Aspects obstructing or facilitating examination success for first year engineering students

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Engineering students often have trouble passing mathematics examinations. Some approaches to remedy this relate to cognition, others to affect. Another one, improving learning strategies, is promising as it relates to both aspects *and* provides a perspective for interventions.

THEORETICAL CONSIDERATIONS

The obstacles students are facing when starting a course in mathematics at university can be categorized in different ways (cf. de Guzmán, Hodgson, Robert, & Villani, 1998). When the emphasis is on learning strategies, interventions can address cognitive aspects, learning resources or the metacognitive level. The design research (van den Akker, Gravemeijer, McKenney, & Nieveen, 2006) project MP²-Math/Plus is based on the hypothesis that learning strategies are the key to influencing learning behaviour (cf. Dehling, Glasmachers, Griese, Härterich, & Kallweit, 2014). Apart from providing a selected group of students with special coaching, MP²-Math/Plus researches learning behaviour and collects data on personal circumstances and examination success. In order to cover different aspects of learning behaviour, the LIST questionnaire (Wild & Schiefele, 1996) was employed. This questionnaire is divided into eleven scales covering different cognitive, metacognitive and resource-related learning strategies. Thus it is appropriate for answering the research question:

What patterns are emerging when analyzing examination success in terms of these three measures: learning strategies, participation in a project on learning strategies, and gender?

SELECTED METHODOLOGICAL DECISIONS

LIST factor scores were calculated (N=653), yielding values between 0 and 100. Mutliple linear regression identified factors with relevant influence. Descriptive statistics were computed (N>1750), differentiating between project participation, examination success, and gender.

RESULTS AND IMPLICATIONS

Internal reliability of the scales was satisfactory ($\alpha>0.7$). The correlations between the factors were below 0.63 (highest between *Effort* and *Metacognition*), allowing for multiple linear regression with LIST factors as predictors and the examination result as outcome. This explained 23% of variance and highlighted the importance of *Effort* ($p=0.000$), *Using Reference* ($p<0.001$), and *Time Management* ($p<0.01$), with standardized $\beta_{Effort}=-0.50$, $\beta_{Reference}=0.24$ and $\beta_{Time}=0.18$. Interestingly, all these are

resource-related learning strategies, and among these three, only *Effort* improves examination achievement. Other supportive (though not significant) influences were found in *Organizing* (structuring and summarizing subject matter) and *Learning Environment*. The hypothesized relevance of *Metacognition* is not directly mirrored in the results, but becomes evident through its relatively high correlation to *Effort*.

Gender had no detectable influence on any kind of learning behaviour, although females participating in MP²-Math/Plus achieved significantly higher pass rates than their male counterparts, e.g. in 2013, 79.31% of female but only 68.29% of male participants passed the examination. On the whole, project participation helped examination success, with some variance among project years, the most substantial success being a pass rate of 72.86% among participants, compared to 57.97% for non-participants in 2013. Moreover, achievement was significantly higher ($p=0.007$, $t(89.928)=-2.125$, $r=0.219$), although the MP²-Math/Plus concept postulates deliberately choosing students with below average prior performance.

These results indicate the importance of fostering aspects covered by the *Effort* scale. These items (e.g., *I do not give up even though the subject matter is very difficult and complex* or *Whenever I have planned a certain workload, I make an effort to master it*) relate to perseverance and motivation, describing attitude rather than aptitude. It seems advisable to continue focusing on affective and motivational aspects and not relying on cognition alone. In order to gain detailed insight, the next step will be qualitative analysis, e.g. through interviews.

Note: The poster presented and discussed at the conference can be found at http://www.ruhr-uni-bochum.de/ffm/Lehrstuehle/stochastik/griese.html.

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