The methodology of calculating student capacities at German Universities

Jörg Hormann, Assistant of the Vice-president for planning and strategy

FAITH, 5th Workshop, Prizren, 08 September 2015

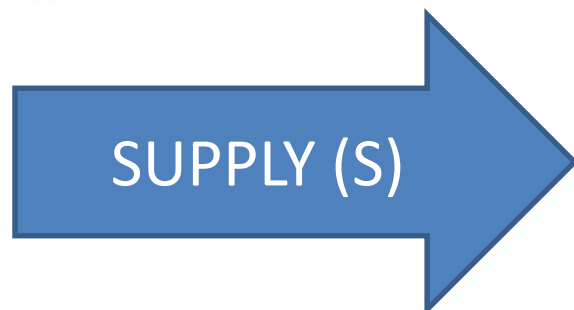# Calculating student capacities - Agenda

1. Introduction

2. Basic Principles – Economic Theory

3. The Supply of teachings

4. The Demand for teachings

   – Curricular values

   – Standard group sizes

5. Loss of students: drop out

6. Multiple study programs

7. More applications

8. Summary

Introduction

- Legal Situation in Germany
  - Strict regulations (by law) for setting up admission limits
  - Admission limits must always be based on maximum capacities
  - All Higher Education Institution must do capacity calculations if they want to set up admission limits
  - Rejected applicants can sue HEIs → HEIs have to prove that their calculations are correct!

- Methodology of Capacity Calculation
  - Developed in the 1970s
  - Calculation of capacities on the basis of available academic staff
    - only marginal consideration of other limiting factors (e.g. rooms)
  - Calculation model with medium-level abstraction
    → Easy to use, but partly away from reality

economic good

SUPPLY (S) → 🍦 ← DEMAND (D)
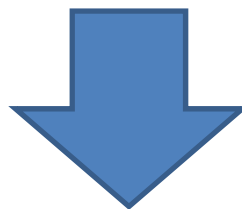
$$S = D$$

(Economic equilibrium)

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$$(1) \quad S = D$$

$$(2) \quad D = d * N$$

The total demand (D) is composed of:
- the demand of one person (d)
- multiplied by the number of persons (N)

$$(3) \quad S = d * N$$

Calculation of student capacities: Basic formula

$$N = \frac{S}{d}$$

N: Maximum number of students

S: Total supply of teachings

d: Demand for teachings of one student

1st assumption:

There is a total supply (S) of Ice-cream of 10 kg

2nd assumption:

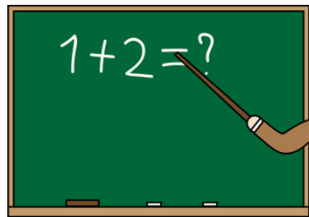One child needs 0,1 kg of Ice-cream to be happy
(= demand of one person d)

HOW MANY CHILDREN CAN YOU MAKE HAPPY ?

Solution:

$$S = d \times N \Rightarrow N = \frac{S}{d} = \frac{10 \; kg}{0,1 \; kg} = 100 \; \text{Children}$$

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Economic good:
Teaching hours
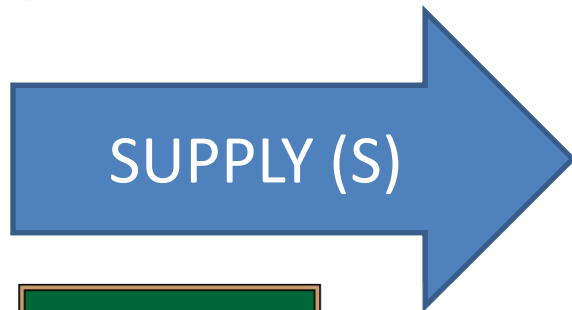
SUPPLY (S)

DEMAND (D)

$$S = D$$

→ Capacities are fully utilized!

Supply of teachings:
Total number of hours, that
can be provided by teaching staff

Demand for teachings:
Number of hours needed by
all enrolled students
in order to graduate

The supply of teachings

Total Supply of teachings

= Total number of hours provided by teaching staff

Basis: One academic unit (e.g. Faculty)
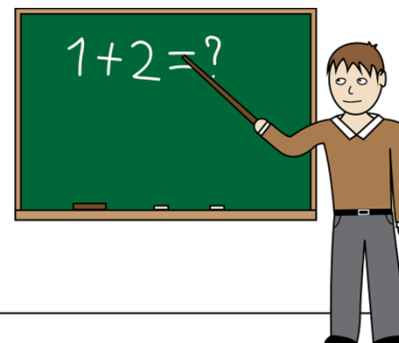
Example: Faculty of Economics, University of Pristina

Category	Headcount	Teaching obligation	Total supply
Regular Professors	12	10 hrs.	120 hrs.
Associated Professors	17	10 hrs.	170 hrs.
Assistant Professors	16	10 hrs.	160 hrs.
Assistants	20	5 hrs.	100 hrs.
		TOTAL SUPPLY OF TEACHINGS	**550 hrs.**

