Modeling student success with students

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INTRODUCTION

Engineering education is a fairly new field of research and student success is in many aspects unexplored territory. Yet, student success is among the most researched topics in higher education. Several agencies have stressed the importance of engineering student success, because they found that there is a shortage of engineers in Europe and it is important that schools of engineering and technology will train more engineers for the labour force [1]. Research has yielded a lot of insight on factors that are related to student success. However, this research has not led to any major changes in student retention, neither in engineering nor in non-engineering subjects [2]. Most studies into student success are based exclusively on statistical analysis, e.g. [3, 4, 5]. In this project we intend to develop a situated model for student success. We include input from students in our research and we use this to enhance our understanding of students and their success and as input for our analysis. This paper is part of this ongoing research effort.

In this paper we report on one of the research activities where we collected data from students on their perceptions of factors that contribute to their success. We invited first year students from different engineering programmes to workshops where we

asked them which factors influence their success and how these factors are related, in the students' perceptions. We compare the student models with models based on survey data collected in the same university and in the same cohort. The aim of this comparison is to find out if students' models correlate with models based on data analysis.

1 WORKSHOPS ON MODELING STUDENT SUCCESS

1.1 Set up of the workshops

The workshop format was chosen to collect data in an unobtrusive way. Students are used to working in small groups on modeling assignments. In these workshops the students were invited to work on a similar assignment, although this time they were asked to model 'student success' instead of engineering like topics. We assumed that this would be a natural environment for students to cooperate and to feel free to express their ideas.

The workshops took place at the end of the academic year of 2010/2011, prior the exams of the second semester. They were scheduled to take about 2 hours each. In total 4 workshops were organised. Each workshop started with a short introduction of the aim of the workshop and a short round introducing the participants. Next, the students were informed how the data would be used and they were asked if there were any objections against recording the discussions. This was followed by the practical instructions for the workshop according to the principles of a snowball method. Students were first individually issued forms on which they were to list 5 variables, events, situations, aspects, behaviours, activities, etc. that were helpful and 5 of such factors that were detrimental to their success. When they finished this assignment, they were to pair up with someone else and compare their lists. Together they would draw up new lists of helpful and detrimental factors. The outcomes would briefly be discussed in the wider group while all the factors were written on sticky notes. The next step was to use the sticky notes to model success. The instructions for the process were simple: the output variable 'success' was given. Students had to use all the sticky notes but could group some of them if they believed there was a lot of overlap between factors. Between factors, students could draw arrows to represent causal relationships, which remained undefined. From every factor only one or two arrows could be drawn, but the number of arrows going to a variable was not fixed. A typical model would look like a flow chart. Students were given large sheets of paper to work on and felt pens to draw arrows and other shapes to support their ideas. All student discussions were recorded to help the researchers check their understanding of the models while analysing them. If the group of students would be large, they would be split up and make separate models. There were two facilitators present during the workshop: the principle investigator and a research assistant who was well informed about the research and about the modelling activities. The facilitators would be available for questions regarding the modelling assignment and they would ask questions to the students to clarify concepts and relations in the models. They would not interfere in the modelling process. The principal investigator made notes during the workshop. These were used as a resource for the analysis of the models.

1.2 Selection of participants

The participants of the workshop were first year students from different fields in engineering. These students had been participating in semi-structured group interviews on student success twice in that same year. In the Netherlands first year students can withdraw from their studies in the first semester without any financial

consequences. Many students who are off on a bad start or who feel unsure about their choice of study early on, usually leave before February 1 of that academic year. The students who participated in these workshops were still enrolled at the end of the second semester. We assume that these students do well in their studies and have the intention of passing the university's first year progress requirement, which means students have to pass 45 out of 60 credits that comprise the first year.

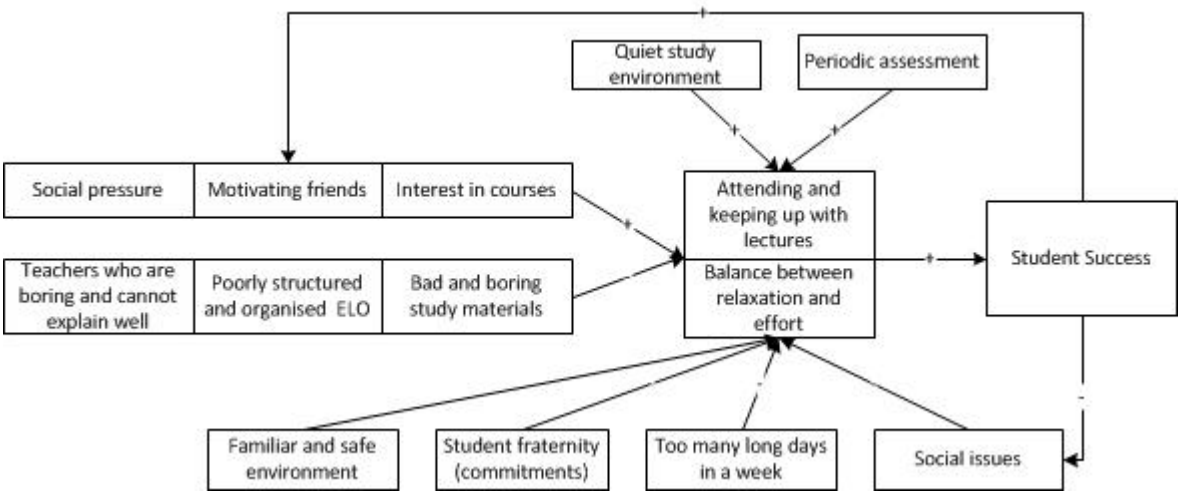
Participation in the workshops was voluntary and the students were asked to sign up for the workshop on dates that suited them. In total 34 students, of which 6 females, produced 10 models for student success.

