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Learning gain of students intending to bridge to a Master's programme in Engineering Technology through an online mathematics course (SPOC) and a mathematics test.

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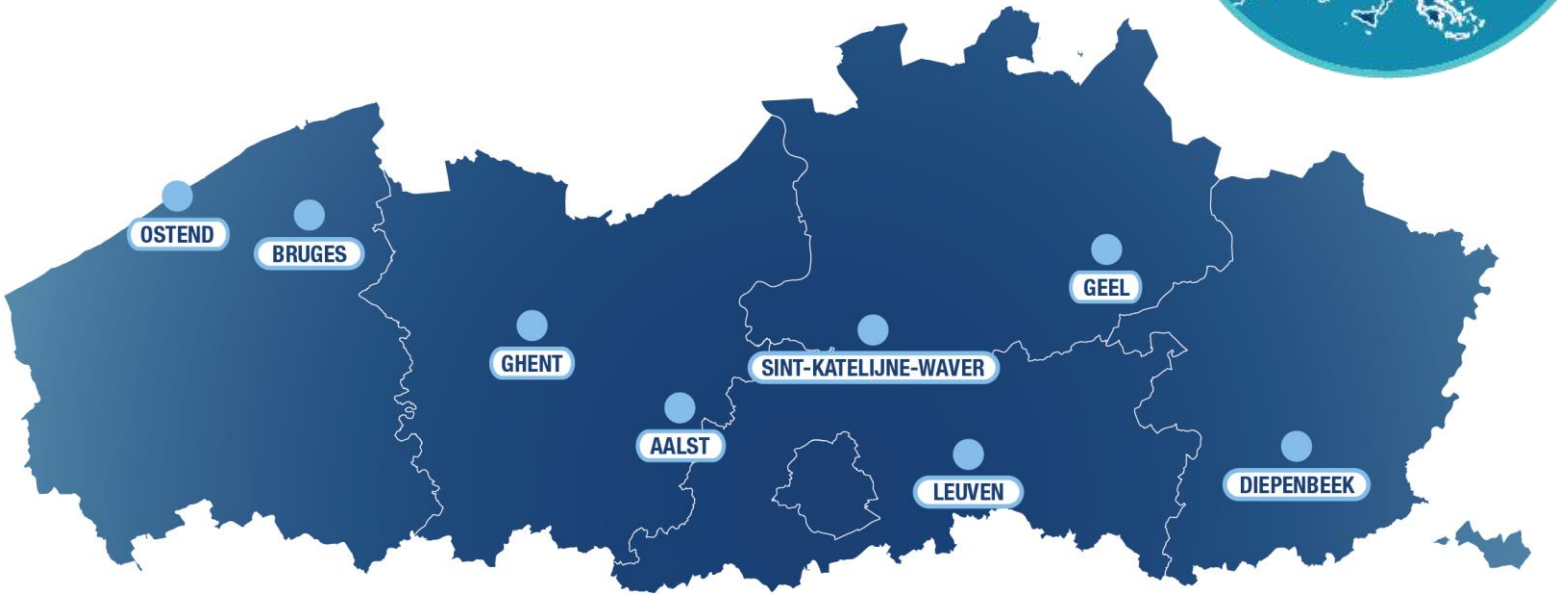
CONTEXT: Faculty of Engineering Technology (FET) - KU Leuven



