

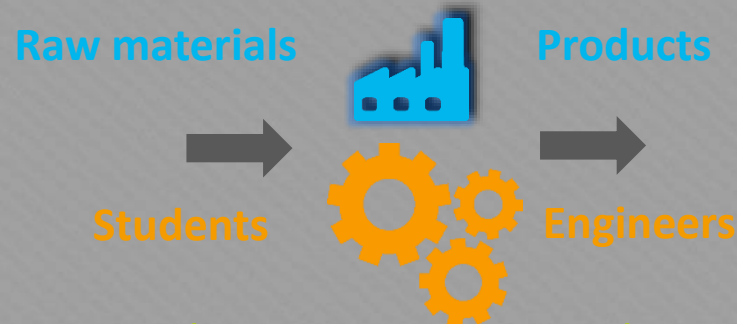


## WP 3 : ASSESSMENT FRAMEWORK

4. Define various indicators of the effectiveness of teaching in chemical engineering higher education,
5. Investigate in more depth methods of effectively acquiring employability competencies,
6. Use decision making technology and multi-objective optimization to identify the most appropriate evaluation methods,

# EVALUATION OF A WHOLE FORMATION

Chemical Industry and Chemical Engineering Education



Using WP2 Results, Data analysis, Literature results, Discussions with Stakeholders, Decision matrix...

Definition of 160 parameters, gathered in 7 global indicators :



Quantification of each parameter : Discussions within the consortium, with stakeholders, recommendations of the EFCE...

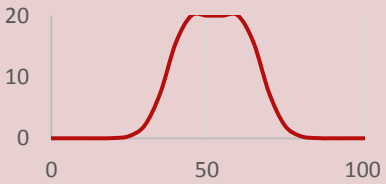
# PEDAGOGY

Teaching		Mean value	Standard Deviation	Score
	Hours (or ECTS) of classical lectures	100	30	$e = 10 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$
	Hours (or ECTS) of tutorials	50	30	
	Hours (or ECTS) of labs	50	30	
	Hours (or ECTS) of Problem & Project Based Learnings	50	30	
	Hours (or ECTS) of NTICs	50	30	
				Maximum score for teaching : 50
<b>Use of feedback questionnaires ?</b>				If yes : 5, if no : 0
	Learning	y	n	5/0
	Enthousiasm	y	n	5/0
	Organization (including course materials)	y	n	5/0
	Group interaction	y	n	5/0
	Individual rapport	y	n	5/0
	Breadth	y	n	5/0
	Examinations	y	n	5/0
	Assignments	y	n	5/0
	Overall	y	n	5/0
	Use of response to feedback questionnaires	y	n	15/0
				Maximum score for feedback questionnaire : 60

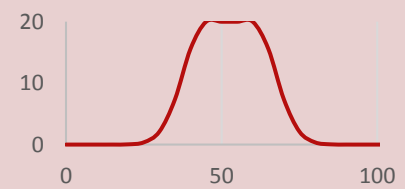
# PEDAGOGY

Teaching		Mean value	Standard Deviation	Score
Number of teaching hours for an ECTS (an ECTS also includes personal work !)		10	5	$e = 30 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$
Total hours of formation per year (as given by accreditation bodies)		800	50	
				Maximum score for teaching time: 60
Percentage of students postponed		0	10	$e = 60 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$
				Maximum score for postponing: 60
<b>Availability for teaching</b>				
	Office on site	y	n	10/0
	Email adress	y	n	10/0
	Percentage of time for teaching	100	10	$e = 10 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$
	Number of students/teachers	5	5	
	Percentage of permanent teachers	100	10	
	Pedagogical formation	y	n	10/0
	Educational advisors	y	n	10/0
				Maximum score for teaching availability: 70
				Total 300

