being seen as isolated and disconnected ?
- Students' attitudes towards mathematics: What are students' attitudes to mathematics and how can we achieve a positive attitude where mathematics is seen as a valuable means to formulate and solve engineering problems ?

Europa (cont…)

- Transition from school to university: How can we alleviate the transition from school mathematics to university mathematics ?
- Didactical principles: What valuable and proven didactical principles (from general mathematics education) can we use in the mathematical education of engineers ?
- Mathematical education research: What are the main topics professional researchers in the mathematical education of engineers deal with and what are the main results relevant to the practitioner?

Europa (cont…)

- Transition from school to university: How can we alleviate the transition from school mathematics to university mathematics ?
- Didactical principles: What valuable and proven didactical principles (from general mathematics education) can we use in the mathematical education of engineers ?
- Mathematical education research: What are the main topics professional researchers in the mathematical education of engineers deal with and what are the main results relevant to the practitioner?

Burkhard Alpers-SEFI

The students are given "typical" tasks which we identify together with a colleague who teaches machine elements, CAD and FEM and who worked for several years in the car industry…..The author investigates the mathematical concepts that are used to work effectively and efficiently on the task, in particular those ones which are important to make reasonable use of the tools involved.

The investigation showed that although most of the mathematical concepts and procedures are "buried in technology" for reasonable usage of the interface mathematical knowledge and understanding is necessary….this refers in particular to a good understanding of the different representations of functions and their derivatives as well as of interpolation concepts.

The Mathematical Expertise of Mechanical Engineers –The Case of Mechanism Design. In Modeling Student's Mathematical Modeling Competencies (Lesh, Galbraith, Haines, & Hurford, 2010)

Oceanía

- **Recommendation 1: assumed knowledge**

That engineering programs should continue to state that students will be assumed to have knowledge of material covered in Year 12 Intermediate Mathematics, including some calculus. For those students entering without that knowledge, an additional developmental subject must precede the normal mathematics subjects.

- **Recommendation 2: designated quantitative stream**

That in 4-year BE programs with a first-year intake of 140 or more, 15% or more of the places be reserved for a designated quantitative stream in which students must take at least 5 subjects of mathematics, statistics, theoretical computer science, quantitative finance and theoretical physics.

Oceanía

- **Recommendation 3: statistics and stochastic modelling**

That a single one-semester optional subject in statistics and stochastic modelling be made available to all engineering students who have completed three mathematics courses, if not already included in the syllabus.

- **Recommendation 4: joint mathematics curriculum committees**

That every engineering program has a joint mathematics curriculum committee that is responsible for determining mathematical topics to be covered. The committee should meet at least twice per year and it should have representatives from engineering, mathematics and statistics departments, as well as two students who have recently completed some engineering mathematics subjects.

Oceanía

- **Recommendation 5: collaborative teaching**

That universities modify their internal financial allocation system so that no budgetary unit is penalised for taking part in genuine multidisciplinary collaborative teaching.

- **Recommendation 6: engineering mathematics staff expertise**

That mathematics departments in BE or ME-awarding institutions should identify which of their staff, if any, have knowledge of engineering applications. If this expertise is lacking, some future academic job advertisements should say that ability to teach mathematics in engineering contexts would be an advantage.

Oceanía

- **Recommendation 7: on-line formative assessment**

That mathematics departments, assisted by the Australian Mathematical Sciences Institute and Australian Association for Engineering Education, investigate the introduction of automated systems of test generation, automatic marking and feedback, so that they can run compulsory on-line quizzes during semesters for large engineering mathematics classes.

- **Recommendation 8: collaborative item bank**

That engineering and mathematics teaching departments collaborate to provide a central bank of good examples of formative test questions, computer laboratory projects and curriculum resources.

Oceanía

- **Recommendation 9: student help centres**

That Engineering Faculties designate at least 4 common hours per week of class free time spread over 3 or more days and that servicing mathematics departments provide staff or senior students in student help centres at those times.

- **Recommendation 10: boosting senior secondary school mathematics**

That able students be more strongly encouraged to progress to subjects comparable to Intermediate Year 12 Mathematics of New South Wales and Victoria.

Mathematics Education for 21st Century Engineering Students — Final Report. Broadridge & Henderson, 2008.

EE.UU.

The Six principles for designing MEA's are:

1. Model Construction principle: problems must be designed to allow for the creation of a model dealing with elements, relationships and operations between these elements, patterns and rules governing these relationships etc.
2. The Reality Principle: problems must be meaningful and relevant to the students.
3. Self-assessment principle: students must be able to self-assess or measure the usefulness of their solutions.
4. Construct documentation principle: students must be able to reveal and document their thinking processes within their solution.
5. Construct shareability and reusability principle: solutions created by students should be generalizable or easily adapted to other situations.
6. Effective Prototype principle: others should easily be able to interpret solutions.

Lesh, R., Hoover, M., Hole, B., Kelly, A., & Post, T. (2000). Principles for developing thought-revealing activities for students and teachers. In A. Kelly & R. Lesh (Eds.), Handbook of research design in mathematics and science education. Mahwah, NJ: Lawrence Erlbaum.

