3.4 Beliefs, attitudes, and emotions

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3.2 Application problems

There exists a plethora of applications and modelling problems and materials for use in mathematics classrooms at various educational levels. These materials range from mere 'dressed up' mathematical problems to authentic problem situations.

Issue 2. *What does research have to tell us about the significance of authenticity to students' acquisition and development of modelling competency ?*

Examples of specific questions:

- What authentic applications and modelling materials are available worldwide ?
- Taking account of teaching objectives and students' personal situations (experience, competence), how can teachers set up authentic applications and modelling tasks ?
- How does the authenticity of problems and materials affect students' ability to transfer acquired knowledge and competencies to other contexts and situations ?

3.3 Modelling abilities and competencies

With the teaching and learning of mathematical modelling and applications, many goals and expectations are combined.

Issue 3a. *How can modelling ability and modelling competency be characterised, and how can it be developed over time ?*

Examples of specific questions:

- Can specific subskills and subcompetencies of 'modelling competency' be identified ?
- How can modelling ability be distinguished from general problem solving abilities ?
- Are there identifiable stages in the development of modelling ability ?
- What are characteristic differences between expert modellers and novice modellers ?
- What is the role of pure mathematics in developing modelling ability ?

Issue 3b. *How can modelling in teacher pre-service and in-service education courses be promoted ?*

Examples of specific questions:

- What is essential in a teacher education programme to enable prospective teachers to experience real, non-trivial modelling situations, and hence acquire modelling competencies for purposes of teaching applications and modelling in their professional future ?
- Which training strategies can help teachers develop security in using applications and modelling in their teaching ?

3.4 Beliefs, attitudes, and emotions

Beliefs, attitudes and emotions play important roles in the development of critical and creative senses in mathematics.

ISSUE 4. *To what extent does applications and modelling have the potential to provide an environment to support both students and teachers in their development of appropriate beliefs about and attitudes towards mathematics ?*

Examples of specific questions:

- What are the implications of research on the role of beliefs, attitudes and emotions for changing teaching practice and classroom cultures with respect to applications and modelling ?
- What strategies are feasible for in-service teacher education that will address the fear experienced by some teachers when faced with applications and modelling ?

3.5 CURRICULUM AND GOALS

It is argued that applications and modelling can make fundamental contributions to the development of students' mathematical competencies.

ISSUE 5a. *What would be an appropriate balance – in terms of attention, time and effort – between applications and modelling activities and other mathematical activities in mathematics classrooms at different educational levels ?*

Examples of specific questions:

- Is it possible – or desirable – to identify a core curriculum in applications and modelling within the general mathematical curriculum ?
- Which applications, models and modelling processes should be included in the curriculum ? Do answers depend on each teacher or should there be some minimal indications in national and state curricula ?
- Is it beneficial to generate specific courses or programs on applications and modelling or is it better to integrate applications and modelling into standard mathematical courses ?

The university level represents a particularly problematic case. Although there are differences between places and countries, university graduates in mathematics embark on a large variety of professional careers, many of which will have links involving applications and modelling – including research mathematicians through their research or teaching responsibilities.

ISSUE 5b. *Should all university graduates in mathematics acquire some applications and modelling experiences as part of their studies ? If so, what kinds of experiences should they be ?*

Concerning general education at the school level, some special questions arise. Mathematics accounts for a large proportion of time in school – this is only justified if mathematics can contribute to general education for life after school.

ISSUE 5c. *How and to what extent can applications and modelling contribute to building up fundamental competencies and to enriching a student's general education ?*

Examples of specific questions:

- What meanings can be given to 'general education', and what is the role of mathematical modelling therein ?