# LEARNING OUTCOMES

EFCE Learning outcomes	Min ECTS value	Max ECTS value	Standard deviation	Score
<b>Fondamentals of sciences and natural sciences</b>	45	60	10	<p>20 if <math>v</math> is between <math>\mu_{\min}</math> and <math>\mu_{\max}</math></p> <p>If <math>v</math> is smaller than <math>\mu_{\min}</math></p> $e = 20 \exp\left(-\left(\frac{v - \mu_{\min}}{\sigma}\right)^2\right)$ <p>If <math>v</math> is larger than <math>\mu_{\max}</math></p> $e = 20 \exp\left(-\left(\frac{v - \mu_{\max}}{\sigma}\right)^2\right)$ 
Mathematics				
Physics				
Chemistry				
Computer sciences				
Numerical methods				
<b>Chemical engineering fundamentals</b>	35	50	5	
Mass and energy balances				
Thermodynamics				
Fluid dynamics				
Heat & mass transfer				
Chemical reaction engineering				
Separations,				
Biomolecular and biological engineering				
<b>Chemical engineering applications</b>	15	25	5	
Basic process & product engineering				
Health, Safety & Environment				
Analytical techniques				

# LEARNING OUTCOMES

EFCE Learning outcomes	Min ECTS value	Max ECTS value	Standard deviation	Score
<b>Non technical subjects / Skills</b>	10	25	5	<p>20 if v is between <math>\mu_{\min}</math> and <math>\mu_{\max}</math></p> <p>If v is smaller than <math>\mu_{\min}</math></p> $e = 20 \exp\left(-\left(\frac{v - \mu_{\min}}{\sigma}\right)^2\right)$ <p>If v is larger than <math>\mu_{\min}</math></p> $e = 20 \exp\left(-\left(\frac{v - \mu_{\max}}{\sigma}\right)^2\right)$ 
Human Sciences and management				
Languages				
<b>First cycle Internship</b>	15	20	5	
<b>Extension of scientific subjects</b>	15	20	5	
<b>Advanced cursus, chemical engineering deepening</b>	40	60	10	
Advanced Chemical engineering				
Product design				
Biotechnological processes				
Process management				
<b>Second cycle Internship</b>	30	40	5	
<b>Total</b>	205	300		
<b>ECTS of Foreign internships or formation</b>	10	30	5	

# LEARNING OUTCOMES

Habilitation (CTI, IChemE...)	y	n			20/0
ECTS of Active formations					Number of ECTS/10
Definition of the formation in learning outcomes	y	n			10/0
Skill & Competences					
Ability to solve problems	y	n			10/0
Ability to analyse information	y	n			10/0
Ability to gather information	y	n			10/0
Self learning ability	y	n			10/0
Ability to identify and formulate problems	y	n			10/0
Ability to work effectively as a member of a team	y	n			10/0
Ability to communicate effectively	y	n			10/0
Appreciation of an interdisciplinary approach	y	n			10/0
Skills are difficult to assess and to quantify ? Maybe through research projects or PBL					Maximum score for skills: 80
					Total : 300

# ATTRACTIVENESS

		Mean value	Standard Deviation	Score
Number of applicants/place				The number v if smaller than 30 ; 30 if it exceeds
Registration fee/mean salary				10-v (hoping it won't be negative...)
Housing facilities		y	n	10/0
Size of the city				$V \cdot 1.10^{-5}$ (shall not exceed 10)
Monthly housing udget/mean salary				$5 \cdot (2-v)$ If not negative...
Existance of a communication cell		y	n	10
Number of persons				v (if less than 10)
Realizations				
	Booklets	y	n	10/0
	Web	y	n	10/0
	Media	y	n	10/0
	Forums	y	n	10/0
Participation of the students				
	In quality	y	n	10/0
	In attractivity	y	n	10/0
	In associations	y	n	10/0
	In communication	y	n	10/0



# ATTRACTIVENESS

		Mean value	Standard Deviation	Score
Percentage of foreign students				$v/10$
Percentage of international available places				$v/10$
Courses in english	y	n		10/0
Average salaries after graduation/mean salary				$30*v$
National ranking				$(100-v)/10$ unless negative
International ranking				$(500-v)/50$ unless negative
Understanding of relevance and attractivity of the Chem Engng field	y	n		10/0
Influence of alumni association	y	n		10/0
Average marks of incoming students				$v-10$ (if between 20 and 0)
Social mixity	20	20		$e = 10 \exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
Percentage of men/women	50	20		
				Total : 300

