More efficient engineering education through supporting implicit ability beliefs

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Summary

Introduction

According to labour market statistics the shortage of engineers is a serious problem in Estonia. Unfortunately, when studying drop out from higher education institutions, it appears that undergraduate drop out is one of the highest in the field of technology (www.haridussilm.ee) and the drop-out rate of first year engineering students is the most problematic (Dekker et al., 2009; Haridussilm, s. a.). The study of university drop-out levels has revealed that interruption of studies is a multi-faceted phenomenon which, as a rule, is the result of various concurrent reasons: wrong choice of specialty, academic failure, low sense of belonging and relatedness, studies not corresponding to personal abilities, etc. (Espenberg et al., 2014).

In addition to interest in speciality (Mamaril, 2014), contentment with curriculum structure (Suhre et al., 2007), academic self-efficacy (Talsma et al., 2018), and effort regulation (Richardson et al., 2012) that have been traditionally regarded as important predictors of academic success, students' views about the malleability of intellectual ability (intelligence beliefs) are also considered as a significant aspect of study motivation and learning behaviour (Burnette et al., 2013). Although the role of implicit beliefs of ability as a study progress indicator has science-based proof (ibid.) and the relevance of ability beliefs has been acknowledged in the context of elementary school also in Estonia (Aus et al., 2017; Vinter et al., 2019), it has so far not been widely applied in the analyses reflecting the academic progress of Estonian students at higher levels of education.

The present work focuses on implicit beliefs of ability (Dweck & Leggett, 1988) in order to enrich the methodology currently used to analyse factors shaping the learning paths of university students in Estonia. To the knowledge of the authors this focus has previously received little or no attention in the

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higher education context in Estonia. The aim is to analyse how do students' implicit ability beliefs and other motivational factors that have been included in the study – academic self-efficacy, interest in speciality and effort regulation –interact in predicting students' academic achievement. Studies show that supporting a growth mindset towards intellectual ability improves the learners' progress in mathematics (Blackwell et al., 2007) and that implicit beliefs of ability of engineering students have an impact on their progress in engineering studies (Dai & Cromley, 2014).

In the context of a professional higher education institution it will be examined, whether it is possible to change learners' implicit ability beliefs with a short seminar-intervention towards a growth mindset as shown with different interventions in the elementary school (Blackwell et al., 2007; Paunesku et al., 2015).

Based on the described research the following hypotheses have been set:

1) The fixed mindset and low effort regulation of the first-year students of TTK UAS predict lower progress in science subjects while higher academic self-efficacy and speciality interest indicate better progress in science subjects.
2) It is possible to bring about positive changes in engineering students' implicit ability beliefs and effort regulation with an intervention that addresses ability beliefs.

Methodology

In order to test the hypothesis, a study instrument in the form of a questionnaire, was first drawn up. It covered the aspects related to the above-mentioned beliefs, learning motivation and study behaviour. To evaluate the validity of subscales, or in order to assess whether the devised instrument is suitable for measuring the beliefs and learning motivation of the students in the field of technical higher education, the questionnaire was piloted before the intervention study. The general sample included 270 students from ten different curricula of TTK UAS.

An experimental intervention study (2 two-hour seminars on implicit ability beliefs and neuroplasticity together with pre-and post-seminar assignments) was carried out among first-year students (N=37) of a curriculum at TTK UAS (conditionally named as *Curriculum X*) aimed at influencing the students' beliefs towards a growth mindset. The students in the sample were interviewed twice using identical questionnaires: before the intervention (October 2017) and after the intervention (November 2017). The first-year students in *Curriculum Y* from the same institution participated in the study as a control

group. The students in the control group, who did not receive the intervention, were likewise assessed twice (in October and November). The academic progress indicators (the average mark in science subjects of the autumn semester 2017) were included in the further analyses.

Results and conclusions

Hierarchical regression analysis was used in order to assess which aspects of study motivation and behaviour were significant in explaining the variance in students' performance in the science disciplines. Academic self-efficacy ($\beta = .34$, $p < .01$), fixed ability beliefs ($\beta = .22$, $p < .05$) and low effort regulation ($\beta = –.26$, $p < .05$) were the strongest predictors of grades in the science subjects among the factors studied. Interest did not predict variance in grades. In order to evaluate the effect of the intervention, a repeated measures two-way ANOVA was carried out for every construct. The results showed a significant interaction of time and intervention for two constructs: ability beliefs and effort regulation.

The hypotheses were only partially verified. As expected, first year engineering students' fixed ability beliefs and lower levels of effort regulation predict worse, and higher academic self-efficacy and speciality interest predict better academic achievement in the science subjects. It is interesting that students generally report a lack of speciality interest as the main reason for quitting their studies, and it has been regarded as one of the defining factors shaping the educational path of students both in sociological studies covering drop out from higher education (Espenberg et al., 2014) as well as in quality studies carried out by the applied university itself. However, the present study revealed that the speciality interest was not significantly associated with either other motivational factors or performance in the science subjects.

The result that implicit ability beliefs, academic self-efficacy and low effort regulation played a significant role in predicting grades in science subjects, supports earlier results from the basic level education (e.g., Blackwell et al., 2007), being a clear indication that addressing beliefs associated with learning is important at all levels of education.

The intervention carried out in the study showed that growing awareness about the malleability of academic abilities was witnessed in the intervention group, a change that was not evident in the control group. The targeted effect of the intervention is further supported by the fact that speciality interest and self-efficacy that are not directly linked to implicit beliefs of ability, showed no significant changes neither in the control nor the intervention group. An opposite than expected result appeared concerning effort regulation. In particular, the desire of students belonging to the intervention group to perform difficult

tasks fell, while in the control group the corresponding figure remained at the same level. Although the result may be somewhat explained by the different academic advancement of study groups in science subjects, these explanations are speculative and would require further study. At the same time, it is also possible that the intervention was not able to adequately prevent problems which may have been caused by other underlying issues, which had an accumulative effect during the autumn semester. On the basis of the above, we note that the assumption was confirmed that by the intervention of implicit ability beliefs, it is possible to influence the implicit ability beliefs of students in the technical field towards growth mindset, but in order to bring about a lasting change in the level of the learning process, support for development-oriented and learning-enhancing beliefs must be systematic to the level of the organisation, including, inter alia, development programmes that support the acquisition of scientific knowledge regarding teaching and learning among lecturers.

Keywords: implicit ability beliefs, fixed mindset, growth mindset, motivation, academic achievement in engineering, intervention study