Engineering in Dutch Schools: Impact on Study Choice

A quantitative analysis

J.T. van der Veen
Head of 3TU Centre for Engineering Education
ELAN, University of Twente
Enschede, the Netherlands
E-mail: j.t.vanderveen@utwente.nl

A. Blume-Bos
Data analist
Twente Academy, University of Twente
Enschede, the Netherlands
E-mail: a.blume-bos@utwente.nl

Keywords: Engineering education, Study-choice, Study-success, Secondary schools.

INTRODUCTION

Since 2004 a growing number of 'Technasium' schools in the Netherlands have introduced engineering projects in their curriculum [1]. Goals include stimulating learner's creativity and broadening their horizon with respect to engineering studies and related jobs. Throughout their school career students work on authentic tasks originating from companies and institutes. The final assignment connects with a Polytechnic or University. As many projects incorporate engineering elements we expect study choice impacts.

Whereas science has a longstanding tradition in international secondary school curriculum, the situation for engineering is quite different. In the Netherlands, and many other countries, learners are not introduced to engineering topics. Engineering studies and jobs may thus go unnoticed. We see international initiatives to invest in engineering education. Sometimes engineering is considered to be the context in which mathematics and science are to be identified [2]. In other instances the focus is on engineering as such [3]. In the Netherlands a bottom-up initiative aimed to fill the engineering education gap since 2004. A total of 83 schools now offer what is called a Technasium-stream throughout their curriculum. Goals of this initiative are to actively engage learners with science and engineering. An additional goal is to raise the number of girls choosing science and engineering career paths. After 10 years we can now monitor the preferences of these Technasium learners when making their study choice. We focus on the data available at the University of Twente to get a first glance at trends that may occur now more schools have rolled-out the full 6 years Technasium curriculum.

The core of the Technasium curriculum is to have all learners involved in real-life problems with a problem owner at a company or organisation. In teams the learners elaborate on the nature of the problem and user requirements. Possible solutions are then weighed and one option is taken to the level of a design, a prototype or a product depending on the level of complexity. Final stages of the design cycle like testing or iterations in the design cycle are sometimes incorporated as well. Each new project covers a period of 8 weeks with a longer final project in their last year. In general students spent 3-4 hours per week on these engineering design tasks. The Technasium curriculum is not obligatory and after the third or fourth year learners can decide to leave this track in favor of other exam subjects.

The final Technasium project allows individuals or small groups of learners to work on a challenging task over a longer period, while being coached by staff members from a Polytechnic or University. Coaching secondary school learners in a final project is supported by the University of Twente as one of the means to give them a better view on the world of science and engineering at our university. This will help them to make an informed decision when choosing their study. Of course the university also hopes to see some of them back as first year's students.

1 RESEARCH QUESTIONS

Many aspects of this new engineering education approach are of interest. In this paper we focus on the study choice and study success effects. Are more learners from Technasium schools choosing engineering studies when compared with learners from all schools? We expect that to happen as a result of raised interest in engineering education. We expect a similar positive effect with regard to more girls choosing engineering studies. We are also interested to see if these 'Technasium students' have an advantage over other students with no or limited background in engineering education. We expect better results and lower drop-out rates for this group as these learners know better what they choose and they are also better prepared, having had numerous engineering tasks before. The coaching of a number of Technasium learners in their final project is performed by research staff of the University of Twente. Do we see these students entering our study programs? We expect that to happen as they appear to like their final projects. The research questions of this study are:

(1) Do Technasium students select engineering studies more often? (sub-question: Do more girls select engineering studies?)

(2) Do these students perform better compared to students with no Technasium background?

(3) Do students that performed their final project under supervision of University of Twente staff choose a study program at the same university?

2 METHOD

We checked student numbers, results and dropout rates for students originating from Technasium schools over four cohorts in the period 2010-2013 [4]. For the 'Technasium group' we checked if students from these schools were having this engineering subject in their list of final exam results. Data were then compared with the total group of students entering the University of Twente over this period. For all

three groups only students with a so-called N -profile[1] are taken into consideration. For the sub-question related to the study choice of the girls we can also compare the percentage of female students in the Technasium group with the percentage of female learners at the Technasium schools.