# RELATIONS WITH RESEARCH

		Mean value	Standard deviation	Score
ECTS of Research internship		30		v (if below 30)
Scientific conferences				v (if below 10)
Visits to laboratories				v (if below 10)
Number of hours (ECTS) by researchers				v (if below 30)
ECTS of innovation project				v (if below 30)
Number of researchers publishing/number of persons in the department		100		v/10
Number of patents /year				v (if below 10)
Joint research with business units				v (if below 10)
Creation of startups				v (if below 10)
Volume of research contracts/mean salary				v/100 (if below 10)
Junior enterprise		y	n	10/0
Number of double diploma				
	National			v (if below 10)
	International			v (if below 10)
Percentage of students having a double diploma (with foreign universities)		100		v
Percentage of Graduates making a PhD		10	10	$e = 10 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$
				Total : 300

# RELATIONS WITH INDUSTRY

		Mean value	Standard deviation	Score
ECTS of Industrial internship		30	0	v (if below 30)
Industrial conferences		10	0	v (if below 10)
Visits to companies		10	0	v (if below 10)
Number of hours (ECTS) by industrials		10	0	v (if below 10)
ECTS of industrial project		20		v (if below 20)
Apprenticeship Formations		y	n	10/0
Percentage of students alternating		10	0	v (if below 10)
Percentage of students that create their company		10	0	v (if below 10)
Number of industrials in the steering committee		10	0	v (if below 10)
Number of industrial chairs		10	0	v (if below 10)
Existence of industrials forums		y	n	10/0
	Number of industries represented	10	0	v (if below 10)
Junior enterprise		y	n	10/0
Hiring sectors				
	Basic Chemistry	y	n	10
	Specialty chemistry	y	n	10
	Energy	y	n	10
	Engineering	y	n	10
	Pharamceuticals	y	n	10
	Agro & Bio industries	y	n	10
	Environment	y	n	10
Job position				
	Production	y	n	10
	Research	y	n	10
	Design engineer	y	n	10
	Technical assistant	y	n	10
	HSE & Quality	y	n	10
Industrial advisors		y	n	10/0
				Total : 300

# EMPLOYMENT

		Mean value	Standard Deviation	Score
Average salary of graduates/mean salary		3	0.5	10*v (if below 30)
Time to find a job (month)		0	2	$e = 30 \exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
Unemployment rate after 6 month		0	100	
Influence of alumni association		y	n	$e = 60 \exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$ 10/0
Percentage of additional formation after graduation		10	10	$e = 10 \exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
Percentage of additional research formation after graduation		10	10	
Average salary 10 years after graduation/mean salary		10	1	v (if below 10)
Percentage of steady job 10 years after graduation		100	0	v/10
Level of responsibility after 10 years				The sum of these figures should not exceed 100
	Project manager	10		v
	Head of service	10		v
	Expert	10		v
	Sales manager	10		v
	Plant manager	10		v
	Executive officer	10		v
	Research director	10		v
	Director of company	10		v
	Director of Human resources	10		v
	Full Professor	10		v
Geographic hiring areas				The sum of these figures should not exceed 30
	Outside the country of formation	10		v
	in Europe	10		v
	in the rest of the world	10		v
				Total : 300