Model Eliciting Activity (MEA) Papers

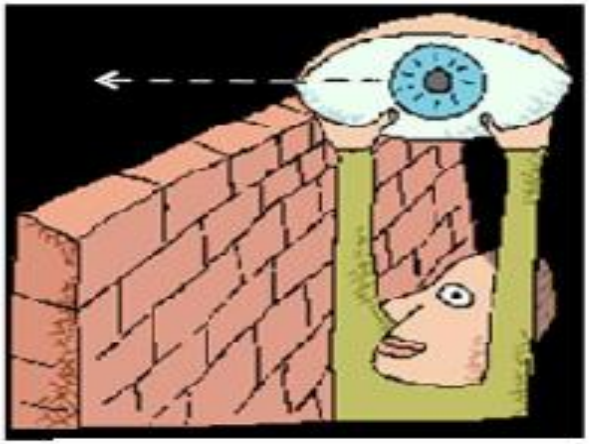
These papers focus on the importance of models and modeling to the engineering education community in general and address how improved learning may be achieved by using the model eliciting activity (MEA) construct. Papers will be presented from a variety of researchers working on the use of MEAs in engineering education.

Monday, June 21, 2010

10:30 a.m. -Noon Kentucky International Convention Center. NSF Poster Session - Exhibit Hall 2C & 2D
1376: NSF Grantees Poster Session
MODEL ELICITING ACTIVITIES: EXPERIMENTS AND MIXED METHODS TO ASSESS STUDENT LEARNING
Larry Shuman, University of Pittsburgh
Mary Besterfield-Sacre, University of Pittsburgh
Tuba Pinar Yildirim, University of Pittsburgh
Nora Siewiorek, University of Pittsburgh

12:30-2:00 p.m. Kentucky International Convention Center, 218
1430: Student Attitudes and Perceptions
Paper 4 of 5
SCALE DEVELOPMENT FOR ENGINEERING MODELING SELF-EFFICACY
Tuba Yildirim, University of Pittsburgh
Mary Besterfield-Sacre, University of Pittsburgh
Larry Shuman, University of Pittsburgh

12:30-2:00 p.m. Kentucky International Convention Center, L11
1431: Student Learning
Paper 3 of 5
GRADUATE TEACHING ASSISTANTS' ASSESSMENT OF STUDENTS' PROBLEM FORMULATION WITHIN MODEL-ELICITING ACTIVITIES
Amani Salim, Purdue University
Heidi Diefes-Dux, Purdue University



Tuesday, June 22, 2010

8:30-10:15 a.m. Kentucky International Convention Center, 213
1231: New learning Paradigms I
Paper 1 of 5
ENGINEERING, REFLECTION AND LIFE LONG LEARNING
Nora Siewiorek, University of Pittsburgh
Larry Shuman, University of Pittsburgh
Mary Besterfield-Sacre, University of Pittsburgh
Kara Sorelli, University of Pittsburgh

8:30-10:15 a.m. Kentucky International Convention Center, 207
1268: Teaching Dynamics
Paper 1 of 5
DYNAMICS BUZZWORD BINGO: ACTIVE/COLLABORATIVE/INDUCTIVE LEARNING, MODEL ELICITING ACTIVITIES, AND CONCEPTUAL UNDERSTANDING
Brian Self, California Polytechnic State University
James Widmann, California Polytechnic State University

8:30-10:15 a.m. Kentucky International Convention Center, L6
1234: Special Session: Next Generation Problem-Solving
MODEL ELICITING ACTIVITIES – INSTRUCTOR PERSPECTIVES
Ronald Miller, Colorado School of Mines
Tamara Moore, University of Minnesota
Brian Self, California Polytechnic State University
Andrew Kean, California Polytechnic State University
Gillian Roehrig, University of Minnesota
Jack Patzer, University of Pittsburgh

A CONSTRUCT FOR BETTER UNDERSTANDING STUDENT KNOWLEDGE AND SKILLS
Tamara Moore, University of Minnesota
Brian Self, California Polytechnic State University
Ronald Miller, Colorado School of Mines
Margret Hjalmarson, George Mason University
Judith Zawojewski, Illinois Institute of Technology
Barbara Olds, Colorado School of Mines
Heidi Diefes-Dux, Purdue University
Richard Lesh, Indiana University

RESULTS TO DATE - MODELS AND MODELING USING MEAS
Larry Shuman, University of Pittsburgh
Mary Besterfield-Sacre, University of Pittsburgh
Brian Self, California Polytechnic State University
Ronald Miller, Colorado School of Mines
Tamara Moore, University of Minnesota
John Christ, United States Air Force Academy
Eric Hamilton, Pepperdine University
Barbara Olds, Colorado School of Mines
Heidi Diefes-Dux, Purdue University
A FOCUS ON MODEL BUILDING
Eric Hamilton, Pepperdine University
Mary Besterfield-Sacre, University of Pittsburgh
Barbara Olds, Colorado School of Mines
Nora Siewiorek, University of Pittsburgh

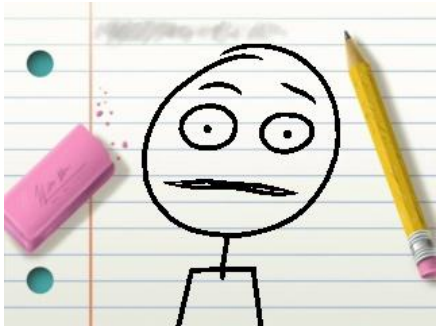
2:15-4:00 p.m. Kentucky International Convention Center, L7
1558: Curricular Issues in Computer-Oriented Programs
Paper 3 of 5
FACILITATING TEACHING AND RESEARCH ON OPEN-ENDED PROBLEM SOLVING THROUGH THE DEVELOPMENT OF A DYNAMIC COMPUTER TOOL
Matthew Verleger, Purdue University
Heidi Diefes-Dux, Purdue University

EE.UU.

cudi
Corporación Universitaria para el Desarrollo de Internet A.C.
Internet 2 - México

CONTACTO

- Nos vemos en línea!



http://www.cudi.edu.mx/ingenieria/

noemi.mendoza@cudi.edu.mx