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The International Community of Teachers of Mathematical Modelling and Applications.
www.ictma.net/

The Community, through its membership, research and other activities, is recognised as "The International Study Group for Mathematical Modelling and Applications (ICTMA)" by its affiliation to the International Commission on Mathematical Instruction (ICMI).

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Contents

Please send future contributions to the editor by email <g.stillman@unimelb.edu.au>. The next Newsletter will be published in December, 2007. We are interested in your contributions to any of the current sections and particularly the continuing discussion of the topic in section 5.

1. New International Executive Committee

Following the General Meeting of ICTMA members held at ICTMA 13 in Bloomington, Indiana, USA, on July, 26,2007, the composition of the new ICTMA Executive is a follows:

President
Prof Gabriele Kaiser (Germany)
Past Conference Organisers
Prof Chris Haines (UK) – Secretary
Prof Richard Lesh (USA)
Elected Members
Toshikazu Ikeda (Japan) – Registrar
Thomas Lingefjärd (Sweden)
Gloria Stillman (Australia) – Newsletter Editor
Co-opted Members
Jonei Barbosa (Brazil)
Katja Maaß (Germany)
Bhadra Tuladhar (Nepal)
Jinxing Xie (China) – Webmaster & List Serve Moderator

2. ICME Affiliated Study Group Activities

At ICME 11 in Monterrey ICTMA members will have two sets of activities related to ICTMA that they can attend the Topic Study Group 21 organised by Morten Blomhoj and Susanna Carreira and the Affilitated Study Group Sessions. TSG21 is about Mathematical Applications and Modelling in the Teaching and Learning of mathematics. For details visit: http://tsg.icme11.org. Four themes are planned for the ASG sessions:

Modelling examples,

Modelling competencies,

Modelling across international aspects and

Theoretical approaches.

More details will be given in the second ICTMA Newsletter which will be published in December, 2007.

3. Forthcoming ICTMA Conferences

The ICTMA group has held biennial meetings since 1983. This conference series provides a forum for discussing all aspects of teaching applications and modelling in all areas and at all levels of mathematics education – from primary to secondary schools, at colleges and universities. The next two ICTMA Biennial conferences will be ICTMA 14 in Hamburg in 2009 and ICTMA 15 Melbourne in 2011.

14TH INTERNATIONAL CONFERENCE ON THE TEACHING OF MATHEMATICAL MODELLING AND APPLICATIONS (ICTMA14)

The 14th ICTMA Conference - ICTMA14 - will be held at the University of Hamburg and organised by the Faculty of Education, Working group on didactics of mathematics. It will be chaired by Professor Gabriele Kaiser. The conference is scheduled from

Monday, 27th July to Friday, 31st July 2009

Academic programme:

A variety of activities is planned, covering plenary lectures, paper presentations and working groups. The following issues will be tackled:

(i) Pedagogical issues, such as the understanding of modelling, promotion of modelling competencies, cognitive aspects;

(ii) Assessment of modelling activities in school and universities;

(iii) Connections to industrial or commercial practice, mathematics at the workplace;

(iv) Influences of technology;

(v) Cross-cultural aspects and international studies.

Conference venue:

The conference will take place in the building of the Faculty of Education at the university's Campus Von-Melle-Park. The Campus is situated near Lake Alster in the very heart of Hamburg.

Conference fee:

The conference fee will be approximately 400 € with a possible reduction for young researchers and will include various events, such as a guided city excursion, conference dinner, snacks and lunch and a hardcopy of the conference proceedings.

Social programme and accommodation:

There will be a strong social programme for participants, and a complementary programme for accompanying persons. Participants can also arrange pre- and post-conference tours to Germany's new capital Berlin.

A great variety of hotels and cheaper accommodation are in walking distance.

The City:

The "Freie und Hansestadt Hamburg", Germany`s second biggest metropolis (1.8 million inhabitants) is a bustling, cosmopolitan port city. Hamburg is situated between the North Sea and the Baltic Sea and easily reachable by its internationally connected airport. The Lake Alster together with the Elbe river, numerous canals and parks adjoining them, have made Hamburg well-known as a "green" metropolis at the water's edge.