Calculation of student capacities: Basic formula

$$N = \frac{550\ hrs.}{d}$$

N: Maximum number of students

✓ *S: Total supply of teachings*

d: Demand for teachings of one student

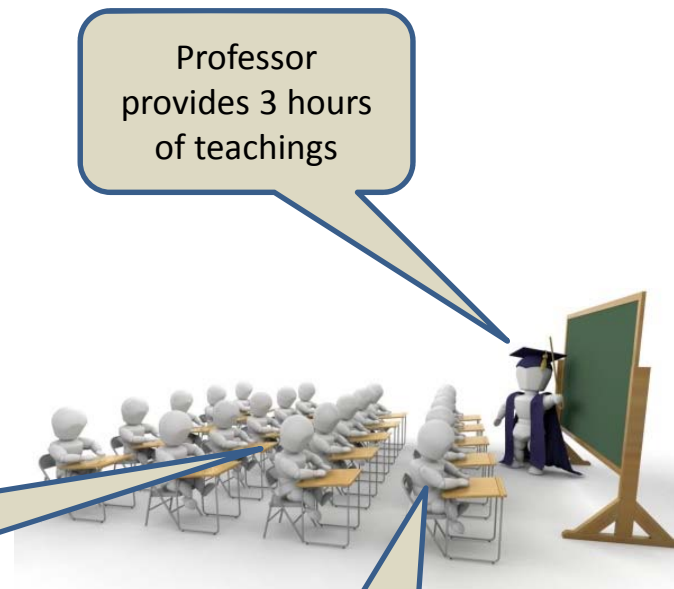How many teaching hours does <u>ONE STUDENT</u> consume in order to pass a study program until graduation?

Example:

Lecture: Mikroekonomika I

Duration: 3 hours

Standard group size: 100 students

Professor provides 3 hours of teachings

All students consume 3 hours of teachings

How many hours does one student consume?

$$d_{Mikroekonomia\ I} = \frac{Hours}{group\ size} = \frac{3\ hrs.}{100} = 0{,}03\ hrs$$

Ekonomiks

Viti parë – Semestri parë

Nr.	Lënda	Orë	ECTS	Obligative	Profesori
1	Mikroekonomia I	3+2+0	8	1 O	Dr.Florentina Xhelili
					Dr.Drita Konxheli
					Dr.Isa Mustafa
					Dr.Ramiz Livoreka
					Dr.Mrika Kotorri
					Dr.Gazmend Qorraj
2	Matematika për ekonomistë	3+2+0	8	1 O	Dr. Ajet Ahmeti
					Dr.Nimete Berisha
3	Informatika	1+1+1	5	1 O	Dr.Afërdita Berisha
					Dr.Vehbi Rama
					Dr.Ferid Idrizi
4	E drejta biznesore	2+1+0	5	1 O	Dr.Armand Krasniqi
					Dr.Arbëresha Raça
					Dr. Mazllum Baraliu
5	Gjuhë e huaj I-angleze	1+1+0	4	1 O	Dr. Shpresa Hoxha
					Mr.Halil Asllani
					Dr.Sadete Pllana
	Gjuhë e huaj I-gjermane				Mr.Arlinda Kotorri
Totali			30		

How many teaching hours does <u>ONE STUDENT</u> consume in order to pass a study program until graduation?

One student would need to pass **all courses** scheduled in the curriculum of the study program:

$$d_{Mikroekonomia\ I} = \frac{Hours}{group\ size} = \frac{3\ hrs.}{100} = 0{,}03\ hrs$$

$$+$$

$$d_{Matematika\ p\ddot{e}r\ ekonomist\ddot{e}} = \frac{Hours}{group\ size} = \frac{3\ hrs.}{100} = 0{,}03\ hrs$$

$$+$$

$$d_{Informatika} = \frac{Hours}{group\ size} = \frac{1\ hrs.}{100} = 0{,}01\ hrs$$

$$+$$

$$\cdots$$

How many teaching hours does <u>ONE STUDENT</u> consume in order to pass a study program until graduation?

One student would need to pass **all courses** scheduled in the curriculum of the study program:

The sum of these quotients of all academic courses of a study program is called the

CURRICULAR VALUE (CV)

of the study program.

This value expresses the total consumption of teaching hours of ONE STUDENT to pass the study program

Ekonomiks

Viti parë – Semestri parë

Nr.	Lënda	Orë	ECTS	Obligative	Profesori
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					Dr.Ramiz Livoreka
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					Mr.Halil Asllani
					Dr.Sadete Pllana
	Gjuhë e huaj I-gjermane				Mr.Arlinda Kotorri
Totali			30		

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Calculation of the curricular value of a complete study program:

