From a discipline-oriented year 1 to an interdisciplinary mathematical modeling course

Anything but Calculus! Alternatives to teaching Calculus in year 1

CMS Summer Meeting 2021

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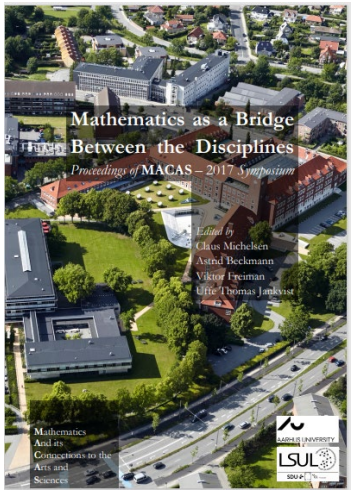
Claus Michelsen

Professor in mathematics and science education at the Department of Mathematics and Computer Science the University of Southern Denmark in Odense, Denmark

Research interests: The role of mathematics in interdiscplinary teaching, transfer between mathematics and other disciplines, mathematical modeling and democratic citizenship

Co-founder of the MACAS Symposia (Mathematics and its Connections to the Arts and Sciences)



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Education, we are proud of

Future Search Seminar, January 2011

60 stakeholders (teachers, administrators, students, leaders, ..) gathered for three days and through dialogue reached a common ground for and arrived at concrete action plans for ‘Education we are proud of’ at the Faculty of Science:

We want to create an element of interdisciplinarity between disciplines that respects the individual disciplines, and at the same time demand cooperation and coordination between the disciplines

Announcement of a position as prodean of education

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The ”interdisciplinary” Science Year

The science year gives you the opportunity to gain a broad knowledge of the disciplines of natural sciences and enables you to see an issue from several points of view

<table>
<tr><td>4. qu.</td><td colspan="2">The Science Project</td><td>Elective</td></tr>
<tr><td>3. qu.</td><td>Biochemistry</td><td rowspan="2">Basic Physics</td><td>Calculus II</td></tr>
<tr><td>2. qu.</td><td rowspan="2">Basic Chemistry</td><td rowspan="2">Biology – from molecule to eco system</td></tr>
<tr><td>1. qu.</td><td>Calculus I</td></tr>
</table>

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F^3 - Disciplines, Research and Community of Practice

- The individual discipline and its relations to the other disciplines are plain
- Academic and framework-setting study start
- Student activating teaching
- Identity and belonging through participation in a scientific practice
- Evaluation is an integral part of teaching

<table>
<tr><td colspan="2">Discipline oriented module (5 ECTS) – dependent of the students' choice of major discipline
The Science Project (10 ECTS)</td></tr>
<tr><td>The Mathematical Modeling Sciences
Physics and Mathematics
(20 ECTS)</td><td>The Empirical Experimental Sciences
Chemistry, Biology and Biochemistry
(20 ECTS)</td></tr>
<tr><td colspan="2">Introduction to F^3 - Disciplines, Research and Community of Practice (5 ECTS)</td></tr>
</table>

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Mathematics and Physics

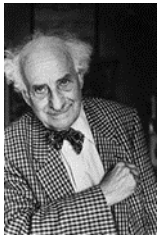
→*The attempt to separate mathematics and physics had catastrophic consequences. Whole generations of mathematicians grew up without knowing half of their science. The result is ugly scholastic pseudo-mathematics*. (Vladimir Arnold)

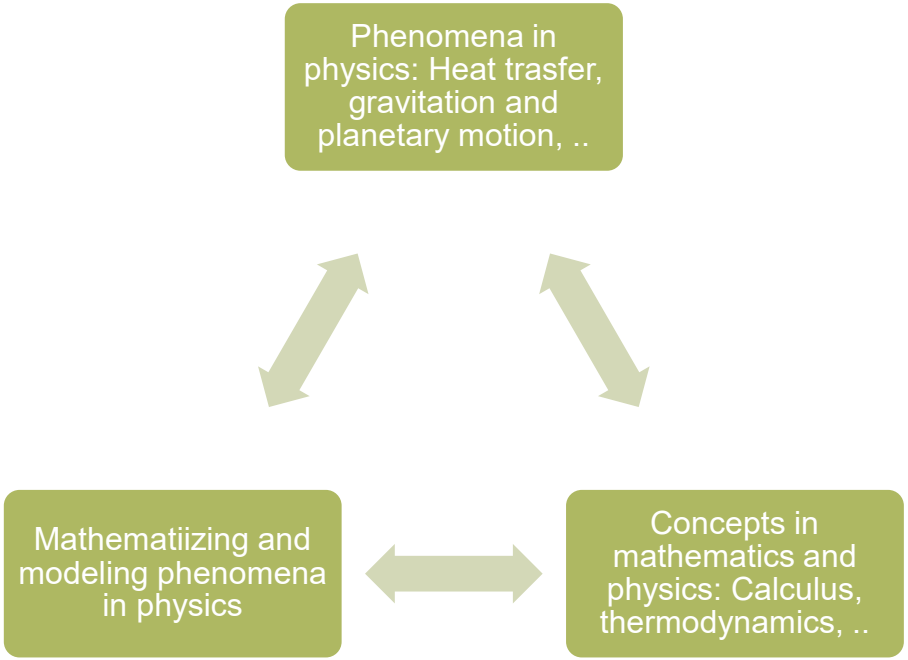
→ *Physics has influenced the development of mathematics from antiquity up to the twentieth century*. (Jesper Lützen)