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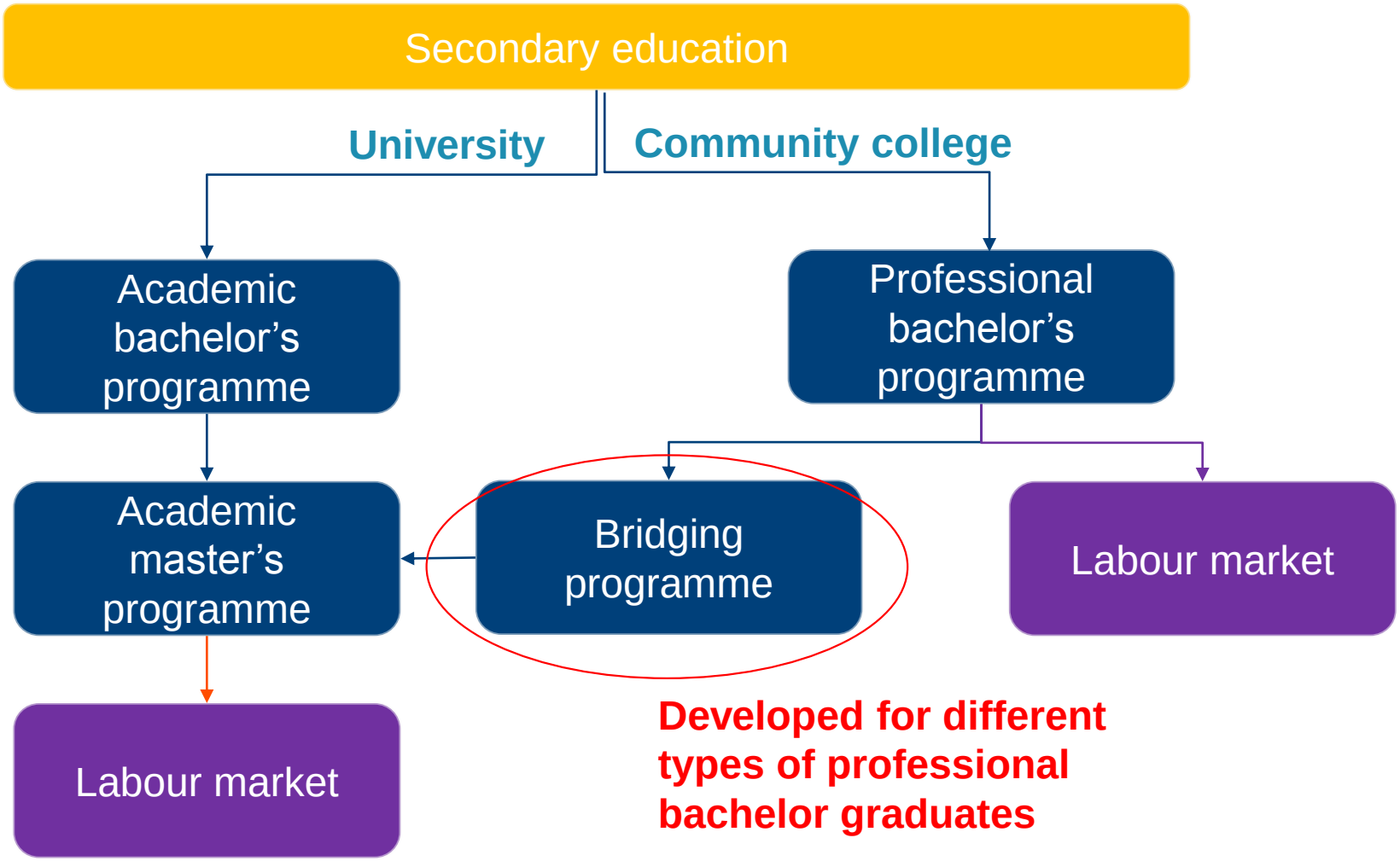
CONTEXT: Education system in Flanders



CONTEXT: Characteristics of a bridging programme

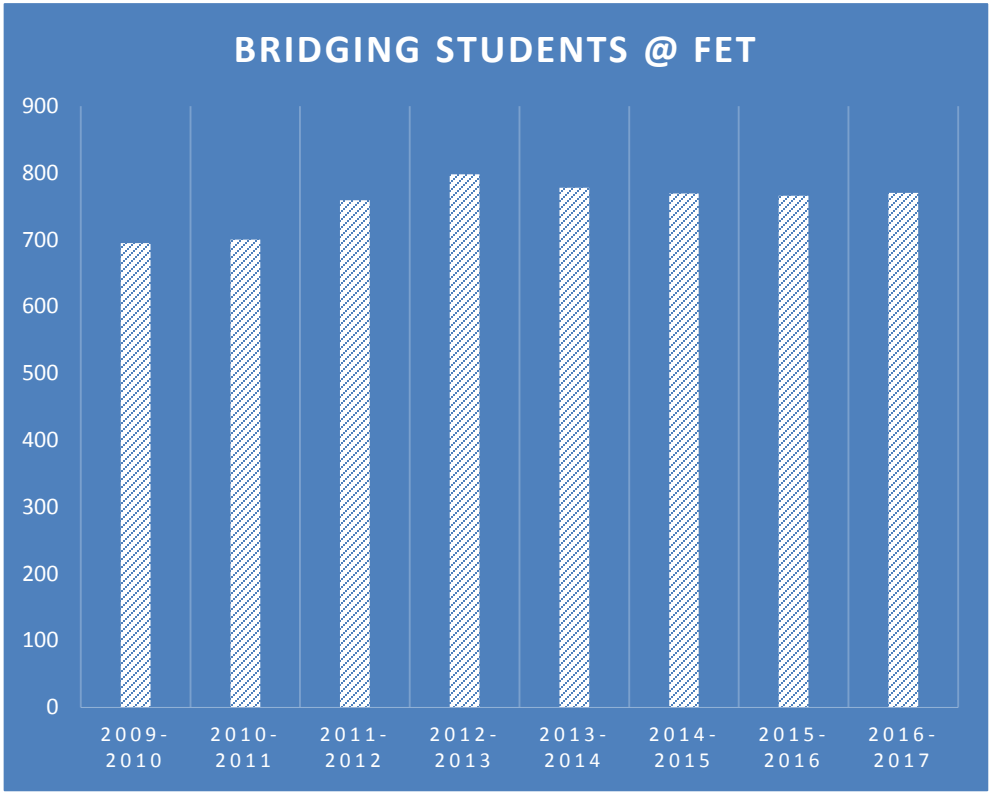
- 45 – 90 ECTS points:
  - In general: 60 ECTS points (one year programme)