# QUALITY

		Mean value	Standard Deviation	Score
Existence of a steering committee		y	n	20/0
Distribution of members				
	Industrial	y	n	10/0
	Number of sectors represented	10		v (if less than 10)
	External teachers	y	n	10/0
	Internal teachers	y	n	10/0
	Students	y	n	10/0
	Researchers	y	n	10/0
	Alumni	y	n	10/0
Frequency of meetings (per year)		4		2.5*v
Existence of a forward thinking		y	n	10/0
Frequency of formations evolution (per year)		1		10*v (if less than 10)
Potential of mobilization of teachers		y	n	10/0
Potential of mobilization of industrials		y	n	10/0
Executive management financial ability		y	n	10/0
Control of the number of teachers		y	n	10/0
Evaluation of teaching				
	Frequency of evaluations/year	2		10*v (if less than 20)
	Evaluation of pedagogical competences	y	n	10/0
	Evaluation of teaching materials	y	n	10/0
	Evaluation of scientific & technical contents	y	n	10/0
	Evaluation of skills & competences contents	y	n	10/0
	Return of evaluation to the students	y	n	10/0
Formation of teachers		y	n	10/0
Existance of an educational committe		y	n	10/0
Existance of a direction board		y	n	10/0
	Industrials	y	n	10/0
	Teachers	y	n	10/0
	Students	y	n	10/0
	Politics	y	n	10/0
				Total : 300

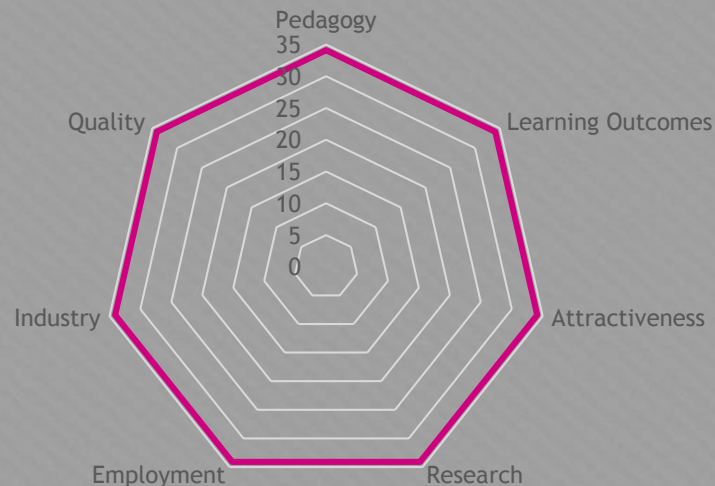
# EVALUATION OF A TRAINING CENTER

## CONCLUSION

160 parameters, gathered in 7 indicators

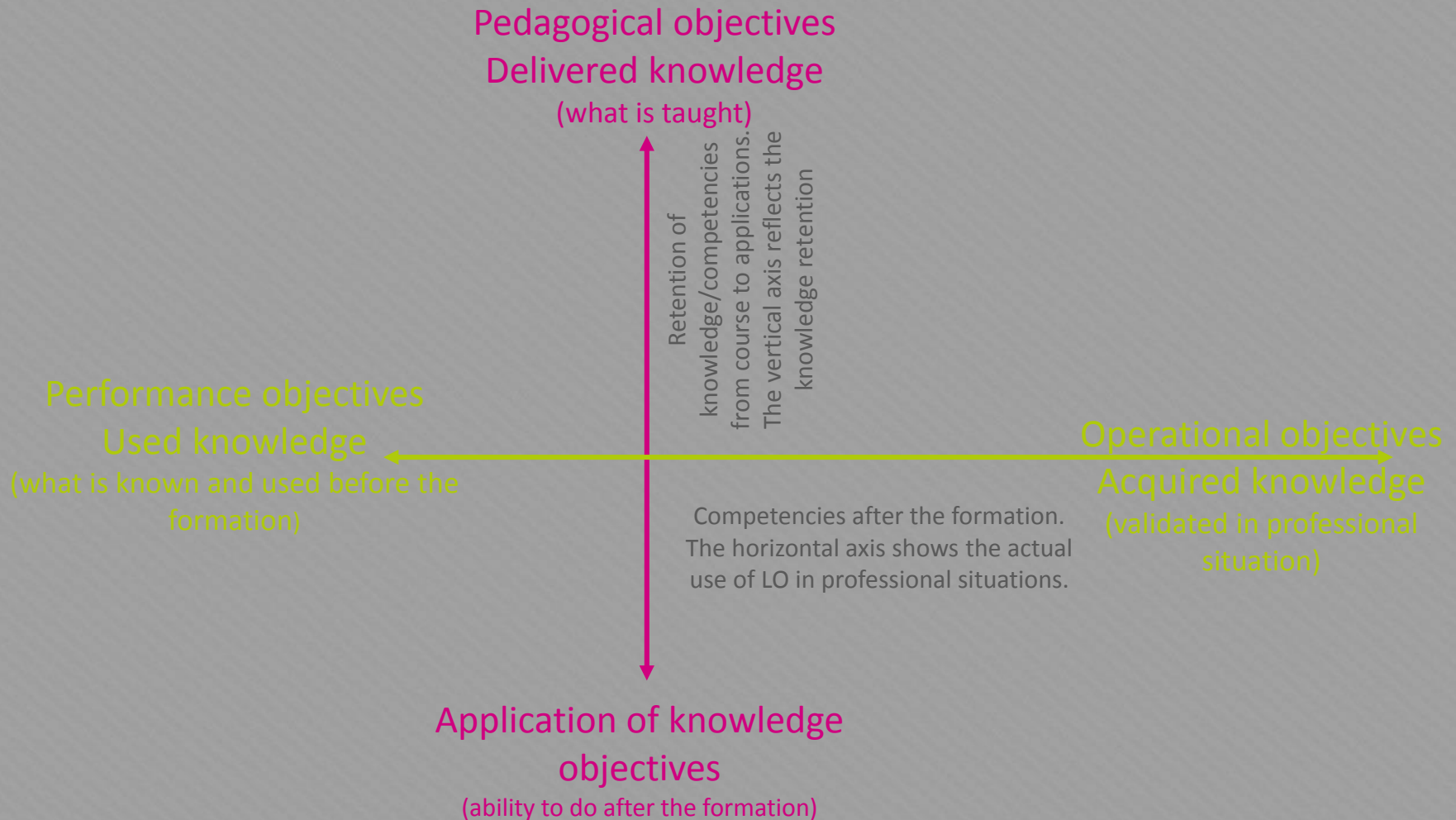
Score of each indicator (300) divided by the **cost of formation**, related to the national average salary.

