Diagnostic tests for students bridging to Engineering Technology

Langie, G.[1]
Vicedean of the Faculty of Engineering Technology
KU Leuven
Leuven, Belgium

Van Soom, C.
Head of the tutorial services of the Faculty of Sciences
KU Leuven
Leuven, Belgium

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INTRODUCTION

Dropout rates in higher education are high. The OECD reports that approximately one third of students in higher education in the OECD countries do not complete their studies [1]. While some progress has been made in increasing the number of graduates in STEM (Science, Technology, Engineering and Mathematics) in most European countries, the substantial drop in the relative STEM numbers (as a percentage of all disciplines) from entrance into university to graduation, suggests considerably higher dropout rates in STEM as compared to other disciplines [1].

Internationally there is a wide body of research on factors that influence students' decision to drop out in the first year [2]. One way of improving retention and graduation rates among students entering higher education programs is to address their ability to succeed academically in these programs.

In many countries entry requirements are employed in STEM-programs. In Belgium, however, all students with an upper-secondary school diploma are eligible for entry to university education. In the context of the orientation of secondary school students, several institutions have started to develop and implement diagnostic tests to measure STEM readiness and to stimulate students to train before the start of the academic year. These tests are adapted to the program the students want to start and focus on skills they should have obtained during the secondary school programs. The predictability of these tests is under investment. For example, the mathematics 'positioning test' seems to have a high predictability in the Faculties of Engineering Science and Sciences of KU Leuven [3].

In the Faculty of Engineering Technology of KU Leuven a pilot has run at the beginning of the academic year 2013-2014. A battery of three diagnostic tests was given to the secondary school students interested in becoming an 'industrial engineer'. These tests focused on mathematics, academic language skills [4] and scientific reasoning [5]. The correlation of these results with the results obtained during the exams of January 2014 is under investment and will be discussed later.

In this paper, we will not focus on the regular students entering university directly after finishing secondary education. We will discuss students who make use of alternative pathways to enter the Master's programs in Engineering Technology and describe the results of a positioning test we organized for these students.

1 BRIDGING STUDENTS

1.1 Definition

In Belgium one distinguishes two types of bachelor degrees: the professional and the academic bachelor.

A professional bachelor degree focuses on professional training (such as nursing and teaching) and does not grant automatic access to a Master's program. Most students start professional occupations after graduation.

The goal of an academic bachelor degree on the other hand is to get all the necessary general academic knowledge and skills to start a Master's program.

Bridging programs were introduced in 2006. The Belgian education system aims to give every student equal opportunities: students with a professional bachelor degree can start a Master’s program on the condition that they have finished successfully a bridging programme. Bridging programs have minimum 45 and maximum 90 ECTS points and focus on all the knowledge and skills these students need to be able to start a Master’s program.

1.2 Bridging students in the Faculty of Engineering Technology

The Faculty of Engineering Technology has the greatest number of bridging students of the KU Leuven. In the academic year 2013-2014 almost 900 bridging students are studying in this Faculty and their numbers are increasing every year with 7% on average, see *Fig. 1*.

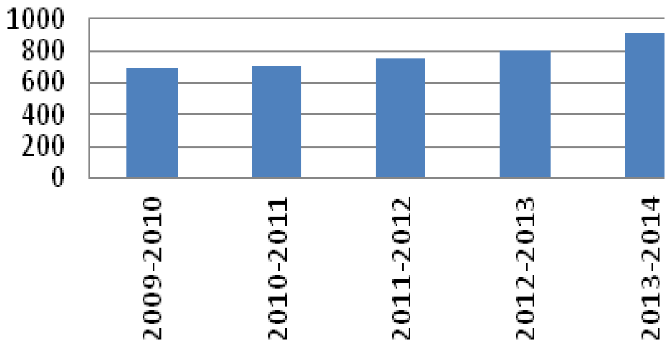

Fig. 1. The evolution of the number of bridging students in the Faculty of Engineering Technology (KU Leuven).

