DEEP OR SURFACE APPROACHES TO STUDYING, WHICH IS APPLIED? COMPARING STUDY SKILLS OF FIRST YEAR ENGINEERING STUDENTS

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1 INTRODUCTION

Most engineers love the disciplinary content of their work, and have no problem throwing themselves into it. The technical content is and will always be very important for engineers, but the industry nowadays asks for engineers with both technical and soft skills [1] [2]. One of the soft skills is learning how to acquire new information. In case of students; learning how to study, or put differently learning how to learn. By gaining this specific soft skill, it can contribute to learning the technical knowledge engineering students need.

Soft skills education is not popular amongst engineering students, and keeping them engaged is not an easy job [3]. So how can engineering students learn these skills? To answer this question it is important to have a closer look at learning; learning is a process that occurs within students. Learning involves change in knowledge, beliefs, behaviour or attitude, which occurs as a result of experience and increases the potential for improved performance and future learning' [4]. How people think about learning, has an influence on their willingness to make those changes and improvements. Dweck [5] showed that students' conceptions on the ability of developing their own qualities and abilities, influence how these will develop. She makes a distinction between two different types of mindsets, a growth and a fixed mindset.

A growth mindset is needed to increase the learning motivation. Students with a fixed mindset belief that intelligence is static, as students with a growth mindset belief that intelligence can be developed. Briefly and black and white stated; students with a fixed mindset avoid challenges, give up easily, see effort as fruitless, ignore useful negative feedback and feel threatened by the success of others. As a result, they may plateau early and achieve less than their full potential. This confirms a deterministic view of the world. Students with a growth mindset embrace challenges, persist in the face of setbacks, see effort as the path to mastery, learn from criticism and find lessons and inspiration in the successes of others. As a result, they reach higher goals of achievement. All this gives them an increased feeling of free will.

At the University of Twente (UT) lecturers of the engineering programmes noticed that skills education was usually evaluated below average and students often did not see the necessity of skills education. The study choice questionnaires filled out by high school students (results 2016) show that the self-assessment of the students relating their study skills prior to starting their study is quite positive. 51% of the students are placed in the category 'low risk' based on their answers.

The same questionnaires show that, despite having a 'low risk' on failure overall, the majority of the students' scores on study skills are not sufficient. This is affirmed by the lecturers who notice that many of the students lack the skill to properly plan their time to study or applying strategies that actually improve their knowledge. As a respond to these observations, a project was set-up to improve the skills education of engineering students, with an initial focus on bachelor students of Civil Engineering.

The engineering programmes of UT would like to see their students to start their studies by taking responsibility for their own learning and working actively on their studies. Which is also one of the underlying principles of the Educational Model [6]. For the

majority of the students this only starts later on in the bachelor programme. The engineering programmes would like to see their students starting to work more effectively and motivated earlier in their studies to prevent delay and drop out.

To be able to properly improve skills education, it is important to get a clear overview of the current state. Are the observations of the teachers correct? Therefore the following research questions are assessed: what do engineering students think about learning? Which study approaches do they apply and how do they prefer to be taught? And how does this differ between the different study programmes?

2 METHODOLOGY

2.1 SETTING

The current research is aimed at first year engineering students of the Bachelor programmes of Civil Engineering, Mechanical Engineering and Industrial Design. The data was collected at the end of several lectures during the end of the second and third quartile of the year, to receive the largest amount of responds. Afterwards a link to the questionnaire was spread using the digital learning environment the students use for their study programmes. Prior to filling in the questionnaire the students received a short explanation about the research, and were encouraged to answer the questions truthfully and not socially desirable.

2.2 INSTRUMENTS

The students filled out a questionnaire regarding their mindset, study approach and preferred teaching approach. This questionnaire was a combination of two validated questionnaires.

To identify the students' mindset a questionnaire based on the theory Dweck [5] has been used. In this section 16 multiple choice questions are asked about views on intelligence and talent, a Likert scale of 6 points was used.