The University:

The University of Hamburg is a state university of the "Freie und Hansestadt Hamburg". Hamburg's view of itself as "gateway to the world" is reflected by the university's diversity of scientific areas and educational possibilities and thus it presents itself as "gateway to the world of knowledge". 38,700 students are inscribed at the University of Hamburg and 851 professors are engaged in teaching and research.

Transport

Hamburg is situated between the North Sea and the Baltic Sea and easily reachable by its internationally connected airport.

For further information, please email to the conference secretary Karen Stadtlander:

stadtlander@erzwiss.uni-hamburg.de

or see the website of Prof. Gabriele Kaiser: http://www.erzwiss.uni-hamburg.de/Personal/Gkaiser/

4. Reports from Recent ICTMA Conferences

4.1 Report on ICTMA Satellite Conference held in Nepal

The five day program of ICTMA Nepal from June 25 to 29, 2007, went very well. Six Plenary lectures were planned as follows:

1. Prof. Harald E. Krogstad, Norwegian University of Science & Technology, Trondheim, Norway
2. Prof. Francois-Xavier Le-Dimet , Universite Joseph Fourier, Grenoble,France
3. Prof. Vinod P. Saxena, Ananda Engineering College, Agra, India
4. Prof. Dr. Hans-Wolfgang Henn, Universität Dortmund, Germany
5. Prof. Daniel Clark Orey, California State University, USA
6. Prof. Zemira R. Mevarech, Bar-Ilan University, Israel

Unfortunately Zermira was unable to attend due to an accident that took place just as she was preparing to leave for Nepal.

A total of 34 contributory papers were registered for presentation. Due to various constraints, several participants could not travel to Nepal. However, the rest of the program went very smoothly. There were a total of 140 participants from 11 different countries. A complete book of abstracts can be downloaded from http://www.ku.edu.np/ictma13/

The Honorable Minister of Environment, Science and Technology, Nepal, inaugurated the conference and was attended by the Vice Chancellor of Nepal Academy of Science and Technology, who is also the President of the Nepal Mathematical Society, Chairman of the University Grants Commission, Ex-State Minister of Environment, Science & Technology, Vice Chancellor of Kathmandu University.

The social programs were very much appreciated by all the participants.

Prof. Bhadra Man Tuladhar
Chair, LOC ICTMA Nepal
Kathmandu University

4.2 Report on ICTMA 13 Conference held in Bloomington, Indianna, USA

The five day program from July 22 to 26, 2007, was very successful. In addition to the delegates in Bloomington, delegates to the *Modelling in Mathematics Learning* Workshop at Makerere University in Kampala in Uganda participated in some sessions via internet link on July 23-25. The Plenary lectures were as follows:

1. Modelling Theory for Math and Science Education - Prof. David Hestenes, Arizona State, USA

2. Priorities in a Research Agenda for Engineering Education - Prof. Barbara Olds, Colorado School of Mines, USA

3. Modelling to Address Techno-Mathematical Literacies in Work - Prof. Richard Noss & Prof. Celia Hoyles, University of London, UK

4. Modelling a Crucial Aspect of Students' Mathematical Modelling - Prof. Mogens Niss, Roskilde University, Denmark

A total of 53 papers were presented at the conference. These papers are published at: http://site.educ.indiana.edu/Papers/tabid/5320/Default.aspx

Several discussion groups operated throughout the conference. The themes and topics of these groups covered Modelling and Teacher Development, Research on Design Assessment and Design Research Methodologies, Modelling and Problem Solving, Modelling and Multi-Disciplinary Education, Modelling and Complex Systems, Modelling, Diversity and Equity and Technology-based Tools for Modelling.