- Students obtain a certificate that gives access to the master's programme

- Typical courses:
  - First semester: Mathematics, Mechanics, Physics, Chemistry, Statistics, …
  - Second semester: More applied to choice of study programme (Electronics and ICT engineering, Chemical engineering, Civil engineering, Electromechanical engineering …)

CONTEXT: Bridging students @ FET

16% of the professional graduates start with a bridging programme



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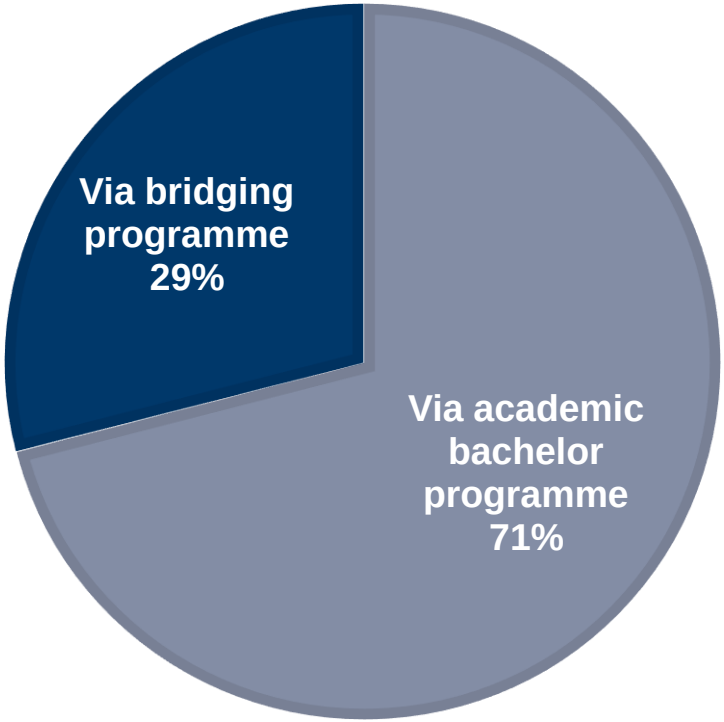
CONTEXT: Number of Master degrees

29% of the graduated master students entered the master's programme via a bridging programme