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	A	B	D	E	F	G	H	I
1	Semester	Course	Type	Compulsory / Elective	student portion	Hours	Group Size	Curricular value
2	1	Mikroekonomia I	Lecture	C	100%	3	100	0,0300
3	1	Mikroekonomia I	Exercise course	C	100%	2	20	0,1000
4	1	Matematika për ekonomistë	Lecture	C	100%	3	100	0,0300
5	1	Matematika për ekonomistë	Exercise course	C	100%			0,1000
6	1	Informatika	Lecture	C	100%	1	00	0,0100
7	1	Informatika	Exercise course	C	100%	1	20	0,0500
8	1	Informatika	Practical training	C	100%	1	15	0,0667
9	1	E drejta biznesore	Lecture	C	100%	2	100	0,0200
10	1	E drejta biznesore	Exercise course	C	100%	1	20	0,0500
11	1	Gjuhë e huaj I-angleze / gjermane	Lecture	C	100%	1	100	0,0100
12	1	Gjuhë e huaj I-angleze / gjermane	Exercise course	C	100%	1	20	0,0500
80	...	...	...	...	...	...	...	...
81						SUM		2,3587

Standard group sizes

The use of standard group sizes is an important input parameter for the calculation of capacities!

➢ The group sizes have a strong influence on the result of the calculation

➢ The group sizes influence the quality of study programs

➢ They should be related to didactic aspects of individual types of academic courses

➢ They may also vary related to the academic discipline

Group size ⬆ ➡ Capacity ⬆ ➡ Less care for individuals ⬇ ➡ Quality ⬇

Standard group sizes (Example Saarland University)

Type of academic course	Group sizes (range)
Lecture	100 – 180
Exercise courses	20 – 60
Workshop, colloquium	15 – 30
Field trip	15 – 20
Practical training (e.g. Laboratory)	10 - 15

Calculation of the curricular value of a complete study program:

	A	B	D	E	F	G	H	I
1	Semester	Course	Type	Compulsory / Elective	student portion	Hours	Group Size	Curricular value
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5	1	Matematika për ekonomistë	Exercise course	C	100%	2	20	0,1000
6	1	Informatika	Lecture	C	100%	1	100	0,0100
7	1	Informatika	Exercise course	C	100%	1	20	0,0500
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10	1	E drejta biznesore	Exercise course	C	100%	1	20	0,0500
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12	1	Gjuhë e huaj I-angleze / gjermane	Exercise course	C	100%	1	20	0,0500
80	...	...	...	...	...	...	...	...
81							SUM	2,3587

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		Lënda	Orë	ECTS	Zgjedhore	Profesori
1		Ekonomia e Kosovës dhe BE	2+1+0	6	1 Z	Dr.Gazmend Qorraj
						Dr.Adriatik Hoxha
2		Matematika financiare	2+2+0	6	1 Z	Dr. Ajet Ahmeti
						Dr.Nimete Berisha
3		Hyrje në biznes	2+0+0	6	1 Z	Dr.Ismet Begu
						Dr.Nagip Skenderi
Totali				6		

A student can choose 1 module out of three

The probability that one particular module will be chosen is 1/3 = 33%

	A	B	C	D	E	F	G	H	I
1	Semester	Course	Lloj	Type	Compulsory / Elective	student portion	Hours	Group Size	Curricular value
2	2	Ekonomia e Kosovës dhe BE	L	Lecture	E	33%	2	100	0,0067
3			U	Exercise course	E	33%	1	20	0,0167
4	2	Matematika financiare	L	Lecture	E	33%	2	100	0,0067
5			U	Exercise course	E	33%	2	20	0,0333
6	2	Hyrje në biznes	L	Lecture	E	33%	2	100	0,0067

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Calculation of the curricular value of a complete study program:

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	A	B	D	E	F	G	H	I
1	Semester	Course	Type	Compulsory / Elective	student portion	Hours	Group Size	Curricular value
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12	1	Gjuhë e huaj I-angleze / gjermane	Exercise course	C	100%	1	20	0,0500
80	...	...	...	...	...	...	...	...
81							SUM	2,3587

'Curricular value' of a study program
=
Demand (better: consumption) for teachings of one student