Study choice was broken down into three categories so as to check for trends in study choice compared with the total population:

- Design-based engineering studies like Mechanical Engineering, Civil Engineering and Industrial Design (code=CTW).
- Science studies such as Chemistry, Physics, Advanced Technology, Biomedical Engineering and Technical Medicine (code=TNW).
- Mathematics, Computer Science, Creative Technology and Electrical engineering(code=EWI).

For study success we checked for dropout and number of credits in the first year of their studies. For study success we checked enrolment data with at least entrance in their second year of studies at the University of Twente. For credits we counted the number of ECTS achieved in the first year by students originating from a Technasium school versus all students as an indicator for the study performance.

We compared the register of students performing a final project under supervision of University of Twente staff with the enrolment data of the university over the period 2010-2013.

3 RESULTS

3.1 Study choice effects

From our 3065 first year students in the period of 2010-2013 (4 cohorts, N-profile) a total of 136 (4.4%) students followed this new engineering track throughout their school career.

The percentage of female students in the ‘Technasium group’ is 15% (20 out of 136). This can be compared with the percentage of female learners in Technasium schools as counted in 2012: 34% [1], and with the percentage of female students entering the University of Twente: 29% (880 out of 3065) [4].

In Table 1 the study choice of the ‘Technasium group’ (row 1) is compared with the total group of freshmen from the Technasium schools (row 2) and the total population of N-profile students entering the first year programs (row 3). Students coming from a Technasium school favour design and construction based engineering studies like Industrial Design and Mechanical Engineering (see Table 1, code=CTW). There is a clear shift away from Science studies (code=TNW) and to a lesser extent also from Mathematics and other engineering studies such as Computer Science and Electrical Engineering (EWI). In Figure 1 we zoom in on this study choice shift from science to engineering. The figureclarifies that this effect is seen over all 4 cohorts of our study. In Table 1 and Figure 1 N-profile students choosing behavioural sciences are not pictured so as to focus on science and engineering studies that connect well with the N-profile of these students.

[1]N-profile comprises NT (Nature & Technology) and NG (Nature & Health) profiles.

Table 1. Study choice of Technasium group compared with all students from their schools and withall N-profile studentsentering University of Twente in 2010-2013.

	Design and Construction Engineering CTW	Science and (bio)medical Studies TNW	Maths, Computer Science, Electrical Engineering EWI
1/Technasium students (n=119)	57%	27%	16%
2/Technasium schools all students (n=200)	49%	34%	17%
3/All students N-profile (n=2486)	37%	41%	23%