To be able to measure different study approaches and preferred teaching style, the questionnaire the ASSIST [7] is used. This questionnaire was first designed by Marton and Saljö [8] and later on adapted by Tait, Entwistle and McCune [9]. The part of the questionnaire containing the ASSIST questions consists of 60 (multiple choice) questions, of which 52 questions cover the study approaches and 8 questions the preferred teaching style. A Likert scale of 5 points was used.

2.3 STATISTICAL ANALYSIS

In analysing the data, the following correlations and comparison are investigated:

- Is there a correlation between mindset and applied study approach?
- Is there a correlation between applied study approach and preferred teaching style?
- What are the differences and similarities between students from the different programmes?

The results of the analyses are presented in Section 3.

The current identification of the different study approaches of this group of students supports lecturers when making their education more adaptive, and to determine the resources they offer to these students [10].

3 RESULTS

In total 419 first year engineering students filled out the questionnaire, 40 responses were excluded from the results due to not answering all the questions of the questionnaire. The number of responses, percentages and distribution over the three different bachelor programmes can be found in Table 1. On a population size of 600 a sample size of minimum 316 (52,7%) is needed to have a margin of error of 0.5 when handling categorical data [11]. The total population size was 622 students, table 1 shows that this minimum percentages has been met.

Number of students…	*who filled in the questionnaire*	*Percentage of responds of the total population*
Total complete responses	N = 378	60,7%
Responses from Civil Engineering students	n = 111	64,9%
Responses from Industrial Design students	n = 63	31,3%
Responses from Mechanical Engineering students	n = 204	81,6%

Table 1. Overview of the number of respondents

In the following subsections, results are presented. Results are called statistically significant when the p-value (significance level) is smaller than 0.05. Note that average scores plus minus the standard error (as one time the standard deviation of the sample average) and a t-test to indicate whether average scores are significantly different are presented.

3.1 MINDSET

The first part of the questionnaire is dedicated to measure the mindsets of the students. Figures 1 and 2 show the distribution over the different mindset categories and the difference between the bachelor programmes. As can be seen in Figure 1, most students are in category 3 of the mindsets, which means they have a growth mindset with a couple of fixed ideas.

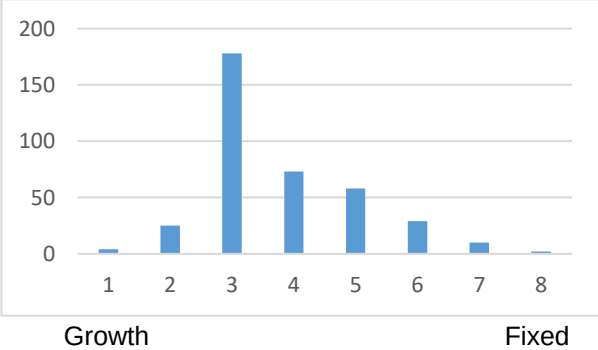

Figure 1. Absolute numbers of students per mindset category, from growth (1) to fixed (8).

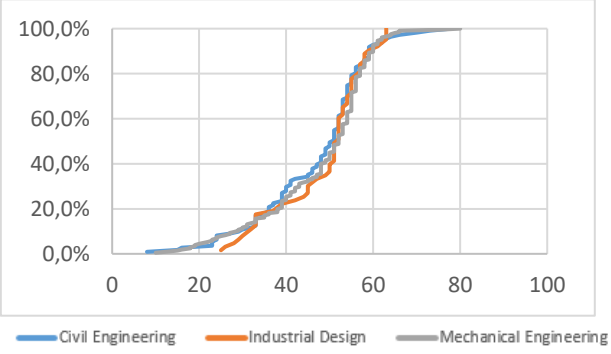

Figure 2. Cummalive distribution of the mindset scores for the three bachelor programmes.