Calculation of student capacities: Basic formula

$$N = \frac{S}{d} = \frac{550\ hrs.}{2,3587\ hrs./Stud} \approx 233\ Students$$
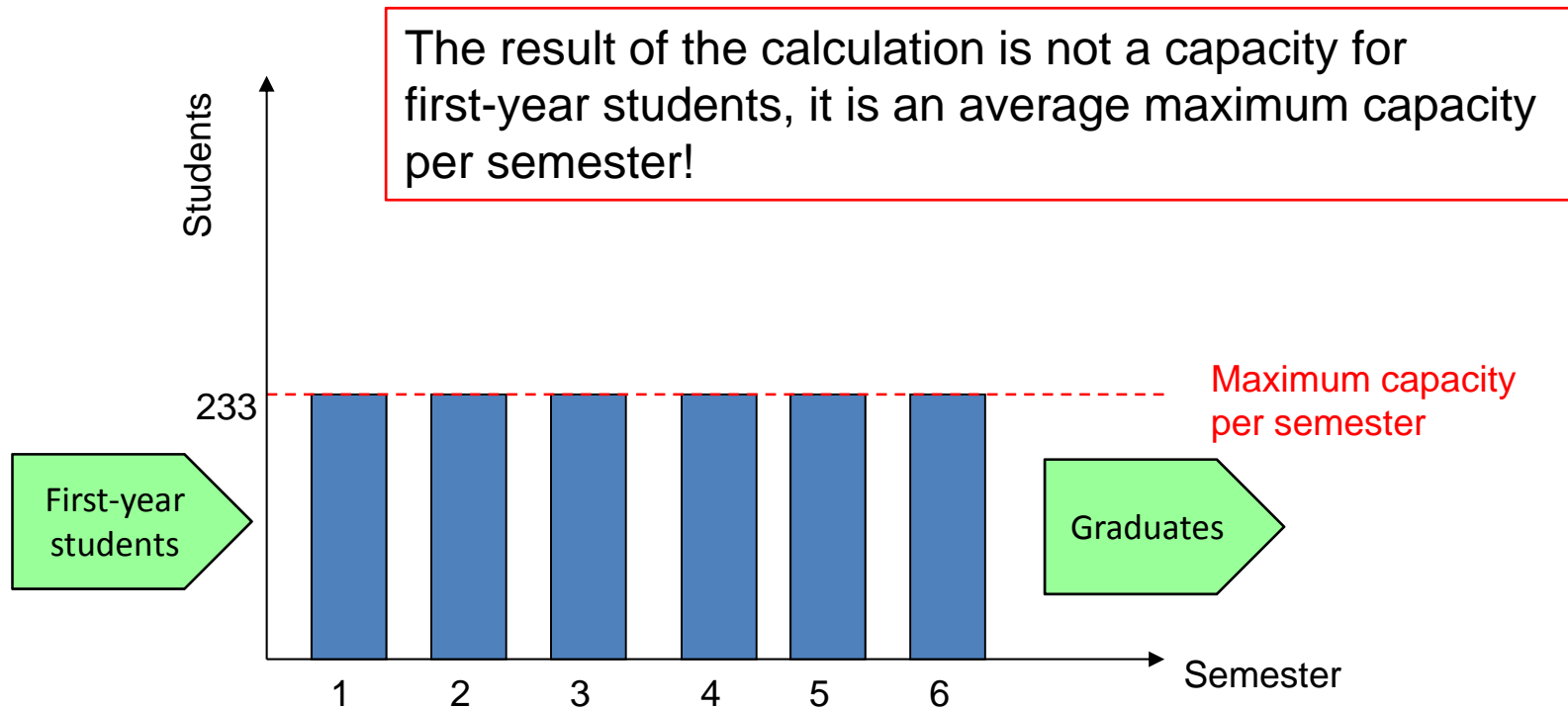
N: Maximum number of students

✓ *S: Total supply of teachings*

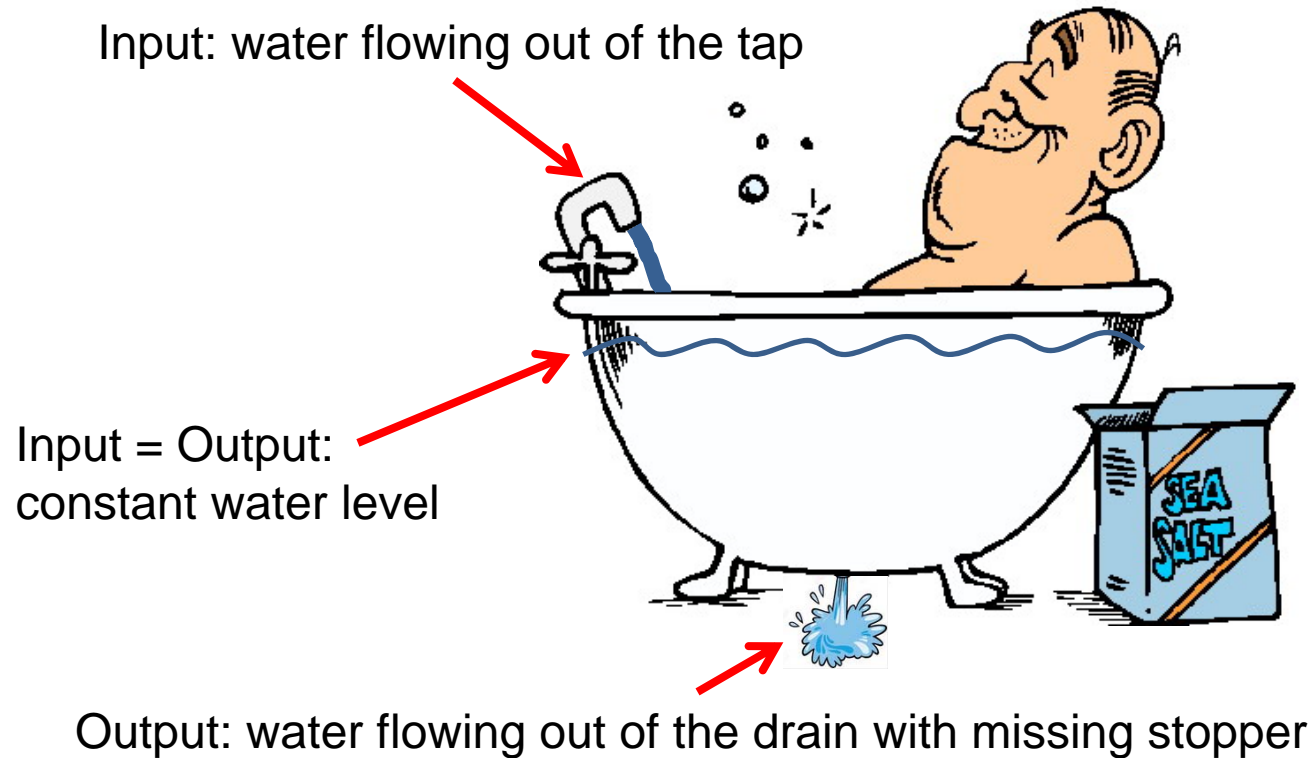✓ *d: Demand for teachings of one student*