GRADUATED MASTER STUDENTS



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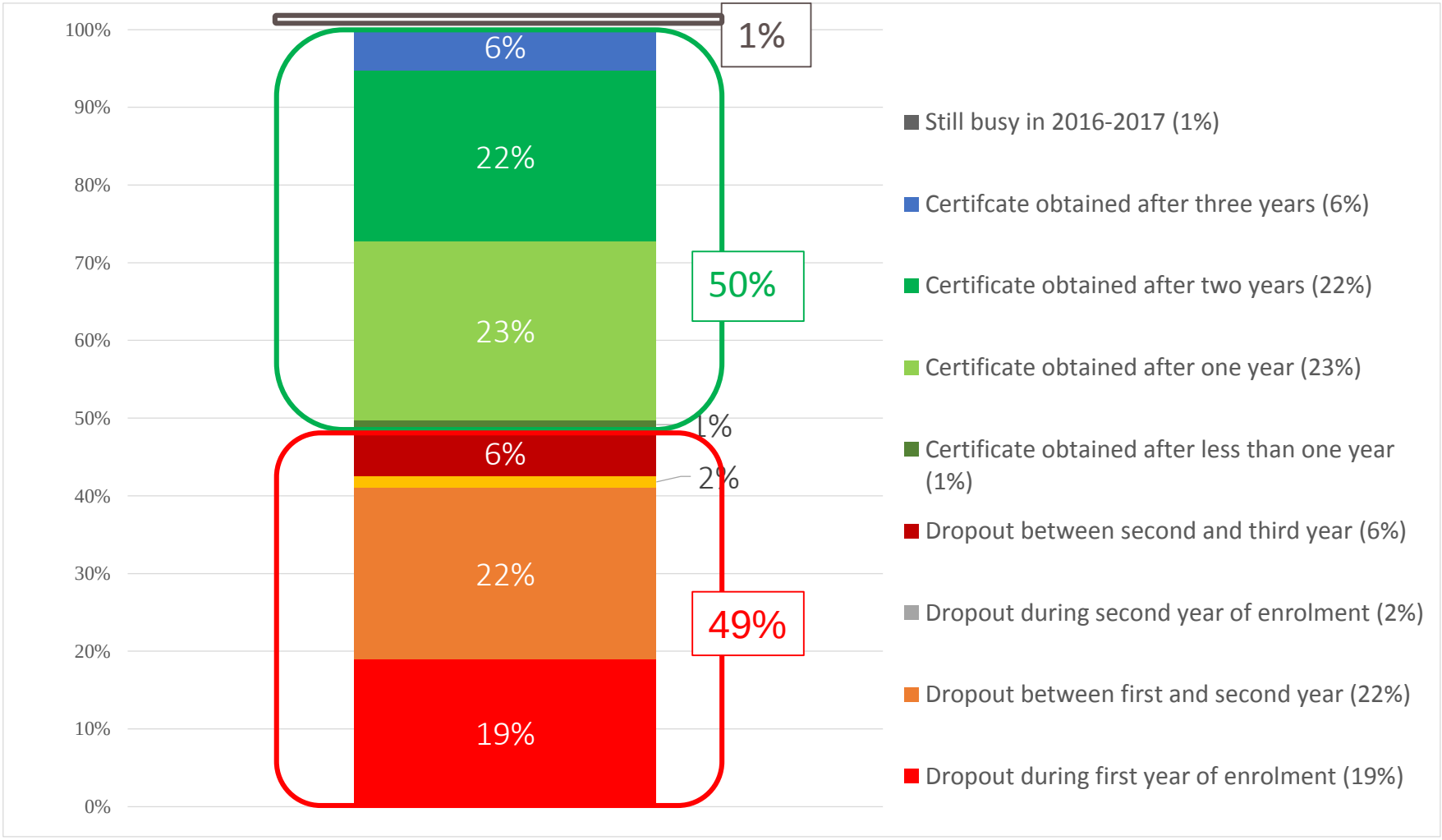
PROBLEM: Dropout and success rate



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The low success rate…

… and the absence of admission requirements in Flanders for STEM programmes

Leads to the need for:

A non-binding and voluntary positioning test for professional bachelor students who are thinking about bridging

Two aims

1) provide students information on their possible future academic achievement in the bridging programme and thus stimulate them to make a well-thought-out educational choice
2) encourage students to participate, if necessary, in intervention initiatives before or during their bridging programme

In this paper we want to focus on…

…MATHEMATICS

Why mathematics?

- Both students and lecturers mentioned mathematical knowledge as one of the major stumbling blocks
- This problem with mathematics is also discussed in STEM literature (Bailli 2000, Bernold 2007, Carr 2013)

Therefore mathematics is 1) of great importance in the diagnostic test and 2) the main subject in one of the intervention intitiatives (SPOC).

Diagnostic test - Mathematics

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Diagnostic test - Mathematics

- A set of 19 MC questions developed by math lecturers
  - Subjects: algebra, calculus, elementary arithmetic, graphics, geometry and trigonometry
  - Divided into three categories: easy (*), average (**), and difficult (***)

- Sample
  - 254 bridging students of the cohort of 2016-2017
    - 97 during last phase of professional bachelor (before enrolment)
    - 157 during the first weeks of the academic year (after enrolment)
  - Response rate 81%

Difficulty and proportion correct answers

p/d values	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
a	0,06	0,18	0,08	0,17	0,04	0,07	0,03	0,04	0,21	0,08
b	0,49	0,38	0,24	0,04	0,64	0,21	0,62	0,00	0,09	0,08
c	0,39	0,07	0,05	0,04	0,06	0,07	0,17	0,04	0,07	0,50
d	0,04	0,02	0,09	0,06	0,06	0,01	0,01	0,77	0,14	0,05
e	0,01	0,02	0,21	0,15	0,09	0,62	0,13	0,10	0,14	0,02
blanco	0,02	0,33	0,33	0,55	0,11	0,03	0,05	0,05	0,35	0,28
Difficulty	*	**(*)	*	**	***	*	**	**	***	*(*)