Several publications are expected to result from the conference. In particular, ICTMA has a tradition of publishing a book that emanates from the conference. It only includes the cream of the crop among

papers or presentations that were made at the conference. But, anybody who made a presentation is eligible. These papers are peer reviewed. As in the past for ICTMA publications, Horwood will be the publisher of the conference proceedings. The tentative title is 'Mathematical Modeling ICTMA13: Education and the Design Sciences'. The editors are Professor Richard Lesh (Indiana University, USA) Dr Peter Galbraith (University of Queensland, Australia) Professor Werner Blum (University of Kassel, Germany) and Dr Andrew Hurford (United States Air Force Academy).

Reflections on the Conference. Mainly, what I heard were a lot of comments like: *"This was the best conference I've attended for a long time!!! I met lots of new people doing work closely related to my own. I learned some new things and met a lot of new people."* In fact, most people seemed to consider the conference to be such a success that, at the closing business meeting, a resolution was made to create an American chapter of ICTMA – with biennial meetings which alternate with the international ICTMA meetings. Bids currently are being reviewed from several places/people who would like to host next year's meeting

Such responses are especially impressive because we were asked to try to do a number of things that are not typical for most conferences that are attended by researchers in mathematics, science, engineering, or technology education. For example:

We were asked to attract participants from a broad range of relevant fields – which ranged from mathematics and science education, to engineering education, and teacher education, and the cognitive sciences, the learning sciences, and instructional systems technologies. Among the 106 people who registered for the conference, fewer that 1/3 had attended past ICTMA conferences.

We were asked to attract significant numbers of graduate students and early career faculty members. Approximately, 1/3 to 1/2 of the registrants fit this category; yet, more than 1/3 of the participants were widely recognised leaders in relevant fields. Many graduate students commented that they especially enjoyed the pre-conference activities that were planned for them, as well as the special "planned research" poster sessions that gave them the opportunity to get feedback about future studies they were planning.

We were asked to involve significant numbers of people from populations that are under represented in SMET education. Approximately 1/2 of the participants and subgroup leaders were women.

We were asked to shift attention beyond short reports of past small pieces of research toward future-oriented research collaborations. More than half of the presentations or topics of discussion emphasized the planning of future research collaborations – often involving researchers from several countries and/or people representing several practical or theoretical perspectives.

We were asked to promote informal discussions and friendship-building activities to promote productive interactions among people from diverse backgrounds and interests – and among experienced and inexperienced. Many people commented how much fun they had in Bloomington, in addition to the work - and how much they enjoyed after-hour activities that brought new people together.

We were asked to not only produce the usual kind of conference proceedings document but to also open up other publications outlets for junior conference participants. The Journal for Problem Based Learning is one of several journals which have made commitments to sponsor at least one monograph or special issue which focuses on collaborations involving graduate students or early career professionals who attended the ICTMA13. Again, I'll have more details to report about this in the near future.

Prof. Richard Lesh

Conference Organiser, ICTMA 13

Indiana University

5. Report from the CERME5 Working Group Modelling and Applications - Differentiating perspectives and delineating commonalties

Gabriele Kaiser, Bharath Sriraman, Morten Blomhøj , Javier Garcia

5.1 Introduction

The modelling and applications working group at CERME5 was again characterised by a heterogeneity of approaches to modelling research. There was a sense of continuity in the work of the group from CERME4 in Spain due to the presence of a core group of researchers representing the different approaches. Concerning growing clarity and common understanding of the different approaches progress has been achieved in the working group from the meetings at CERME4 to CERME5. One of the leading goals of the organisers was to ensure both a continuity for the present discussion as well as accumulate current perspectives coherently into the existing literature for use by modelling researchers.

The participants of the group represented a big variety of countries: Participants from 8 European countries (Cyprus, Denmark, France, Germany, Great Britain, Netherlands, Portugal, Spain) and 4 non-European countries (Brazil, Israel, Lebanon, USA) attended the working group.

In the working group 18 papers and 1 poster were presented. The papers were classified into 3 groups: papers

- with theoretical reflections,
- promoting research towards action,
- presenting empirical research.

Most papers belonged to the last group, which was structured along the age level of the cohort addressed in the studies, i.e. lower secondary level, upper secondary level, university level, in-service-teaching level.

