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## **TWG6: Students' practices and assessment**

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### **INTRODUCTION AND DISCRPTION OF THE ORGANIZATION**

This report summarizes the work of TWG6 “students’ practices and assessment” of the third INDRUM conference in Hannover (Germany). It had 19 registered participants from nine different countries, and 14 contributions – nine papers and five posters.

The themes addressed in the contributions of our group mostly focused on students’ practices. These especially covered the following activities: self-regulated and informal learning, problem-solving, programming, communicating about mathematics, and note-taking. But we also had contributions on possible learning barriers as well as on students’ self-perceptions and their emotions towards mathematics.

The sessions of TWG6 were organized as follows. In two 90-minute presentation sessions, the authors of the papers were asked to present the main ideas of their paper within 20 minutes, followed by a short slot for essential questions. The authors of a poster could present their poster within 5 minutes. In subsequent discussion sessions the whole group discussed the papers presented intensively. These sessions had been originally planned in three phases: a phase with questions to the authors of each paper in the plenary, followed by small group discussions about these questions, and a final reporting phase. However, our group spontaneously decided to stay in the plenary discussion mode, because already in the first phase with questions to the authors of the papers presented, intensive debates evolved – not only with the authors but within the whole group. Discussions around the posters took place in a separate poster session.

### **SYNTHESIZED SUMMARY OF THE CONTRIBUTIONS**

The group leaders assigned the contributions to one of the two following overarching themes: students’ practices in traditional settings and students’ practices in innovative courses or related to innovative course elements.

#### **Students’ practices in traditional settings**

Five papers and four posters had been assigned to this overarching theme. An overview of the topics of the corresponding papers can be seen in Table 1.

The first three papers in Table 1 focus on students’ learning behavior in their self-study phase. *Tim Kolbe & Lena Wessel* investigated the learning strategies used by engineering students in a mathematics service course. They specifically found that the students relied much on rehearsal strategies, and used many course-external resources such as YouTube videos. *Robin Göller et al.* compared the self-regulated learning behavior of four students from two different countries: two students from Finland and

Authors	Topic
Tim Kolbe & Lena Wessel	Self-regulated learning by engineering students in a mathematics service course
Robin Göller, Juulia Lahdenperä, & Lara Gildehaus	Self-regulated learning of two German and two Finish students with the common goal of getting though the exam
Lukas Günther, Nico Marten, & Katharina Berendes	Development of an analytical framework for describing informal learning situations in mathematical study programs
Johanna Ruge	Dynamic barriers in students' learning processes
Jocelyn Rios	Multilingual students' experiences in introductory college mathematics courses

**Table 1: Papers on students' practices in traditional settings**

two students from Germany. They found that although the students shared the goal of passing the exam, their learning behavior differed and was probably influenced by the institutional context, for instance, the possibility to receive institutionalized help in the case of difficulties. The paper by *Lukas Günther et al.* focused on informal learning situations as opposite to institutionalized learning. They developed a framework for analyzing students' activities in such situations in detail, which can make way to suggestions for supporting them in their self-study phase. *Nico Marten* then presented a poster on a project in which this framework is used to analyze how engineering students at a German university gather information for finding answers to mathematical problems, and then to offer appropriate support.

The other two papers from Table 1 focus on barriers that might inhibit students' learning activities. *Johanna Ruge* reflected on so-called "dynamic learning barriers". In such dynamic learning barriers, students inhibit their own learning although they actually want to learn, for example, because of constraints impressed by the institutional environment such as examinations, but also by a curriculum prescribing precisely the subject matter to be learned. Finally, *Jocelyn Rios* showed that also language might be a learning barrier in mathematics classes. She, for instance, found that multilingual students who prefer to do mathematics in a language other than the language of the classroom are less likely to feel comfortable speaking in class.

In addition to the contributions above, we had three posters focusing on students' affective state. *Aaron Gaio at el.* investigated the development of students' self-efficacy with regard to mathematics in their first year at a university in Italy, and found that students tend to overestimate themselves at the beginning of their studies. *Sophia Pantelaki* investigated the development of students' emotions towards mathematics, and found that social interaction might influence these emotions positively. Finally, *Takuo Oguro at el.* focused on a special emotion, namely math anxiety. They found

that the math-anxiety of students majoring in social and human environment at a university in Japan did not increase – against their hypotheses. A reason might be that the mathematics courses observed were activity-oriented.

### **Students’ practices with innovative course elements or in innovative courses**

An overview over the four papers assigned to this theme is shown in Table 2. In addition, *Johanna Rämö et al.* presented a poster proposing an innovative teaching model that promotes cooperative learning, which builds upon group work facilitated by the teachers in primetime meetings.

<b>Authors</b>	<b>Topic</b>
Frank Feudel & Anja Panse	Students’ perspectives on suitable positions of blanks in guided notes
Elena Nardi	Students’ narratives on exponential growth in colloquial situations
Irene Biza	Students’ usage of digital resources for problem-solving
Laura Broley et al. (presented by Chantal Buteau)	Effective orchestration features of a project-based learning course on programming for mathematics investigation

**Table 2: Papers on students’ practices with respect to innovative course elements or in innovative courses**

The foci of the four papers in Table 2 were rather individual. *Frank Feudel & Anja Panse* investigated at which elements of a mathematics lecture students appreciate blanks in guided notes (notes with blanks students fill in during the lecture) and why, and found that the extent of appreciation and the reasons for students’ preferences varied between different elements of a mathematics lecture. *Elena Nardi* investigated in a mathematics education course that especially aimed at making mathematics visible in daily life and society how students communicate about exponential growth in a colloquial situation related to the Covid-19 Pandemic. She found that many students spoke rather sloppy about exponential growth in this situation although an accurate description might be important for being able to judge the political decisions made.