Definition of radar plots, allowing **improvements**



# EVALUATION OF A SINGLE MODULE

Based on the different types of **knowledges** involved in formation



# EVALUATION OF A SINGLE MODULE

---

Definition of 6 metrics,

- $M_1$  : Strategic nature of the course/discipline,
- $M_2$  : Relevance of the proposed formation,
- $M_3$  : Pedagogical relevance of the teaching approach,
- $M_4$  : Perception of relevance of the pedagogical approach,
- $M_5$  : Evaluation of acquisitions,
- $M_6$  : Evaluation of transfer

Assessed by different stakeholders using Lickert scale

- Academics,
  - Graduates,
  - Students,
  - Employers
- 1 : Strongly disagree  
2 : Disagree  
3 : Neither agree or disagree  
4 : Agree  
5 : Strongly agree



# METRIC 1

## M1 : Strategic nature of the course

Analysis of the needs: this teaching unit (course) is necessary for a chemical engineer

It covers all the needs it should

It is sufficiently detailed for a chemical engineer

It is adapted to the real activities of a chemical engineer

It includes a prospective approach, bringing new concepts and taking into account the future needs of the market

The study program is in concordance with other competing universities

This teaching unit (course) contributes to the attractiveness of the formation of future students

Assessed by Academics, Graduates and Employers, such as  $M_1 = \frac{(2A + G + 2E)}{5}$

# METRIC 2

## M2 : Relevance of the proposed formation

The content of the teaching unit (course) is adequate

Its position in the overall program is appropriate

Its duration / workload / ECTS is appropriate

Appropriate learning outcomes are clearly formulated for this teaching unit (course)

Its relations (or prerequisites) with other teaching units (courses) are appropriate

It allows accessing the four levels of knowledge taxonomy (knowledge, comprehension, application and analysis)

Assessed by Academics, Graduates and Employers and Students, such as

$$M_2 = \frac{(2A + G + E + S)}{5}$$

# METRIC 3

## M3 : Pedagogical relevance of the teaching approach

The proposed formation and pedagogy is appropriate to the learning outcomes

The proposed pedagogy allows accessing and improving different levels of knowledge taxonomy (Knowledge, Comprehension, Application, Analysis)