→*The close symbiotic relationship between mathematics and physics will rise to new heights in the 21st century*. (Michael Atiyah)

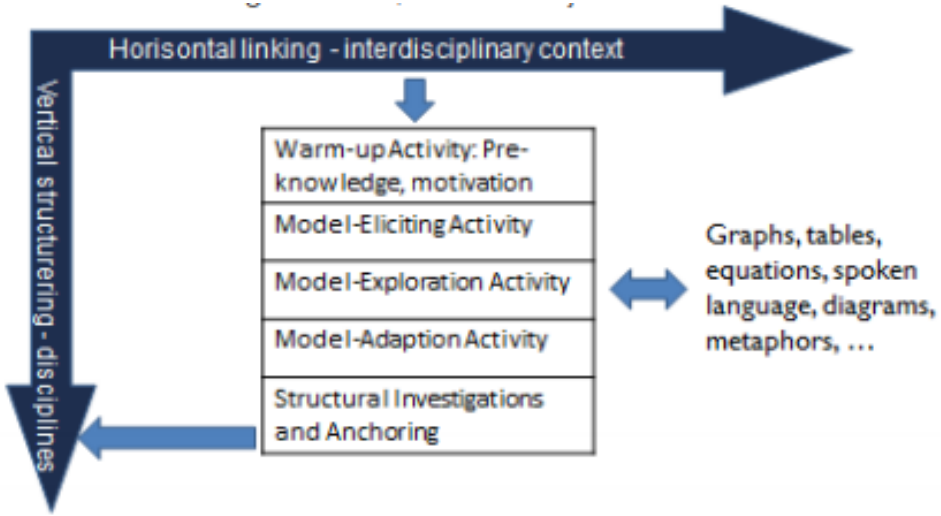
The Mathematical Modeling Sciences

Mathematics has arisen and arises through mathematizing. Guided reinvention should be used in learning and teaching mathematics (Hans Freudenthal)





The Didactical Idea



Modeling activies as the bridge between interdisciplinary (contexts) and disciplinary (concepts) activities

Chapter 9
Promoting Transfer Between Mathematics and Biology by Expanding the Domain

Check for updates

Claus Michelsen

Mathematical modeling is also physics—interdisciplinary teaching between mathematics and physics in Danish upper secondary education

Claus Michelsen

Laboratory for Coherent Education and Learning, University of Southern, Campusvej 55, 5230 Odense M, Denmark

E-mail: cmich@imada.sdu.dk

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Abstract
Mathematics plays a crucial role in physics. This role is brought about predominantly through the building, employment, and assessment of

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Teaching: The Three Phases Model

INTRO PHASE: KNOWLEDGE - PROFESSOR

- Concepts, theories, models and basic ideas are introduced
- The content is put into perspective
- Focus on difficult areas of the content

TRAINING PHASE: SKILLS - TA

- Training skills
- Problem solving
- Experimental work

STUDY PHASE: COMPETENCES – STUDY GROUP TUTOR

- Follow-up on intro phase and training phase, preparation for intro phase
- Dialogues and reflections about content in a social context
- Preparation and maintenance of logbook and personal portfolio

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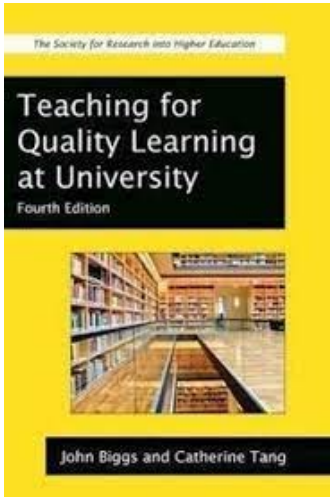
Supporting the Three Phases Model

→EDUCATIONAL LOUNGE: Open monthly seminars on educational themes (student centered learning, diversity among students, students' development of identity and belonging, ..) with presentations by internal or external experts followed by discussions

→TEACHERS' WORKSHOP: Monthly workshops for 1. year teachers with experience sharing and discussions of educational and pedagogical issues and implementation of The Three Phases Model (alignment, activities in the study groups, practice of science ..)

→ STUDY GROUP TUTOR PROGRAMME: Three days intensive course before semester start (group dynamics, problem-based learning, ..)



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Evaluation 2015 and Afterwards

→The student evaluations show increasing student satisfaction with the course, and especially with the inclusion of concrete examples

→The average total time for completion of the bachelor's programme reduced and dropout rates reduced

→Still division in mathematics and physics, both in teaching and the written exam - and very little modeling.

→From 2015: Separate mathematics admission without the course.

→From 2016: Separate admission to all programmes and the course is no longer offered. Teaching is still organized according to the Three Phases Model.

After all - a happy end?

Thorough cultural change throughout the educational system is necessary.
Since 2020 a Master's Programme in STEM Education is offered to Danish secondary education teachers in mathematics and science

	15 ECTS	15 ECTS
1. Semester	STEM Education	The Empirical Experimental Sciences
2. Semester	STEM Culture and Practice	The Mathematical Modeling Sciences
3. Semester	Elective Courses	The Technological Innovative Sciences
4. Semester	Master's Thesis	

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Thanks for your attention

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