➢ simplified model: Input = Output

The result of the calculation is not a capacity for first-year students, it is an average maximum capacity per semester!

➢ simplified model: Input = Output

Input: water flowing out of the tap

Input = Output:
constant water level

Output: water flowing out of the drain with missing stopper

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➢ Reality: Input > Output: Loss of students

Students

233

First-year students

unused capacity

Maximum capacity per semester

Graduates

1   2   3   4   5   6

Semester
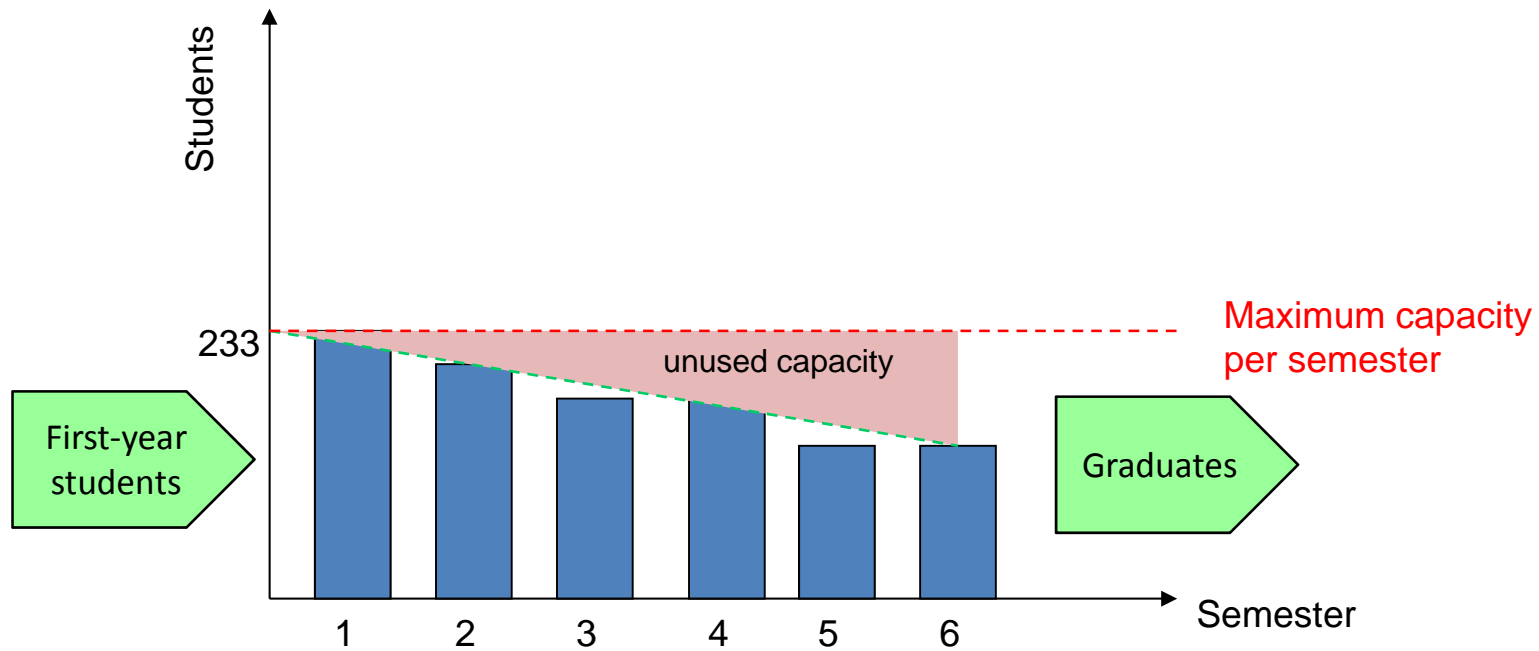
➢ Reality: Input > Output: Bathtub is old and has some more holes in it