5.2 Revisiting the classification of approaches

The discussion was structured using a classification of the variety of approaches developed by Kaiser & Sriraman (2006) on the basis of the discussion at CERME4. This classification was based on the goals of modelling and distinguished various perspectives within the discussion according to the central educational aims in connection with modelling. It describes briefly the backgrounds these perspectives are based on as well as their connection to the initial perspectives. Two issues of the Zentralblatt für Didaktik der Mathematik (see Kaiser, Blomhoj, and Sriraman 2006 and Sriraman, Kaiser, and Blomhoj, 2006) were devoted to papers representing the different perspectives. We refrain from reproducing the whole classification table and restrict ourselves to the main categories:

Name of the perspective	Central aims
Realistic or applied modelling	Pragmatic-utilitarian goals, i.e.: solving real world problems, understanding of the real world, promotion of modelling competencies
Contextual modelling	Subject-related and psychological goals, i.e. solving word problems
Educational modelling; differentiated in a) didactical modelling and b) conceptual modelling	Pedagogical and subject-related goals: a) Structuring of learning processes and its promotion b) Concept introduction and development
Socio-critical modelling	
Epistemological or theoretical modelling	Theory-oriented goals, i.e. promotion of theory development

The following approach can be described as a kind of meta-perspective:

Cognitive modelling	Psychological goals: a) analysis of cognitive processes taking place during modelling processes and understanding of these cognitive processes b) promotion of mathematical thinking processes by using models as mental images or even physical pictures or by emphasising modelling as mental process such as abstraction or generalisation

Figure 1. Shortened version of the original classification of current perspectives on modelling (from Kaiser & Sriraman, 2006, p. 304).

Several researchers agreed that the classification as given was useful and could aid understanding of the interrelations between the very different and complex approaches adopted by researchers and practitioners. As one of the main points of criticisms the need to separate out didactical approaches and research perspectives was pinpointed. Didactical approaches are characterised by a normative orientation concerning the overall aims of applications and modelling in mathematics education in contrast to research perspectives which guide studies on special aspects concerning applications and modelling. This missing distinction leads to difficulties, because individual researchers and practitioners usually operate across several perspectives both concurrently and consecutively. It was concluded that classifications of approaches allow a systematisation of the debate, but it has to be stated clearly that such a classification is only a working instrument in order to facilitate the understanding of the debate, based on idealisations and simplifications.

In the extensive discussions during the group sessions, several fundamental issues were raised. This discussion addressed the following issues:

The need to devise and develop common notions and terms;

The need to revise the classification of Kaiser and Sriraman (2006);

The usefulness of including concrete examples to illustrate the differences between perspectives;

Prospects for future collaborative work of the group.

In order to solve a few of the aspects described above one of the sub-groups developed a task for each perspective in order to get a better understanding of the classification table, which is shown below.

Perspective	Task	Feature
Realistic Modelling	Create a price structure for a taxi driver.	This is an open task. You have to create a model and therefore you need the whole modelling circle
Contextual Modelling	A taxi driver has a fixed price of €2.00 and the price/km is €0.15. The age of the taxi driver is 43 and his taxi is 7 years old. How much costs a drive of 6 km?	This is more a word problem.
Educational modelling	The same task as in contextual modelling	A teacher can use a modelling task to explore linear functions. The teacher uses the understanding of the context to develop mathematical concepts. The question is how a task should be placed in the curriculum
Socio critical	How should a taxi driver be paid?	You can think about different price structures,

modelling		but the intention is to think also about the social question. You can argue that a taxi-driver should be paid for every hour he is working.
Epistemological modelling	How much money did the taxi driver earn at the end of a day?	In this question many concepts are hidden. You have to think about the price structure…. how many customers? How much gasoline was needed? The original cost of the car? A deep analysis is necessary considering various perspectives.

Figure 2. Original classification of perspectives on modelling exemplified using the problem of the cost of a taxi ride.

In the discussion of this attempt it became clear, that it was difficult for some researchers to see the differences between educational and contextual modelling. The description of the socio-critical approaches is not unique: One could be critical about the model, the assumptions, the validity of the model, but one could also be critical about how modelling is used in society. The epistemological perspective was very difficult to understand and to exemplify.

