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Supporting university freshmen – an intervention to increase strategic knowledge

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Rationale

At school, we actually only had exercises where we could calculate with numbers and formulas. Now, it was really abstract what we had to do. [...] We didn't really know: Where should we begin? How does this work? (Aylin, mathematics student, 1st semester)

The quote above shows that some strategic knowledge is needed for problem solving at university level. Additionally, a necessary condition to deal with those problems is to be familiar with the related content of the lecture. The literature provides a lot of successful strategies both for problem solving (Pólya, 1945) and learning (Ramsden, 2003), but it is also known for a long time that it is insufficient for improving students' skills to provide them with a list of those strategies (Schoenfeld, 1985). Therefore, I am cyclically developing an intervention program to help students act strategically.

Research interest

This study aims to test how an intervention may influence the students' problem solving and learning processes and how the induced changes affect their success in university mathematics.

Design of the intervention

The intervention is embedded into the classic problem sessions of a first-semester lecture of B.Sc. students and future secondary school teachers (weekly sessions, 14×90 minutes). So far, there have been two pilot studies accompanying the Calculus 1 lecture. The classic purpose of the problem session, to discuss homework already submitted by the students, has not been altered. However the main objective of the intervention is to foster students' self-regulation by engaging them in metacognitive processes. Therefore the students' actions are systematically reflected. This is done in three steps:

- 1) From a constructivist point of view it is of great importance that students develop their own strategies rather than using a checklist. Therefore students work on a few problems every week at home and write down used strategies.
- 2) To support the individual development of strategies, different approaches are collectively reflected. In particular, those students who were unable to find a solution themselves get the opportunity to explicate their strategies and can benefit from the experience of their more successful fellow students. A lot of different ideas, especially those that might not lead to a solution, are reviewed and evaluated. Lastly, at least one solution chosen by the students is completely expanded upon. That way, students who were not able to solve the problem by themselves can have a deep insight into that process.
- 3) During a reflection phase at the end of each class, the utilized strategies are discussed once again and those that could be helpful for more than one particular problem are written down on a "strategy board". Usually those strategies resemble those postulated by Pólya (1945) and Schoenfeld (1985).

For instance, when dealing with sequences or series, one firstly needs to clarify affiliated concepts like convergence and divergence. Then different strategies might be helpful, for example to generate different representations (a sketch, tables, etc.) or look at special cases. Considering related problems might also be a helpful strategy.

Evaluation

The program evolves cyclically based on student interviews, observation of solving processes, evaluation sheets and systematically documented experiences. At the end of the first pilot phase, the students were asked how often they use certain strategies (4-level likert scale). It showed that those displayed on the strategy board had significantly higher values than others. Especially self-reflection and clarification of concepts are frequently used. Nevertheless a qualitative analysis of videographed solving processes showed that the students still had a lot of difficulties to clarify concepts on their own. Therefore, in the following phases, we tried to increase their activity level concerning this task. We also integrated one unknown problem per week so we could experience a whole problem solving process together.

In the second pilot phase, the design needed to be altered since the composition of students was very different. In summer most of the students have already failed at least one exam in Calculus 1.-In addition to possible lower mathematical skills, their academic self-concept might be affected. We observed a much lower activity level than in winter, so we had to add introductory tasks to encourage the students to actively take part in the sessions. This could also apply to single weaker students that in winter would be unnoticed.

Perspective

As the order of courses was changed in the academic structure, the main study, starting April 2016 will take place in the context of Linear Algebra. The necessary adaption of the concept will be an interesting task. For the first time, we will also be able to treat a statistically relevant number of students, so in addition to ongoing qualitative research, quantitative evaluation will be possible.

References

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