The proposed pedagogy is appropriate to different students' learning styles (Active and Reflective learners, Sensing and Intuitive learners, Visual and Verbal learners, Sequential and Global learners)

The proposed pedagogy promotes active learning

The pedagogy improves skills and competencies

The proposed pedagogy (e.g. labs, tutorials, projects, works, multimedia documents (if present)) improve the teaching

The proposed pedagogy enables working in professional situation

The proposed pedagogy enables appraising the progression

Teacher's explanations were clear

The course is intellectually challenging and stimulating

The teaching unit (course) is dynamic and enthusiastic

My interest in the subject has increased as a consequence of this course

I learned something which I consider valuable

# METRIC 3

## M3 : Pedagogical relevance of the teaching approach

Group interactions were encouraged	
The breadth of the teaching unit (course) was appropriate	
Proposed objectives agreed with those actually taught, so you knew where the course was going	
The balance between classical and active learning was adequate	
I understand the relevance of the topic for my future profession	
Further reading, homework, laboratories (if applicable) contributed to the appreciation and understanding of the subject	
Methods of evaluating student work were fair and appropriate	
Feedback on examinations/graded materials was valuable	
The mark you obtained (if already available) reflects my level and effort	
Course pace was appropriate	
I was able to appraise my progression	
If you needed some explanations you would?	Situational judgment test
To study for the exam you would?	Situational judgment test

Assessed by Academics, Graduates and Students, such as

$$M_3 = \frac{(2A + 2G + S)}{5}$$

# METRICs 4 & 5

## M4 : Perception of relevance of the pedagogical approach

The proposed pedagogical approach improved my interest in the subject

Course materials were well prepared and carefully explained

The quality of the materials (e.g. videos, ...) and documents was appropriate

Teacher's explanations were clear

M4 is assessed by Students only !

## M5 : Evaluation of the acquisitions

M5 is calculated according to the average marks and standard deviation, taking into account the students cohort possible evolutions

# METRIC 6

## M6 : Evaluation of transfer

Competences in the particular subject

Practical skills

Ability to combine theory and practice to analyse the engineering problems

Ability to comply with practice standard and know how to deal with hazards

Ability to apply the concepts to new problems

Ability to extend the concepts to new problems

Ability to work in professional situation

Ability to evaluate own performances and outcomes

Motivation

Adaptability

Written & oral communication

Team work

Assessed by Academics, Graduates and Employers, such as

$$M_6 = \frac{(A + 2G + 2E)}{5}$$

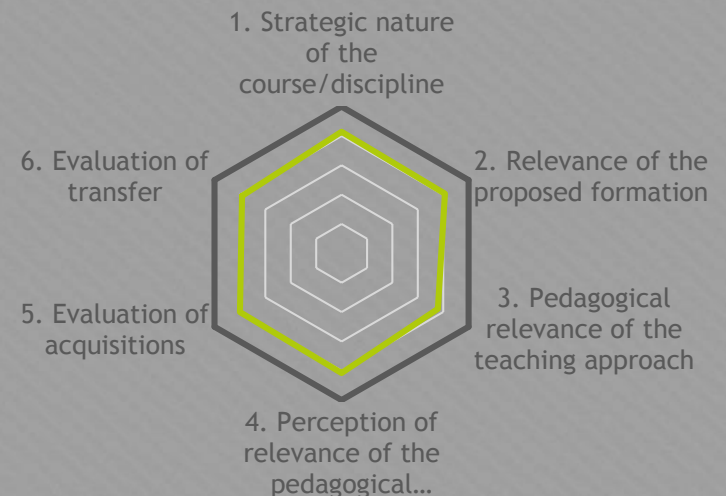
# EVALUATION OF A SINGLE MODULE

## CONCLUSION

Assessment of different stakeholders, using web suveys :



Quantification of a single module using radar plots :





## WP 4 : PILOT IMPLEMENTATION

7. Test the framework at partner institutions focusing on various pedagogic methodologies.