5.3 Proposal for a revised classification system

As already mentioned one of the criticisms was the need to separate the different intentions which are underlying studies or publications, i.e. papers or studies might either be characterised as comprehensive didactical approaches or as approaches connected to distinct research intentions. Didactical approaches are normative theoretical approaches characterised by overall norms education shall follow and aims to be supported by applications and modelling, formulated by those belonging to this perspective. They characterise the teaching approaches connected with applications and modelling, which are favoured by the various perspectives and are strongly influenced by the theoretical background to which the perspectives refer. In contrast approaches connected to distinct research intentions guide empirical or theoretical studies concerning applications and modelling. They are of course not independent from the didactical approach, but they might either focus more on cognitive aspects such as concept development, development of modelling competencies or the affective domain of learners such as engagement or motivation, confidence, self-efficacy, and beliefs. Keeping that difference in mind, it is obvious that individual researchers and practitioners might operate across several perspectives both concurrently and consecutively.

Comprehensive didactical perspectives or normative theoretical approaches:

Name of the approach	Central aims	Background	Authors of paper presented at CERME5
Realistic or applied modelling	Pragmatic-utilitarian goals, i.e.: solving real world problems, understanding of the real world, promotion of modelling competencies	Anglo-Saxon pragmatism and applied mathematics	Burkhardt; Schwarz, Kaiser; Romo Vasquez
Contextual modelling	Subject-related and psychological goals, i.e. solving word problems	Problem solving debate and psychological laboratory experiments	
Model eliciting approach	Psychological goals, i.e. apply model elicited through solving the original problem to a new problem	Problem solving debate	Mousoulides, Sriraman, Pittalis, Christou
Educational	Pedagogical and subject-related goals:	Didactical theories	Andresen;

modelling	a) Structuring of learning processes and its promotion b) Concept introduction and development c) Promotion of motivation and improvement of attitudes towards mathematics d) Promotion of critical understanding of modelling processes and models developed	and learning theories	Berman, Verner, Aroshas; Blomhoj, Hoff Kjeldsen; Canavarro; Maaß
Socio-critical and socio-cultural modelling	Promotion of critical understanding of modelling processes and models developed as overall goal connected with recognition of cultural dependency of modelling examples and modelling approaches developed	Socio-critical approaches in political sociology, ethno-mathematics	Barbosa
Epistemological modelling	Promotion of connections between modelling activities and mathematical activities, re-conceptualization of mathematics and reorganisation of school mathematics from a modelling point of view	Anthropological Theory of Didactics	Barquero, Bosch, Gascón; Ruiz, Bosch, Gascón

Approaches connected to distinct research intentions:

Name of the approach	Central aims	Background	Authors of paper presented at CERME5
Cognitive approaches	a) Analysis of cognitive processes taking place during modelling processes and understanding of these cognitive processes b) Promotion of mathematical thinking processes by using models as mental images or even physical pictures or by emphasising modelling as mental process such as abstraction or generalisation	Cognitive psychology	Borromeo Ferri; Jurdak, BouJaoude; Roorda, Vos, Goedhart; Vos, Roorda
Affective approaches	Promotion of positive attitudes towards mathematics and mathematics teaching Promotion of adequate self-perception such as self-efficacy Influence of special aspects such as authenticity of the real world context	Related psychological approaches	Vorhoelter; Wake, Pampaka
Pragmatic, teaching-oriented approaches	Evaluation of the effectiveness of teaching proposals or the possibility to realise special examples in school, analysis of teaching strategies, intervention measures by teachers	General pedagogical research	
Theoretical approaches	Development of meta-analysis of models and modelling approaches		Peled

Figure 3. Revised classification of current perspectives on modelling.