Figure 2 shows a cumulative distribution of the mindset scores of the three bachelor programmes. There is no significant difference between the bachelor programmes, the spread of the results from the Industrial Design students is smaller, but this could be due to a smaller sample group, and is not significant according to the KS2 test. When comparing the distribution of the mindset scores and the learning approaches applied by the students, no significant correlation was found. This indicates that there is no relation between the mindset students have about learning and intelligence and the study approaches they apply during their studies.

3.2 LEARNING APPROACHES AND PREFERENCE IN TEACHING

The next results present the study approaches and the preferred styles in which students are taught. When comparing the three different approaches, on average the surface approach is applied most and the deep approach is applied least (see Table 2). When looking at preferred teaching styles, on average the students prefer deep teaching over surface teaching (see Table 3). The maximum score a student could get for the approach and preference is 20.

Table 2. Average scores per applied approach

Deep approach	Strategic approach	Surface approach
10,1	10,6	12,7

Table 3. Average score per preferred teaching style

Preference for deep teaching style	Preference for surface teaching style
10,6	8,7

As can be expected a correlation can be found between these two elements. Table 4 shows the correlation between the learning approaches and preferred teaching styles.

Table 4. Correlations between applied study approaches and preferred teaching styles

	Preferred deep teaching style	Preferred surface teaching style
Deep approach	0,43	-0,10
Surface approach	-0,16	0,14

Students who apply deep study strategies prefer to be taught by a lecturer incorporation deep teaching activities. For students who apply a surface learning approach the opposite is shown. Although all correlation coefficients are statistically significant (albeit barely for deep approach vs. surface teaching), correlation coefficients are rather weak, which is slightly surprising. For the strategic approach, no significant correlations were found with the preferred teaching styles.

3.3 DIFFERENCES BETWEEN THE BACHELOR PROGRAMMES

When comparing the three bachelor programmes, differences can be found in relation to the study approaches applied by the students. Figure 3, shows the cumulative distribution of the scores for the study approaches (top) and teaching styles (bottom).