The latter two papers focused on students’ usage of digital tools. *Irene Biza* investigated students’ usage of digital resources when solving a problem on divisibility. She found that the availability of such resources influenced students’ problem-solving activities, for example because they used these to search for solutions to the problems posed that had been found by others. She then rose the question of how the availability of such resources could be used to create productive learning activities. Finally, *Laura Broley et al.* identified in a project-based course on programming for mathematics investigation what effective orchestration features of such programming courses could be from the students’ point of view, for instance, teaching assistants that can push the students to the next step in the case of problems, and a pleasant class atmosphere.

## **IMPORTANT POINTS FROM THE DISCUSSION**

Our group had intensive discussions on each paper. Instead of presenting details of all these discussions, we want to summarize some important general points that emerged during them. These mainly evolved around four themes:

- 1) Impact of students' practices on teaching and vice versa
- 2) Methodological issues in empirical research – especially on students' practices
- 3) More general theoretical issues that arose from the research presented
- 4) Our identities as researchers

**Impact of students' practices on teaching and vice versa:** We want to highlight three issues discussed. One refers to digital resources. Their availability has a great impact on students' practices, e.g., on their problem-solving activities. In our discussions, it became obvious that further research is necessary to specify this impact with the goal to design learning situations in which the usage of such resources and especially the process of seeking and processing information provided by online resources becomes a productive learning activity. A second important issue refers to the tendency to guide students' practices in teaching innovations too much, which might take away their own responsibility for their learning. Therefore, a balance is needed between providing freedom and help for designing productive learning situations. A third important issue that came up in our discussions was the possible effect of active learning on students' practices. There was an agreement that active learning does not only have the potential to change students' practices like their participation in class, but also their view of mathematics, for example about the relevance of mathematics in society.

**Methodological issues in empirical research – especially in research on students' practices:** We want to mention two important issues here that came up in our discussions several times. One is the problem that research on students' practices often relies on self-reports. On the one hand, activities/phenomena reported do not necessarily coincide with the actual state. Especially a non-reference of certain phenomena does not allow conclusions about these. For example, if students do not mention certain experiences in a course does not mean that these did not occur. Maybe other experiences were just considered more relevant. A further problem of self-reports is that students might have a different perspective on educational notions than researchers, for example, on "understanding". Both issues should be considered when interpreting research results relying on self-reports. A second important issue we want to mention here is the influence of the context on research results. Several of our contributions indicated that the institutional setting and the design of courses research takes place in have a substantial influence on the results. This should be considered when interpreting such research result, and a replication of studies in other contexts might help to specify the influence of the context.

**Theoretical issues that arose from the research presented:** We want to mention three important issues. One was the issue of using general theories or frameworks in mathematics education research, for example a general framework on informal

learning situations or a general note-taking framework. We discussed benefits and problems of using such frameworks. On the one hand, they might allow conclusions for more students (in all kinds of settings), but they might disregard specificities of mathematics, for instance, of mathematical reasoning. A second issue that came up in the discussions was the role of the mathematical content in research on students' practices. As it is one aspect of the research context, it certainly influences the results. However, the actual role the mathematical content plays in a specific study probably depends much on the question(s) investigated. The third important theoretical issue we want to mention here refers to basic educational notions from mathematics education research such as learning, but even the notion "mathematics". We recognized that it is hard to define them and questioned whether a definition is really necessary, in particular, because students also have their own interpretations of these notions.

**Our identities as researchers:** This was the most general theme that came up in our discussions. Formerly, most of our participants had originally been socialized in the discipline of mathematics. This might influence practices carried out as mathematics education researchers, for instance, the desire to define notions used precisely. However, since mathematics education research is multidisciplinary, we asked ourselves whether our identities might have changed. One view that many of us agreed on is that we have multi identities that we call upon in different situations.

## **CONCLUDING REMARKS AND FUTURE PERSPECTIVE FOR TWG6**

Our group had lots of interesting contributions focusing on all kinds of students' activities like self-regulated and informal learning, problem-solving, programming, communicating about mathematics, and note-taking, as well as on barriers that might inhibit students from carrying out such activities and from engaging with mathematics. The contributions were good starting points for fruitful discussions which brought up lots of general issues that are relevant for the mathematics education community at large – and for research on students' practices in particular.

However, some important themes were underrepresented in our group this year:

- We only had few contributions focusing on students' affective and emotional state although these probably highly influence the activities students finally carry out. We therefore hope for more contributions focusing on these themes in the future.
- We only had one study that touched upon the problem of equity although inequity is a big problem in current education – also at university.
- The "assessment" part of our TWG's name "students' practices and assessment" was only touched upon this year in two studies in which portfolio assessments were used for gathering data, although assessment is a very important issue that highly influences students' study behavior.

Therefore, research focusing on these themes might enrich this group in the future much, but, of course, also more research on students' activities considered this year in other contexts to find out to what extent the results presented might be generalizable.