5.4 Future directions

The above described framework for the description of the modelling debate provides a basis for mutual understanding of the protagonists from different perspectives. The descriptions developed above give insights into the origin of the different perspectives and its relations to the underlying background philosophy. It makes clear, that the various approaches promoting applications and modelling in school or university teaching come from very different theoretical perspectives spanning the debate from ethno-mathematics to problem solving. They are characterised by different views on important aspects of applications and modelling such as their views on goals and intentions of applications and modelling, which vary from promotion of a better understanding of the real world to the promotion of learning mathematical theory. Accordingly, their views on the role of the context are highly differentiated ranging from the call to authentic real world examples to more or less artificial, mathematically oriented examples. In addition, their perception of the modelling process is also highly different demanding a modelling cycle starting from real world problems and coming back to them or modelling processes which start from a real world problem, but lead to mathematical reflections and the development of new mathematical theory.

Bearing in mind the different educational, philosophical, and cultural background of the various perspectives on applications and modelling developed internationally this overview will not only allow the identification of differences between the various perspectives, but as well the identification of commonalities. This will hopefully promote a mutual understanding within the debate and foster long-term intensive research collaborations between researchers from different perspectives.

5.5 References

Kaiser, G., Blomhoj, M., & Sriraman, B. (Eds). (2006). Mathematical modelling and applications: empirical and theoretical perspectives. *Zentralblatt für Didaktik der Mathematik,* 38(2).

Sriraman, B., Kaiser, G., & Blomhoj, M. (Eds.) (2006). Modelling perspectives from around the world. *Zentralblatt für Didaktik der Mathematik*, 38(3).

Kaiser, G., & Sriraman, B. (2006). A global survey of international perspectives on modelling in mathematics education. *Zentralblatt für Didaktik der Mathematik,* 38(3), 302-310.

6. Brief News Items

6.1 New Constitution

During the General Meeting of ICTMA members held at ICTMA 13 in Bloomington, Indiana, USA, on July, 26, 2007, the new ICTMA constitution was adopted by members. It is available for viewing at the ICTMA website: www.ictma.net/

6.2 CREMM – Reference Centre for Mathematical Modelling in Teaching

The Reference centre began in October, 2006, with Maria Salett Biembengut as founder. Check it out at: http://www.furb.br/cremm/ingles/index.php

7. Recent Dissertations

Carrejo, D. (2004). *Mathematical modelling and kinematics: A study of emerging themes and their implications for learning mathematics through an inquiry-based approach*. Unpublished doctoral dissertation. University of Texas, Austin. Supervisors: Jill Marshall and Anthony Petrosino.

In recent years, emphasis on student learning of mathematics through “real world” problems has intensified. With both national and state standards calling for more conceptual learning and understanding of mathematics, teachers must be prepared to learn and implement more innovative approaches to teaching mathematical content. Mathematical modelling of physical phenomena is presented as a subject for new and developing research areas in both teacher and student learning. Using a grounded theory approach to qualitative research, this dissertation presents two related studies whose purpose was to examine the process by which in-service teachers and students

enrolled in an undergraduate physics course constructed mathematical models to describe and predict the motion of an object in both uniform and non-uniform (constant acceleration) contexts. This process provided the framework for the learners' study of kinematics.

Study One involved twenty-three in-service physics and math teachers who participated in an intensive six-hour-a-day, five-day unit on kinematics as part of a professional development institute. Study Two involved fifteen students participating in the same unit while enrolled in a physics course designed for pre-service teachers and required in their undergraduate or graduate degree programs in math and science education. Qualitative data, including videotapes of classroom sessions, field notes, researcher reflections, and interviews are the focus of analysis. The dissertation presents and analyzes tensions between learner experience, learning standard concepts in mathematics and learning standard concepts in physics within a framework that outlines critical aspects of mathematical modelling (Pollak, 2003): 1) understanding a physical situation, 2) deciding what to keep and what not to keep when constructing a model related to the situation, and 3) determining whether or not the model is sufficient for acceptance and use. Emergent themes related to the construction of the learners' models included several robust conceptions of average velocity and considerations of what constitutes a "good enough" model to use when describing and predicting motion. The emergence of these themes has implications for teaching and learning mathematics through an inquiry-based approach to kinematics.