2 PROBLEM

Many students register for a bridging program for Engineering Technology, but the study success of these students is low: almost 50% of them drop out. The fact that so many students with an economically valuable professional bachelor degree, enter the labour market with one year retardation, results in a huge economic loss . Moreover those who finally succeed in obtaining their Master’s degree have another profile than the classical Master’s students [6]. We should be aware of this profile shift, especially when the number of bridging students starts to outnumber the number of regular students.

3 POSSIBLE SOLUTION

Many bridging students are overwhelmed by the degree of difficulty of the bridging program. It’s our responsibility to inform them as clear as possible before the start of the bridging program about the goals and content of the program and the required skills. We are in need of a non-binding, predictive diagnostic test tailored to the specificity of the bridging program. This test should be organised at the end of the professional bachelor program and should be combined with efficient intervention actions.

4 RESULTS

4.1 Methodology

We organized a pilot during the physics course in the fourth week of the academic year 2013-2014 (2013, October 18th) for 63 bridging students of which 55 students are new students. New students are students who enscribed for the first time in this bridging program. In total 115 students are studying in the bridging program in 2013-2014 and 63 of them are new students.

As a starting point we implemented the same tests as organised for the regular first-year students of the academic bachelor programs in Engineering Technology: mathematics, academic language skills [4] and scientific reasoning [5].

We collected for these students

- the average results obtained during the exams in January 2014 (%) (exams);
- previous achievement in secondary education (%, self reported) (sec);
- the type of secondary education (type sec);
- hours/week of mathematics during secondary education (self reported) (math h)
- previous mathematics performance in secondary education (%, self reported) (math sec);
- the results obtained on the three tests (mathematics (math), academic language skills (language) and scientific reasoning (reasoning).

4.2 Results

The average percentage for all students obtained during the exams in January is 47%. The new students obtained an average percentage of 40%. A comparison between new students and reregistering students of their average percentages obtained on the exam and on the three tests is shown in *Table 1*.

Table 1. Average percentage obtained on exams and the three tests per student group

	group	N	Mean	Std. Deviation	Std. Error Mean
exam	new	63	40,3	13,9	1,7
	not new	52	54,4	9,9	1,4
math	new	55	36,0	15,0	2,0
	not new	11	37,2	14,8	4,5
language	new	55	49,5	22,5	3,0
	not new	10	44,5	15,0	4,7
reasoning	new	55	66,7	17,8	2,4
	not new	10	67,5	17,8	5,6

New students have a lower mean percentage on their exams (M = 40.3, SE = 1,7) compared to reregistering students (M = 54.4, SE = 1.4). The difference is significant (t (110,9) = -6,3, with a large effect size (r = .51). There is no difference in entrance test scores between new and reregistering students

Bivariate correlations between some of the variables mentioned in paragraph 4.1 are reported in Table 2 for all 63 students who participated at the tests.

*Table 2.*Correlations between the scores on exams of January 2014, score on the mathematics, academic language skills and scientific reasoning tests for all bridging students who participated at all the tests) (N = 63, Pearson's correlation, listwise deletion).

		exam	math	language	reasoning
exam	Pearson Correlation	1	,260*	-,028	,085
	Sig. (2-tailed)		,040	,829	,506
math	Pearson Correlation		1	,013	,438**
	Sig. (2-tailed)			,922	,000
language	Pearson Correlation			1	,046
	Sig. (2-tailed)				,721
reasoning	Pearson Correlation				1
	Sig. (2-tailed)				

* $p < 0.05$, ** $p < 0.01$.

Since additional information on previous achievement was only available for a limited number of 31 students, we performed an additional correlation analysis on this subgroup (*Table 3*).