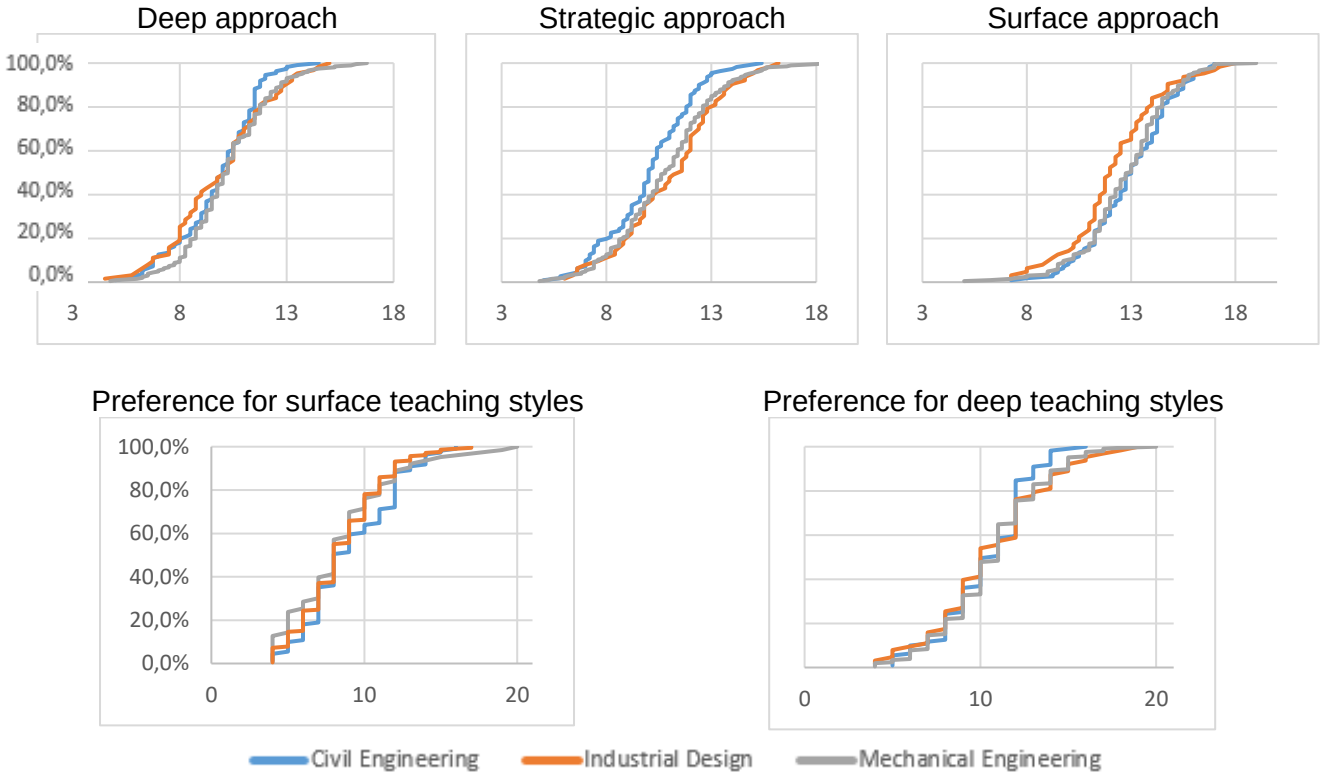

Figure 3. The cumulative distributions of the applied deep, strategic and surface approach and their preference in teaching style.

For the study approaches there are some clear differences between bachelor programmes. The upper left panel of Figure 3 shows that Mechanical Engineering students apply most deep study approaches (average scores of 10.25±0.14 versus 9.78±0.18 and 9.91±0.29 for Civil Engineering and Industrial Design students respectively). The difference with Civil Engineering students is significant. The upper centre panel shows that Civil Engineering students stand out. They apply on average significantly less strategic study approaches (average score of 10.01±0.20) than Industrial Design students (11.09±0.30) and Mechanical Engineering students (10.80±0.17). Finally, the upper right panel shows that Industrial Design students apply on average less surface study approaches (12.19±0.29) than Mechanical Engineering (12.75±0.15) and Civil Engineering students (12.97±0.19). Note that the difference with Civil Engineering is significant. For the teaching styles, differences between bachelor programmes are less distinct. Civil engineering students prefer slightly more surface and slightly less deep teaching styles compared to other students. This is not unexpected given the results for the learning approaches. However, differences with other students are not statistically significant. In fact, for the teaching styles, we found no statistically significant differences between the bachelor programmes.

4 DISCUSSION & CONCLUSION

The results of this study show that the study approach that the student apply most is the surface approach, which indicates that the students do not fully comprehend the skill to study for deep learning or see the necessity of applying deep learning strategies. This is in line with the observations made by the lecturers. Of the three different bachelor programmes, the Civil Engineering students apply the surface study approach most often.

There is a silver lining, because overall the students do express that they have a preference in deep teaching styles. This could indicate that the students don't know or are not aware of the effect of their study approaches. This is strengthened when looking at the mindset of the students, most students have a growth mindset with a couple of fixed ideas. This indicates that the students do believe that putting in effort will have a positive effect on their learning, the engineering students do know that studying equals hard work.

Although the correlations are not that strong, they are the correlations that were expected. Especially the correlations between the deep and surface study approaches and there corresponding preferences in teaching styles. Which was a surprise is that no correlations were found between the mindset of the students and their study approach. This could also be a result of students not knowing what the effect is of the study strategies they apply or not knowing which activities are part of which strategy. For example that student think underlining text in their books is a proper way to study structural mechanics.

The results of the two questionnaires have not been compared to the study results of the individual students. Nor a comparison of genders has been made. Both analysis would be interesting to do in further research.

It would also be interesting to do further research to see whether making students more aware of their study strategies and mindset, and teaching them strategies that support deep learning will support them in adapting a more deep study approaches. Currently interventions to execute this are implemented in the bachelor programme of Civil Engineering.

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