P=proportion correct; d=proportion distractors

Ideal P/D value according to Van Berkel (1999)

- P value: 0.60
- D value: 0.10

Difficulty and proportion correct answers

p/d values	V11	V12	V13	V14	V15	V16	V17	V18	V19
a	0,04	0,04	0,01	0,08	0,06	0,07	0,25	0,03	0,76
b	0,04	0,14	0,00	0,21	0,01	0,38	0,06	0,06	0,11
c	0,04	0,11	0,07	0,06	0,11	0,12	0,36	0,68	0,06
d	0,79	0,06	0,63	0,41	0,58	0,09	0,03	0,05	0,02
e	0,04	0,50	0,03	0,16	0,10	0,07	0,07	0,06	0,04
blanco	0,06	0,15	0,26	0,08	0,14	0,27	0,24	0,13	0,02
Difficulty	***	*(*)	**	***	*	**	**(*)	*	*

Cronbach alpha and item-total correlations

- α = .73 → internal consistency of the test is good

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
Rit	0,33	0,16	0,31	0,34	0,37	0,35	0,27	0,30	0,07	0,54
α if Item Deleted	0,72	0,74	0,72	0,72	0,72	0,72	0,73	0,72	0,74	0,70

	V11	V12	V13	V14	V15	V16	V17	V18	V19
Rit	0,22	0,28	0,42	0,10	0,45	0,13	0,43	0,35	0,27
α if Item Deleted	0,73	0,73	0,71	0,74	0,71	0,74	0,71	0,72	0,72

Rule of thumb Rit (Ebel, 1972)
<0.20 – poor item
0.20-0.29 – fair item
0.30-0.40 – good item
>0.40 – excellent item

What is a good item?

High(er) p-value, high Rit Easy item, answered incorrectly by a small group of low performing students.	**High(er) p-value, low Rit** Easy item, does not differentiate between the good and low performing students.
Low(er) p-value, high Rit Difficult item, only answered correctly by the group of good performing students.	**Low(er) p-value, low Rit** Difficult item, does not differentiate between the good and low performing students
Quality is good	**Quality is doubtful**

SPOC Mathematics

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SPOC Mathematics

SPOC = Small Private Online Course

PURPOSE?

- Opportunity to refresh mathematical knowledge
- Preparation for the math test
- Tool to refine their knowledge before enrolling in the bridging programme

Difference in test performance?

Mathematics		N	Mean	SD	t
Followed SPOC	No	39	37%	21%	3,586
	Yes	52	53%	21%	(p=0.001)

→ Students who attended this course before taking the test, obtain **significantly higher results** on the test than students who did not.

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Source: Questionnaire filled in by students who took the test before enrollment

What if we control for other variables?

Prior academic achievement		N	Mean	SD	T
Followed SPOC	No	22	69%	7%	0,815
	Yes	39	70%	6%	(ns)

Mean academic achievement of professional bachelor.

Motivation		N	Mean	SD	T
Followed SPOC	No	35	26	4	1,831
	Yes	46	28	4	(ns)

LASSI (Learning and study strategies inventory) scale with a maximum score of 40. Higher score means higher motivation.

➔ There are no differences in prior academic achievement and motivation between the students that followed the course and the ones that did not. So, it are not the better performing students or the more motivated students that follow the SPOC.

What if we control for other variables?

Level of mathematics				Mean	SD	N
Followed SPOC	No	Level of math during secondary education	Low	18%	13%	5
			Medium	29%	17%	17
			High	47%	15%	16
	Yes	Level of math during secondary education	Low	37%	26%	8
			Medium	49%	20%	22
			High	62%	15%	22

Low <4 hours mathematics/week; medium 4-6 hours mathematics/week; high 6 or more hours mathematics/week.

→ Students perform significantly better on the test if they took a higher level of secondary school mathematics ($p<.001$). Students who had taken the same level of mathematics obtain higher results on the test if they enrolled in the SPOC.

What do the students think about the SPOC?

- The course content is
  - Too limited: 24%
  - Just right: 71%
  - Too detailed: 5%

- The level of difficulty is
  - Too easy: 17%
  - Good: 83%

What do the students think about the SPOC?

- The SPOC boosted my confidence in my mathematical ability/knowledge:
  - Not at all: 3.5%
  - Not really: 17.2%
  - No effect/neutral: 43.1%
  - Yes: 36.2%

Thank you for your attention
Questions?