Summary of the discussion on "Mathematical Competence" at the 18th SEFI Mathematics Working Group Seminar, Gothenburg, June 2016

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The first group discussion in Gothenburg was concerned with the theme **"Mathematical Competence"**. The discussion was preceded by a keynote presentation on the concept of mathematical competence given by Professor Mogens Niss from Roskilde University where the concept was developed (for the corresponding paper cf. the seminar proceedings at http://sefi.htw-aalen.de). The discussion was guided by the following focus questions:

- In which ways does the concept of mathematical competence help to inform the mathematical education of engineers?
- Do you take into account – consciously or unconsciously – mathematical competencies in your offering of mathematical learning opportunities?

The contributions by the participants of the discussion session can be summarized as follows:

- It was emphasized by several participants that students need a stable and solid knowledge foundation. Boundary conditions have to be taken into account like time available and expectations of colleagues teaching application subjects regarding contents to be covered.
- Students need more motivation when dealing with mathematical concepts. They have to see the connections to engineering reality, mere hints on important later usage are not sufficient. Since the competence concept puts emphasis on doing and using mathematics in relevant contexts and situations, it provides orientation in this direction. For getting information on relevant contexts and forms of usage a close linkage with colleagues teaching application subjects is required. The split of responsibility between mathematics and application subjects needs to be discussed, particularly regarding the modelling competency, since the colleagues are the experts on relevant models in their fields of application. Input from industrial employers and professional bodies might also be helpful. One should clarify how the mathematical competencies relate to other engineering competencies and whether later in a study course mathematical competencies are addressed, possibly implicitly.
- Regarding the different competencies within the competence concept, some participants wanted to put the modelling competency in the foreground. The role and coverage of the reasoning competency needs clarification. It is obvious that in engineering formal proofs are less important than in mathematics as a science of its own. But still engineers have to provide justifications for their work and this includes mathematical reasoning. Since engineers also have to communicate their justification in oral or written form, the communication competency is required as well. Moreover, to connect mathematics and application subjects properly, students should recognize the mathematical representations they encounter in their fields of application. Here again, a close contact to colleagues teaching application subjects is necessary in order to include such representations when teaching mathematics.
- It turned out in the discussion that even when colleagues were not explicitly aware of the competence concept (including the list of competencies), they have put up similar lists on their own. One participant stated that "elements of competencies are in everything we do".

- Finally, since most students are assessment driven, it is important to clarify the issue of properly assessing mathematical competencies. Corresponding to the theory of “constructive alignment” (Biggs), goals, learning arrangements and activities and assessment have to match. Regarding forms of assessment log books for projects, oral examinations and peer evaluation of project reports were mentioned. It was also stated that students find questions requiring interpretations particularly hard.

Normally, the competence concept is not discussed with students. Doing this might help them to recognize and accept the goals of mathematics education and to appreciate the role of mathematics in engineering education.