Decreasing water level
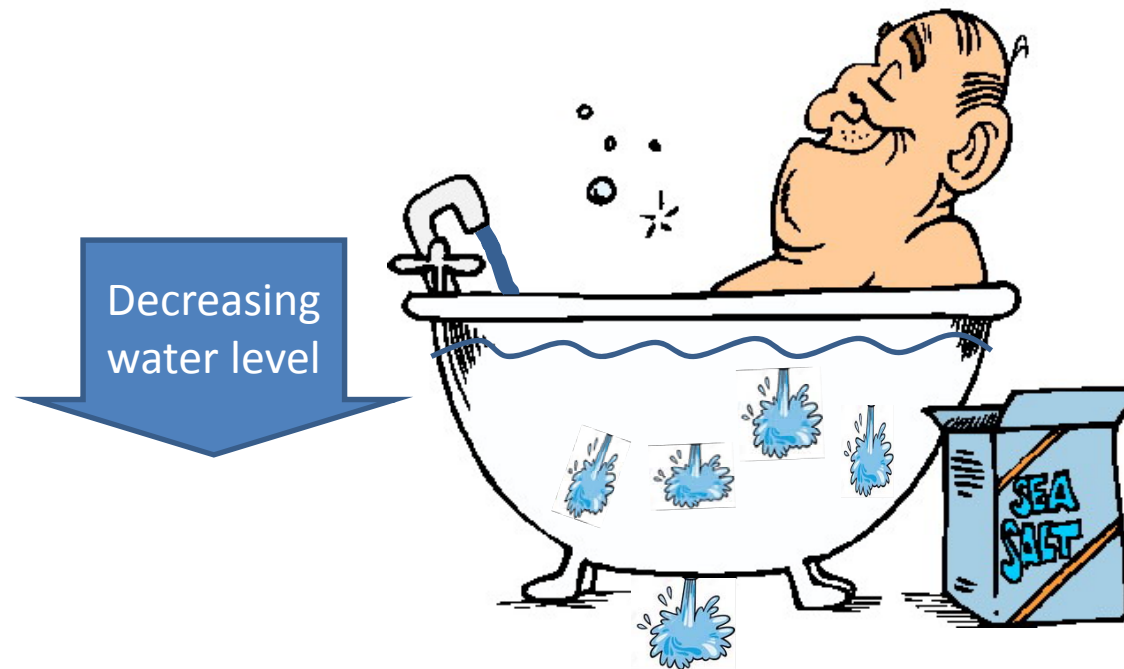
Solution: Turn up the tap until the water level stays constant!

➢ Reality: Input > Output: Loss of students

Maximum capacity
per semester

=

Average number of
students per semester
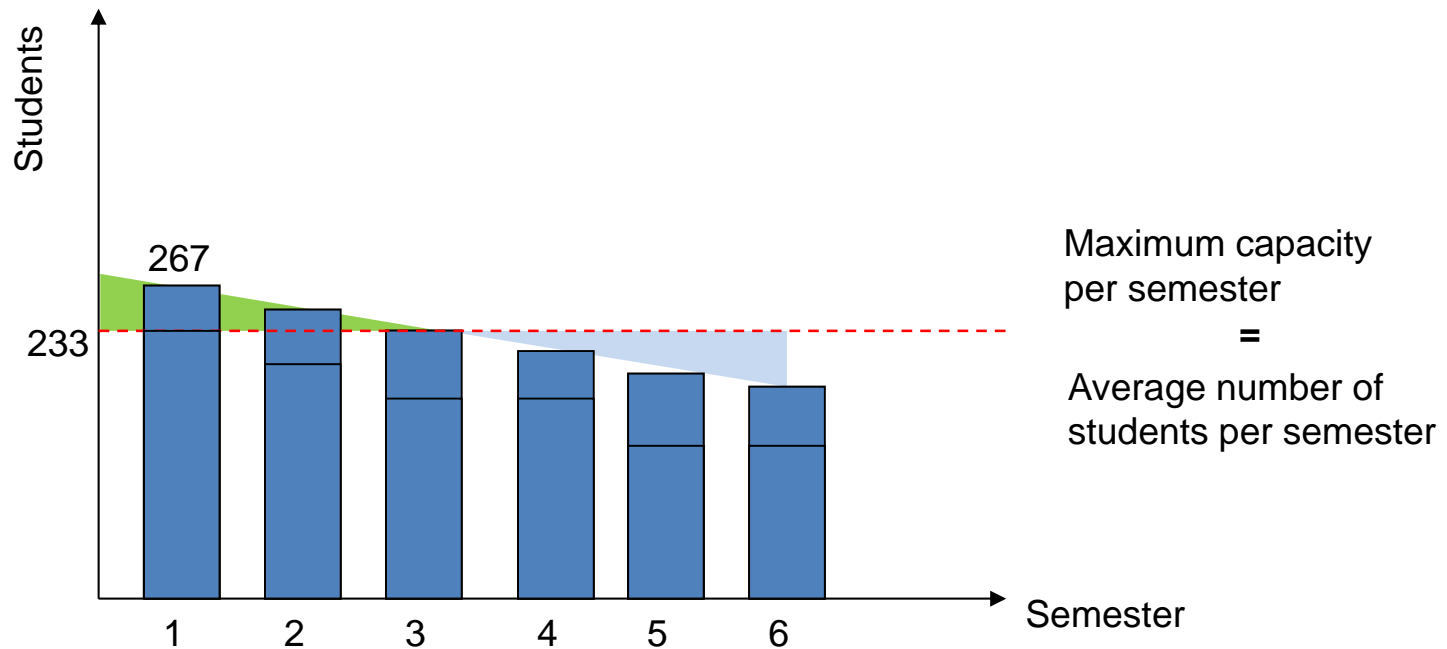
Solution: Raising the number of first-year students