2 RESULTS OF THE WORKSHOPS

2.1 Method of analysis

The models looked like flow charts. This can be seen in *Figure 1,* which shows one of the models made by students. Some of the boxes are linked together.

Figure 1 Student model by 3 students.



We analysed the models as follows: for each model we counted the distance between the output variable and the input variables. For instance the distance between 'Attending and keeping up with lectures' and 'Student Success' is 1. The distance between 'Periodic Assessment' and 'Student Success' is 2. Some boxes are linked. We assumed that this means that the students believe these three variables belong together somehow and we counted the distance for all these three variables as 2. We disregarded any loops in the model, in this case the two arrows that go from 'Student Success' to 'Social Issues' and to the linked variables of pressure, friends and interest. We repeated this process for all the 10 models and counted the frequency a variable was one, two or three 'arrows' away from the output variable. Next the variables were clustered into: curriculum organisation, teachers, social environment/support, study behaviour, student disposition and facilities. The frequencies are reported in *Table 1*.

Table 1 The frequencies of distances of factors to the output variable 'Success'.

Frequency distance 1	Frequency distance 2	Frequency distance 3	Variable description

Curriculum organisation			
4	1	3	Balance between study and relaxation
5	3		Quality of study materials (accessibility, availability)
Teachers			
3	5	2	Motivating teachers (who keep you alert and who explain well)
Social environment/support			
1	5	2	Fellow students and flatmates for support and motivation
1	2	1	Fraternity and study association for social contact and continuity
Study behaviour			
4	2	1	Making a planning and sticking to it (discipline)
Student disposition			
1	4	1	Interest in the subject and coursework
Facilities			
2	4	2	Quiet work environment without distraction

2.2 Interpretation of the outcomes

The most important issue for students is balance between study related activities and leisure. As is the case with many engineering curricula [6], Delft students experience the curriculum as overloaded. This places high demands on students and therefore the students have high demands for their study materials. This was explained in the workshop by a student: 'You don't always have the time or energy to attend all the lectures. You must be able to understand the materials without any help from a teacher.'

The teachers score high on Frequency Distance 1 and 2. Teachers who keep students involved in the course and who can explain well and in a structured well-paced fashion are viewed as important to success. Another source of motivation are fellow students, for instance in project groups. Students also mention that fraternities and study associations are important for continuity. A weekly meeting with friends helps to structure time when students are off to study for exams and in weeks when the schedule is very busy. Study behaviour is an important factor according to the students, especially the planning of work and sticking to their planning. Because the curriculum is overloaded, students cannot afford to loosen their study regime. There would hardly be any time to catch up again. This ties in with the curriculum organisation factors. Students also observe that without interest in the subjects it is hard to stay motivated and to muster energy to sit down and do the coursework. Finally, the students mention the facilities. They find it important that they can study in a quiet work environment where they do not get distracted.

In previous research on student success, most variance is explained by student related variables, such as ability and motivation [7]. The students in our workshops indicate that mostly curriculum related variables influence their success directly. It is possible that for these students variables such as ability are given or that they simply believe that effort is more important than ability (cf. [8]). Another explanation could be found in attribution theory of motivation. The basic premise of this research is that when students believe that their academic achievement depends on controllable

factors, they are more motivated and generally achieve at higher levels than when they feel a lack of control over their own learning [9]. However, it remains unclear why variables such as ability are not included in any of the models.

3 SURVEY IN STUDENT COHORT 2010

3.1 Rationale for the survey and response

As part of the on-going research on student success, the researchers collected data through an online survey for first year students in October 2010. The survey was based on an extensive literature review [2] and included questions on variables that were selected based on interviews with a selection of first year students at the same university [8]. In total, the questionnaire contained 79 questions. The dataset was combined with data taken from the central student administration and from curriculum and programme datasets at this university.

The survey contained questions regarding students' backgrounds (such as ability and socio economic status), social and academic integration (such as student union or fraternity membership), academic confidence (such as self-reported confidence of skill in maths and science), motives (such as job prospects), and commitment (such as choosing for a particular university). Furthermore, the survey also contained questions regarding student study behaviour (such as a deep approach to learning) and on the students' perceptions on the educational climate (which was operationalized in four topics: perceptions of teachers, assessment, facilities, and curriculum organisation).