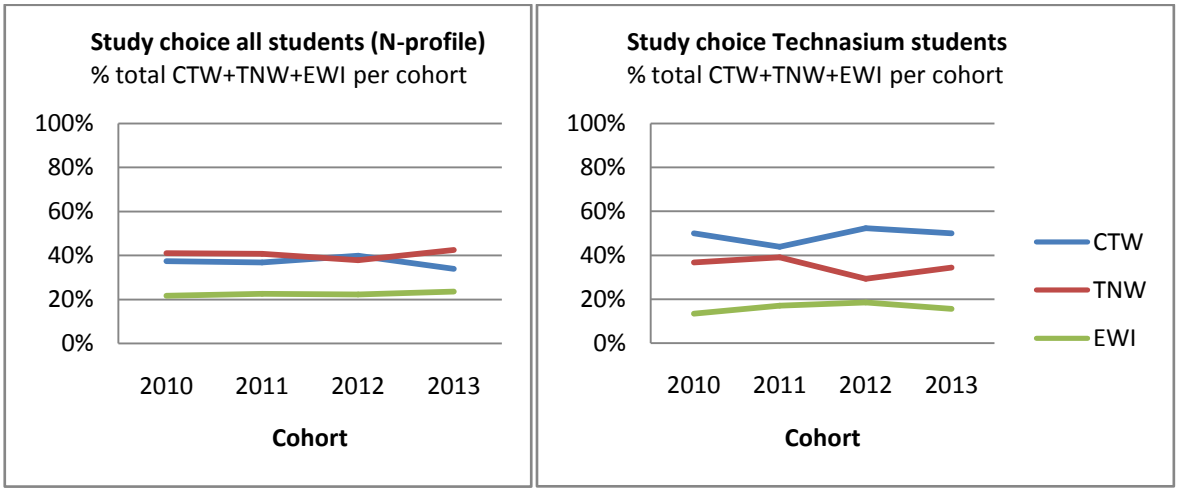

Fig. 1. Study choice trends compared for 2010-2013 cohorts. Students from Technasium schools (right) vs all students with N-profile (left).

3.2 Study success

Study success measured in average number of credits is equal for Technasium students and the total group of N-profile students: 51 ECTS (out of 60). Dropout rate for the Technasium group is slightly higher with 20% versus 15% for all science and engineering students. Zooming in on the dropouts versus the whole Technasium group we find equal exam grades for the engineering subject (7.3 vs 7.4, out of 10) but a large difference in mathematic exam grades (6.3 vs 7.1). However, numbers of students are small.

3.3 Final project and study choice

Over the period of 2010-2013 University of Twente staff members coached 178 Technasium learners in their final project, mostly in groups of two or three. Looking at the schools of these learners 163 come from our regional network of five Technasium schools. Clearly proximity is important for schools and learners when they select coaches for final projects. From this group of 178 we identified 47 learners (26%) who selected a study program at the University of Twente.

4 CONCLUSIONS AND DISCUSSION

Despite the small numbers we already see study choice effects that may grow if engineering education is introduced in more secondary schools. Further analysis will show whether we are attracting new groups of students or moving students from science towards engineering. Preferably we would like to have learners to be exposed to both science and engineering allowing learners to make a well-informed study choice after some inspiring learning experiences. An alternative explanation for the shift in study choice is self-selection either at the time of selecting a (Technasium) school (12 years) or at the time of selecting exam subjects (16 years).

Clearly there still are some challenges to attract more girls via this route. Apparently many girls join the Technasium route (overall 34%) but do not enter our technical university's engineering programs. From quantitative data alone it is not clear why this is the case. Further analysis is needed on this aspect.

Finding similar study success (credits) is a good starting point for an educational innovation like Technasium. Interviewing students will give some more insight in how their engineering design experience helps them in their studies. Engineering studies do not yet take into account that some students already have a background in design and engineering. With respect to dropout we identified a subgroup of students with low mathematics grades. Study counsellors should take into account that low mathematics grades are an indicator for possible future dropout at technical universities. Supporting Technasium learners with their final project can help them make a better informed study choice. This choice might be at the same university (26%) or somewhere else. Clearly proximity and established contacts are good reasons for choosing coaches at the nearest university, whereas proximity might not be the primary reason for choosing a study program.

We recognise that this study has a quantitative character and should be supplemented with qualitative data coming from panel discussions or interviews with the students of our study. We conclude that the science and engineering landscape has changed and that we see first effects on study choice behaviour. Study success is not much different for this new group.

REFERENCES

[1] Vijlder, F. de, D. Bakker & M. van den Blink (2014). Innoveren vanachter de keukentafel. Publication related to 10 years Technasium. Convoy Publishers (in Dutch).

[2] Berland, L., Steingut, R. & Ko, P. (2014). High School Student Perceptions of the Utility of the Engineering Design Process: Creating Opportunities to Engage in Engineering Practices and Apply Math and Science Content. Journal Sci Educ Technol (2014) 23:705–720.

[3] National Research Council (2012) A framework for K-12 science education: practices, crosscutting concepts, and core ideas. The National Academies Press, Washington.

[4] Blume, A. (2015). University of Twente freshmen from Technasium schools. Internal report, University of Twente, the Netherlands.