Report on Panel 2: Students‘ prior knowledge (in mathematics)

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This panel was organized as follows: After a short introduction by the panel chair, Prof. Alpers, there were two input talks by Prof. Lawson, Coventry University, and Prof. Dehling, Ruhr University Bochum. In a subsequent discussion the participants added their insights and measures regarding the topic of this panel.

The main reasons for this panel are two kinds of complaints one can often hear. There are complaints by lecturers about the missing mathematical prerequisites of incoming engineering students which are ever decreasing. On the other hand, there are complaints by students that they do not see in which ways the mathematics education relates to engineering studies and work such that motivation for engaging in mathematics is low. The panel dealt with the justification of both kinds of complaints and measures to overcome the underlying situation.

Duncan Lawson reported about his experience of nearly two decades of mathematics support. He confirmed for the UK that knowledge of incoming students was decreasing particularly in the 90ies according to results of diagnostic tests made over the years. He stated that students are still not well-prepared mathematically such that support is absolutely required. In the UK so-called mathematics support centers were set up for this purpose. They are meant to be drop-in-centers where students can get help in a supportive, non-threatening atmosphere. Face-to-face contact allows to analyse the underlying reasons for problems with mathematics and hence to provide tailor-made advice and support measures. An adequate placement of the support center in the library contributes to the awareness of students that they can get help. In the mathematics support center at Coventry there have been about 7000 visits by students so far. Via the **sigma** center for excellence in university-wide mathematics and statistics support (http://www.sigma-cetl.ac.uk/) which is a joint effort of the universities in Coventry and Loughborough, knowledge about support centers is spread over the whole country via regional hubs. Reports about the important issues for successful implementation of support centers can be found in http://www.sigma-cetl.ac.uk/index.php?section=22. There are also many materials available which can be used at support centers for dealing with specific mathematical topics and problems. These are freely available at http://www.mathcentre.ac.uk/ .

Herold Dehling emphasized that the need for mathematical competence is rather growing in engineering such that complaints about higher drop-out rates should not lead to a reduction of the level of mathematics education. For supporting students in getting the necessary competence, the Ruhr University Bochum has a service center for mathematics and its applications which provides the service teaching for all study courses in science and engineering, undertakes joint curriculum development with those courses, trains coaches and tutors for the respective classes and provides consulting services. By having an organization with clear responsibilities and contact persons for the different “users” one can make sure that the service is provided according to the needs of the study courses. The training of tutors is compulsory and performed by people with mathematical background in collaboration with people from the field of didactics. A mathematics learning center, staffed by tutors, provides consultancy which is better accepted by students than the official office hours offered by lecturers. There are two special projects addressing the students at risk and students’ motivation. In the MathePlus project students at risk are identified by a short quiz early in the first semester. Those who are not “hopeless” are offered a special training for which they have to

apply and sign a “contract” to strengthen their commitment. They then get special support for enhancing their learning skills, they have to write a learning diary and to attend weekly office hours. So far, the pass rate of those who accepted this offering superseded the general pass rate significantly. It must be noted, though, that the work is very labour intensive. More information on this project is available on http://www.ruhr-uni-bochum.de/mp2/matheplus.html . In the second project, MathePraxis, students work on real life engineering applications in order to enhance their insight in the usefulness of mathematics for engineering. More information on this can be found on the same website.

In the subsequent discussion the four guiding questions given to the panel were handled:

Are students entering university with less knowledge of mathematics than before or are expectations greater than before?

There is a wide consensus that over the years there has been an overall decrease in incoming students’ mathematical knowledge. They have less training such that their fluency in dealing with symbols is often lacking. They might have other mathematical competences like modeling but a certain degree of fluency is absolutely necessary for engineering students to follow mathematical derivations in application subjects. There is also a larger diversity now with different routes of access to study courses and this heterogeneity adds to the problem. In summary, one can state that there definitely exists a problem and that universities have to take measures to deal with it if it is politically intended to increase the number of academics. The input speeches have demonstrated successful examples of doing this.

How much mathematical skill must an engineer have?

This question is hardly to answer because there are so many kinds of engineering study courses (and subsequently so many different job profiles for engineers). The necessary skills can only be defined in a curriculum for a specific engineering study course. In order to facilitate this work, the SEFI Mathematics Working Group provides a curriculum framework document for mathematics curricula in engineering for which a preliminary document can be found at the group’s web site http://sefi.htw-aalen.de. The final document will be available in early 2013 together with one concrete mathematics curriculum for a practice-oriented study course in mechanical engineering.

How can students be motivated to take on supplementary courses?

An early response is important to show students that they are in need for help. The support should also be well-placed and made known to students via different channels. In order to increase the level of commitment, a “contract” like the one in Bochum seems to be an appropriate way. There was also a concern that one should concentrate on the non-hopeless cases, maybe even starting in the second semester when students have had the experience of failure and are hence better motivated to accept help. Since for the weaker students it is often a big problem to attend supplementary courses beside their normal work load, it should be possible to stretch the first two semesters to three or to insert a semester zero.

Which courses teach mathematics most effectively and when should such courses be offered?

This question was not discussed extensively due to time reasons. But it is clear that mathematics courses should be designed in close connection to central “users” of mathematics in a specific study

course and that they should be adapted to the study course accordingly. A “one-fits-all” approach would neglect this. Additionally, Dehling gives an example for even integrating praxis examples into a study course to increase the motivation to deal with mathematics. Such application projects are a valuable supplement to the classical teaching. It was also suggested to invite members from engineering departments to mathematics lectures to give short talks about the importance of mathematics in real life engineering problems.

In conclusion, one can state that there is a real problem with the mathematical knowledge of beginning engineering students. The challenge is to help and guide students through their mathematics education without reducing the necessary level of competence for a study course. But there are good practice examples which show that one can deal with the problem to a certain extent. It is clear as well that this takes a lot of resources, particularly for offering a sufficient number of tutors and instructors.