The response rate of this questionnaire was 21% (579 of 2757). The sample was representative for the wider population in terms of gender and bachelor programmes.

3.2 Comparison between concepts from the survey and the workshops

Table 2 Comparison between concepts from the workshops and the survey

	Variable description workshops	Name of matching variable(s) in survey	Description of item in survey
1	Work life balance	N Lectures and N Active	The number of hours scheduled for lectures and active learning activities were calculated based on course schedules of the first half of the first semester.
2	Materials are accessible and available	a. Material b. Late c. Book	a. Materials were difficult to understand b. Materials were not available or available too late. c. It was difficult to find out what books were needed in a course.
3	Motivating teachers	a. Explain b. Enthusiasm	a. Teachers can explain concepts in different ways. b. Teachers are enthusiastic about their courses.
4	Social support of flatmates and fellow students Social support and continuity through fraternity	No matching variables available.	
5	Making a planning and sticking to it	Study behaviour (SB) factor consisting of	

		items that reflect planning and keeping up with course work. a. Goal b. Behind c. Bursts d. Enough e. Exam f. Keep up g. Syst	 a. I set goals, which I stick to. b. I'm always behind on my work. c. I work in bursts. d. I don't do enough for my studies. e. I mainly study for the test. f. I keep up with my course work. g. I don't study systematically.
6	Interest in the course work	Interest	Do you find your studies as interesting as you expected?
7	Work environment	a. Study Faculty b. Study Campus	There are plenty of working spaces to study quietly a.: at the faculty/ b.: on campus.

The operationalisation of these concepts is based on a number of assumptions. For the concept of work life balance we look at the number of lecture hours and hours for active teaching and learning activities such as practicals and project work. The assumption is that the more scheduled hours there are, the less liberty students have to distribute their time freely. This will lead to a perceived misbalance between studies (work) and leisure (life). For topics 2, 3, 6 and 7 we included Likert-scale type items in the survey. For topic 4 we had no equivalent in the survey. We had asked after union membership and the number of flatmates if students live independently. These questions however, do not reflect the support students may or may not experience. We leave this topic out of further analysis. For topic 5 on study behaviour we had constructed 20 items that reflected elements of the theory for self regulated learning as reported by Schmitz and Wiese [10] and Zimmerman and Kitsantas [11]. Items that had to do with planning and goal setting loaded onto a single factor using promax rotation.

In this study we combined items from the survey into composite variables to approximate the variables identified in the workshops.

3.3 Correlations with student success.

We take the variable credits obtained in the first education period (when the survey was administered) and in the first year as proxies for student success. The number of credits students obtain indicate students' progress. In Delft many assignments are graded as pass or fail and in general there is not a lot of significance attached to the height of grades. For that reason we decided to look at the number of credits obtained only. We discern between the number of credits obtained in the first education period and number of credits obtained in the first year. Research shows that the number of credits in the first period is generally a good predictor of success later on in students' studies [7]. We administered the survey in the first education period, but we organized the workshops at the end of the academic year. Therefore we look at credits obtained at two moments in the first year. The correlations between the variables and credits obtained are shown in *Table 3*.

Table 3 Correlations with Credits obtained in first education period and in the first year.

	Variable name	EC obtained in first education period	EC obtained in the first year
1	CO_balance N Lectures 1st period	-,119**	-,243**

	N Active 1st period N Lectures full year N Active full year	,126** -,102* ,047	,240** -,233** ,177**
2	CO_materials	,120**	,139**
3	TC_motivtc	,019	,004
4	SB_factor	,308**	,375**
5	SD_interest	-,041	.015
6	FC_studyenvironment	-,019	-,063

* Correlation is significant at the 0.05 level (two tailed). ** Correlation is significant at the .01 level (two tailed).

4 CONCLUSIONS AND DISCUSSION

The differences between the correlations for credits obtained in the first education period and credits obtained in the first year are striking. For credits obtained in the first year all correlations are higher than for credits obtained in the first education period. Another interesting observation is that the number of lectures in the first education period has negative correlations with both indicators for student success, while the number of hours for active learning has positive correlations. CO_materials and study behaviour also have higher correlations with credits obtained in the first year than with credits obtained in the first education period.

The teacher variables do not show significant correlations for the wider population. Nor does Interest show any correlation with the output variable. Much of the literature shows that interest and the desire for deep learning are important for student success and this is also observed by the students in the workshop. However, we do not find any effects of interest in our data.

In the survey there are no effects of environment on the number of credits obtained. This is not surprising, there have not been any studies where any effects of this kind of variable were found. It could be that this environmental variable has indirect effects on student success, but we did not research this.

Overall we can argue that the students in the workshops have done well in pointing to some important variables. They identified curriculum organisation, materials and study behaviour as the most important variables affecting their student success. These are also the variables that have significant correlations with numbers of credits obtained for the wider population. By comparing the outcomes of workshops where students received no instruction on the possible content of their models for student success and a survey based on literature review of studies done mostly outside engineering, we can increase the validity of our research. Creswell [12] observes that all research methods have inherent limitations and that by combining methods these limitations can be neutralized.

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