Semester	Students	Stay-in	%
1: Winter 2012	233	233 / 233	1,00
2: Summer 2013	218	218 / 233	0,94
3: Winter 2013	204	204 / 233	0,88
4: Summer 2014	199	199 / 233	0,85
5: Winter 2014	186	186 / 233	0,80
6: Summer 2015	180	180 / 233	0,77
		Sum	**5,24**

The whole cohort of beginners from Winter 2012 did not stay for 6 semesters (as intended), it stayed for 5,24 semesters!

$$Rate\ of\ loss: r_L = \frac{actual\ duration\ of\ studies}{regular\ duration\ of\ studies} = \frac{5,24\ semesters}{6\ semesters} = 0,8733$$

The maximum capacity for first-year students can be calculated as follows:

$$N_{Semester\ 1} = \frac{Calculated\ capacity}{Rate\ of\ Loss} = \frac{N}{r_L} = \frac{233}{0,8733} = 267\ Students$$

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Extending the statistical database ➔ Considering more than one cohort

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Calculation of the rate of loss

Semester	Students per Semester					
	1	2	3	4	5	6
Winter 2012	233	0	206	0	174	0
Summer 2013	0	218	0	201	0	163
Winter 2013	233	0	204	0	188	0
Summer 2014	0	224	0	199	0	183
Winter 2014	233	0	216	0	186	0
Summer 2015	0	230	0	203	0	180
Sum 1	699	442	626	400	548	346
Sum 2	466	672	420	603	374	526
stay-in (in semesters)		0,961373	0,950226	0,963259	0,935	0,959854
stay-in (in total)	1	0,961373	0,913522	0,879958	0,822761	0,78973
actual duration of studies	5,3673					
regular duration of studies	6					
Rate of loss	0,8946					

Calculation of student capacities:

Study program: Ekonomiks Bachelor

$$N = \frac{S}{d} = \frac{550 \; hrs.}{2{,}3587 \; hrs./Stud} \approx 233 \; Students$$

N: Maximum number of students

✓   *S: Total supply of teachings*

✓   *d: Demand for teachings of one student*

Multiple study programs

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Universiteti i Prishtinës "Hasan Prishtina"
Fakulteti Ekonomik

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BALLINA   DEKANATI   LAJME DHE NGJARJE   QENDRA-GJILAN   QENDRA-MITROVICË   KONTAKT

Kliko në linqet e mëposhtme për të parë syllabuset për secilin program studimi.

Bachelor - Programet

Master - Programet

1. Banka, financa dhe kontabilitet
2. Menaxhment dhe informatikë
3. Marketing
4. Ekonomiks
5. Kontabilitet

Kliko në linqet e mëposhtme për të parë syllabuset për secilin program studimi.

Bachelor - Programet

Master - Programet

1. Banka, financa dhe kontabilitet
2. Menaxhment dhe informatikë
3. Marketing
4. Ekonomiks
5. Ndërmarrësi dhe zhvillim lokal

Curricular Value: Ekonomics Bachelor:

	A	B	D	E	F	G	H	I
1	Semester	Course	Type	Compulsory / Elective	student portion	Hours	Group Size	Curricular value
2	1	Mikroekonomia I	Lecture	C	100%	3	100	0,0300
3	1	Mikroekonomia I	Exercise course	C	100%	2	20	0,1000
4	1	Matematika për ekonomistë	Lecture	C	100%	3	100	0,0300
5	1	Matematika për ekonomistë	Exercise course	C	100%	2	20	0,1000
6	1	Informatika	Lecture	C	100%	1	100	0,0100
7	1	Informatika	Exercise course	C	100%	1	20	0,0500
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11	1	Gjuhë e huaj I-angleze / gjermane	Lecture	C	100%	1	100	0,0100
12	1	Gjuhë e huaj I-angleze / gjermane	Exercise course	C	100%	1	20	0,0500
80	...	...	...	...	...	...	...	...
81							SUM	2,3587

Curricular Value: Ekonomics Master:

	A	B	D	E	F	H	I	J
1	Semester	Course	Type	Compulsory / Elective	student portion	Hours	Group Size	Curricular value
2	1	Metodologjia e hulumtimeve	Exercise course	C	100%	2	20	0,1000
3	1	Makroekonomia e avancuar	Exercise course	C	100%	2	20	0,1000
4	1	Mikroekonomia e avancuar	Exercise course	C	100%	2	20	0,1000
5	1	Integrimet konomike evropiane	Exercise course	E	50%	1,33333333	20	0,0333
6	1	Metodat e aplikuara matematikore dhe analizat statistikore	Exercise course	E	50%	1,33333333	20	0,0333
7	2	Ekonomiksi industrial	Exercise course	C	100%	2	20	0,1000
8	2	Globalizimi dhe tregu i punës	Exercise course	C	100%	2	20	0,1000
9	2	Ekonomiksi i zhvillimit të Kosovës	Exercise course	C	100%	2	20	0,1000
10	2	Ekonomiksi i zhvillimit te kapitalit njerëzor	Exercise course	E	50%	1,33333333	20	0,0333
11	2	Politikat ekonomike dhe financat publike	Exercise course	E	50%	1,33333333	20	0,0333
12	3	Ekonomiksi i tregtisë ndërkombëtare 2	Exercise course	C	100%	2	20	0,1000
13	3	Ekonomiksi i rritjes dhe zhvillimit	Exercise course	C	100%	2	20	0,1000
14	3	Ekonometria 3	Exercise course	C	100%	2	20	0,1000
15	3	Ekonomiksi i Unionit monetar	Exercise course	E	50%	1,33333333	20	0,0333
16	3	Politikat ekonomike të BE	Exercise course	E	50%	1,33333333	20	0,0333
17	4	Tezat e masterit						
18							SUM	1,1000

Supply of teaching (Faculty of Economics): S = 550 hrs.

Curricular values:

Study program	CV	Portion (z)	CV x z
Ekonomiks BSc	2,3587	60 %	1,4152
Ekonomiks MSc	1,1000	40 %	0,4400
…	…	…	…
		Sum	1,8552

Weighted average: $\overline{CV}$

$$N_{Faculty} = \frac{S}{\overline{CV}} = \frac{550 \; hrs.}{1,8552 \; hrs./Stud} \approx 296 \; Students$$

Capacity of one study program:

$$N_P = N_{Faculty} \times z_p$$

$$N_{BSc} = 296 \times 60\% = 178 \, Students \div Rate \, of \, Loss \, (0,8733) = 204 \, Students$$

$$N_{MSc} = 296 \times 40\% = 118 \, Students \div Rate \, of \, Loss \, (0,8730) = 135 \, Students$$

$$N = \frac{S}{d}$$

Application 1 (N is unknown):

➢ Determination of capacities (e.g. for setting admission limits)

Application 2 (S is unknown):

➢ Determination of academic staff needed (e.g. for new study programs)

Application 3:

➢ Determination of capacity utilization

Example Application 2 – Determination of staff needed:

Task:

You plan to start a new study program. You already developed a curriculum, so you are able to calculate a curricular value, and you want to admit 100 students each semester.

d: Curricular value (based on curriculum): 2,8467

N: 100 Students (per semester!)

Now you can calculate the needed Supply (hours):

$$S = N \times d = 100 \times 2,8467 \approx 284 \; hours \; (per \; semester!)$$

➢ You would need about 28 new professors (teaching obligation 10 hrs.)

Example Application 3 – Capacity utilization:

Task:

You know the amount of hours that the whole academic staff of one faculty is able to provide (S: Supply of teachings). You also have statistics of the number of students in all study programs of this faculty. You want to determine the grade of capacity utilization of this faculty.

S: Supply of teachings: 550 hrs.

Student statistics - Winter 2015

Study Program	Sem 1	Sem 2	Sem 3	Sem 4	Sem 5	Sem 6	Total
Ekonomiks BSc	208	199	191	186	180	174	1138
Ekonomics MSc	94	91	88	80	--	--	353

$$(1) \quad S = D$$

$$(2) \quad D = d * N$$

The total demand (D) is composed of:
- the demand of one person (d)
- multiplied by the number of persons (N)

Example Application 3 – Capacity utilization:

$$(2) \quad D = d * N$$

Study Program	Regular duration	Total Students
Ekonomiks BSc	6 Semesters	1312
Ekonomics MSc	4 Semesters	353

$$Utilization = \frac{Actual\ Demand}{Supply} = \frac{D}{S} = \frac{544,4\ hrs.}{550\ hrs.} = 98,9\ \%$$

Methodology:

➢ Quite simple methodology, that uses data which should anyway be available at HEIs

➢ Necessity to establish some assumptions (definitions), e.g. standardized group sizes

Advantages:

➢ Easy to use

➢ Generalized approach, no need to plan single academic courses

Disadvantages:

➢ Static approach ➔ substantial changes (e.g. in the number of staff) lead to problems / mistakes

➢ Some aspects are not considered (e.g. students, who need more time than the regular duration of a program or attend courses more than once)

Thank you very much for your Attention!

Feel free to ask your questions!

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