Maaß, K. (2003). ***Mathematical modelling in classrooms of year 7/8*****. Doctoral thesis. University of Hamburg. Supervisor: Prof. Dr. Gabriele Kaiser. The dissertation has been published as follows: Maaß, K. (2004).** ***Mathematisches Modellieren im Unterricht – Ergebnisse einer empirischen Studie*****. Hildesheim: Verlag Franzbecker**.

A 15-month study (04/01 - 07/02) examined the extent to which beliefs of Year 8 students about mathematics can be changed through modelling with real-world problems in mathematics classrooms. Central aspects of the study were the integration of modelling examples into every day life at school over a longer period of time and modelling processes as the central topic.

This study deals with the following questions which are assumed to lead to results:

1. To what extent is it possible to foster modelling abilities of lower secondary level students on a meta level through making modelling processes the explicit topic?

2. To what extent are mathematical beliefs modified/changed by this kind of teaching?

To answer these questions, modelling examples according to the following questions were practiced in lessons: How large is the surface of a Porsche? What are favourable mobile telephone rates in relation to habits of use? Is it possible to supply Stuttgart-Degerloch with warm water exclusively from solar panels?

It is a qualitative based study that mainly aims at generating hypotheses. Methodologically, the position of the study is located in the Grounded Theory. Various methods of data collection have been applied: Tests about the mathematical and modelling competencies, questionnaires on mathematical beliefs, interviews with students, concept-maps, and students' diaries about their learning experiences and tasks from exams. These instruments have been adopted at the final stage of the study. The evaluation of verbal data was done by open coding.

The results show strong connections between attitudes towards modelling examples and mathematical beliefs and their modifications in the course of the study. Beyond that, typical patterns of mistakes in doing modelling became quite clear and seemed to be connected to attitudes towards modelling examples as well.

Weitendorf, J. (2007). ***Real world problems in calculus teaching*****. Doctoral thesis. University of Hamburg. Supervisor: Prof. Dr. Gabriele Kaiser. The dissertation has been published as follows: Weitendorf, J (2007).** ***Realitätsbezüge im Mathematikunterricht*****. Hildesheim: Franzbecker.**

The central goal of traditional German calculus teaching is to make students understand mathematical concepts such as limit, derivative and integral. After the introduction of these concepts the students are asked to solve special kinds of problems called "Funktionsuntersuchung" (examinations of

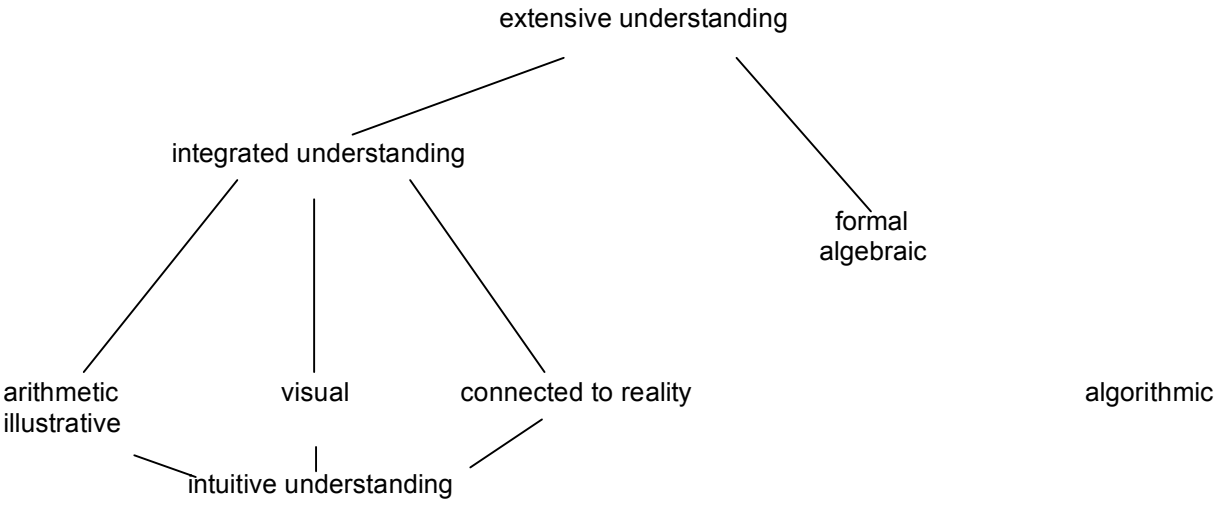
functions). “Funktionsuntersuchung” is the process of finding out the properties of a function following a schematic procedure. Empirical research has shown that the students are successful in solving those problems, but in doing so they normally do not improve their understanding of the connected mathematical terms.