Table 3.Correlations between the scores on exams of January 2014, mathematics test, academic language skills test, scientific reasoning test, previous achievement in secondary education and previous mathematics performance in secondary education (for a subgroup of 31 bridging students) (Pearson's correlation, listwise deletion, N = 31).

		exam	math	language	reasoning	sec	math sec
exam	Pearson	1	**,57****	,03	,20	**,37***	,31
	Sig. (2-tailed)		**,00**	,9	,28	**,03**	,09
math	Pearson		1	,17	**,46***	,24	,13
	Sig. (2-tailed)			,35	**,01**	,20	,49
language	Pearson			1	,20	-,32	-,21
	Sig. (2-tailed)				,28	,08	,27
reasoning	Pearson				1	-,11	,01
	Sig. (2-tailed)					,56	,95
sec	Pearson					1	**,67****
	Sig. (2-tailed)						**,00**
math sec	Pearson						1
	Sig. (2-tailed)						

* $p < 0.05$, ** $p < 0.01$.

Although we are focusing on a limited number of students, we studied the success rate of new students as a function of the number of hours mathematics during secondary education (*Table 4*). This success rate is expressed with the number of enscribed credits which are obtained (≥10/20) after the exams.

Table 4. Percentage of new students who have >50% of their credits obtained at the exams in January as a function of the hours of mathematics during secondary education.

	Less than 50 % of credits obtained	50 %or more of credits earned	Total
Less than 4 weekly hours of math	13	5	18
	72,2%	27,8%	100,0%
4 or 5 weekly hours	15	7	22
	68,2%	31,8%	100,0%
6 or more weekly hours	8	10	18
	44,4%	55,6%	100,0%
Total	36	22	58
	62,1%	37,9%	100,0%

Although chi square testing revealed no significant differences between the proportions in the cells, we observe that a larger percentage of students who followed a previous study track with 6 or more hours of math, gained at least half of their credits, compared to students from the group with less than 4 weekly hours of math.

The link between the type of education they followed during secondary education and the exams are mentioned in *Table 5*. 19 new students (and 25% of all bridging students) followed ASO (this education focuses on general education) while 47 new students (and 73% of all bridging students) studied TSO (less general, more technical focus).

Table 5. Percentage of new students who (did not) have >50% of their credits obtained at the exams in January as a function of the type of education during secondary education.

	Less than 50 % of credits obtained	50 % or more of credits earned	Total
TSO	35	12	47
	74,5%	25,5%	100,0%
ASO	11	8	19
	57,9%	42,1%	100,0%
Total	46	20	66
	69,7%	30,3%	100,0%

Although chi square testing revealed no significant differences between the proportions in the cells, we observe that a larger percentage of new students who followed an ASO education, gained at least half of their credits, compared to students from the group who followed a TSO education.

4.3 Discussion

55% of the students in the bridging program are new students (= study this program for the first time), what's an indication of the problematic situation.

New students have less good results on the exams, although the results of the tests are almost identical. This probably means that students have to get used to the new way of studying and doing exams.

As expected, the score obtained on diagnostic test focusing on mathematics has the highest correlation with exam scores, but it's not very convincing. Several reasons can be relevant: (1) the selection of the questions should be adapted to the public, (2) the test is organised during the fourth week of the academic year and this is too late to have representative results and (3) the students were not motivated to fill in the tests.

Previous achievement in secondary education also correlates moderately with exam scores, which is in line with previous observations [1]. The correlation between prior math achievement in secondary education and exam score is border significant.

The tests focussing on academic language skills and scientific reasoning have no predictability at all, however the latter is highly correlated with the results on the mathematics test.

Both the number of hours of mathematics and the type of education they followed during secondary education had no significant effects on the success rate, although the results point towards a positive effect of mathematics and a general ASO education.

5 SUMMARY AND ACKNOWLEDGMENTS

It's clear that the mathematics test is a test with moderate predictability for study success for bridging students in the Faculty of Engineering Technology. The tests focusing on academic language skills and scientific reasoning are not predictive at all. However the limited number of some groups of students prevents to make conclusions which are statistically relevant. So for the moment we do not have a good reason to eliminate the academic language skills and scientific reasoning tests in the battery of tests for next year.

Next year we will organise these tests at the very beginning of the academic year and add one extra test in the hope to be able to define a good battery of predictive tests for bridging students.

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