During my study I developed an alternative approach emphasising the real meaning of the mathematical concept in contrast to its exact mathematical definition. The sphere of a concept was discussed as extensive as possible.

As already stated by Newton the mathematical definition of the derivative is quite complicated. In his essay “De quadratura curvarum” written in 1676 he uses the word “disappearing”, as he tries to discuss the rate of change. According to his approach there exists an average velocity, but not an instantaneous one. I concluded in my study, that students had the same problem with the instantaneous rate of change.

Another aspect of my approach is that students have different access to mathematics. This aspect was shown by ideal typical characterizations, which were developed out of the data. It was possible to classify the students as belonging to the types “algorithmic”, “formal” or “visual”. These three types were discriminated in a second dimension with regard to the representation of the different references to reality. One result of the study is that it is helpful to have a lot of different realistic examples so that each student has the opportunity to find his own way. On the other hand one can not expect that the entire offered examples can be reconstructed by each student. But it could be shown that the students, who are quite close to the formal type, are able to give more than one realistic example connected with a special mathematical concept.

The following scheme of steps of understanding the concept function associated with reality was developed to investigate the students´ understanding.



The extensive understanding represents an ideal goal.

The existence of computer-algebra-systems is another aspect to change the traditional syllabus. Examinations of functions are trivialised by these systems. On the other hand these systems are very helpful, if not necessary, when solving problems dealing with reality. The following example shows such a problem.

The German income act about the amount of income tax in relation to income reads as follows:

1. Before 7,235 Euro (Basic tax-free allowance): 0;
*2. From 7,236 Euro till 9,251 Euro: (768,85 * y + 1.990) * y;*
*3. From 9,252 Euro till 55,007 Euro: (278,65 * z + 2.300) * z + 432;*
*4. From 55,008 Euro: 0.485 * x – 9,872.*
Note: "y" is one 10000th of that part of the taxable income calculated according to pararagraph 2 which is more than 7.200

Euro.
"z" is one 10000th of that part of the taxable income calculated according to paragraph 2 which is more than 9,216 Euro.
"x" is the taxable income as calculated according to paragraph 2.

After giving the text to the students two questions are of interest: How much is the highest and how much is the lowest tax rate? The answer to the first question is easy, because one only has to know how to calculate the slope of a linear function. The answer to the second one leads directly to the derivative.

Additional questions that are close to reality are in connection with laying of rail beds, hanging cable, revenue, cost and profit.

Another result of the study is that an understanding of mathematical terms in connection with reality seems to last longer; but more research is necessary to prove this exactly.

8. Recent Publications of Interest

Barbosa, J. (2006a). Mathematical modelling in classroom: a socio-critical and discursive perspective. *Zentralblatt für Didaktik der Mathematik, 38*(2), 293-301.

Barbosa, J. C. (2006b). Students' discussion in mathematical modelling. Paper presented at 3th International Conference on the Teaching of Mathematics, Istanbul, Turkey. [Available at http://www. tmd. org.tr/sites/ICTM3/]

Blum, W., Galbraith, P., Henn, H.-W., & Niss, M. (Eds.) (2007). *Applications and modelling in mathematics education. The 14th ICMI study*. New York: Springer.

Borba, M. C., & Villarreal, M. E. (2005). *Humans-wih-media and the reorganisation of mathematical thinking: Information and communication technologies, modelling, experimentation and visualisation*. New York: Springer.

Borromeo Ferri, R. (2006). Theoretical and empirical differentiations of phases in the modelling process. *Zentralblatt für Didaktik der Mathematik, 38*(2), 86-95.

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