IMPROVING TEACHING EFFECTIVENESS IN CHEMICAL ENGINEERING EDUCATION

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Project aim

Develop a framework which will support the assessment of teaching effectiveness in delivering not only core chemical engineering knowledge, but also core employability competencies in a range of geographical and educational context.

More detail on www.iteach-chemeng.eu

Consortium partners

Newcastle University

UNIVERSITÉ DE LORRAINE

INTERNATIONAL BALKAN UNIVERSITY

U.PORTO

STU
SLOVENSKÁ TECHNICKÁ UNIVERZITA V BRATISLAVE

technische universität dortmund

16 associate partners formally signed up, representing professional institutions, employers, HEIs

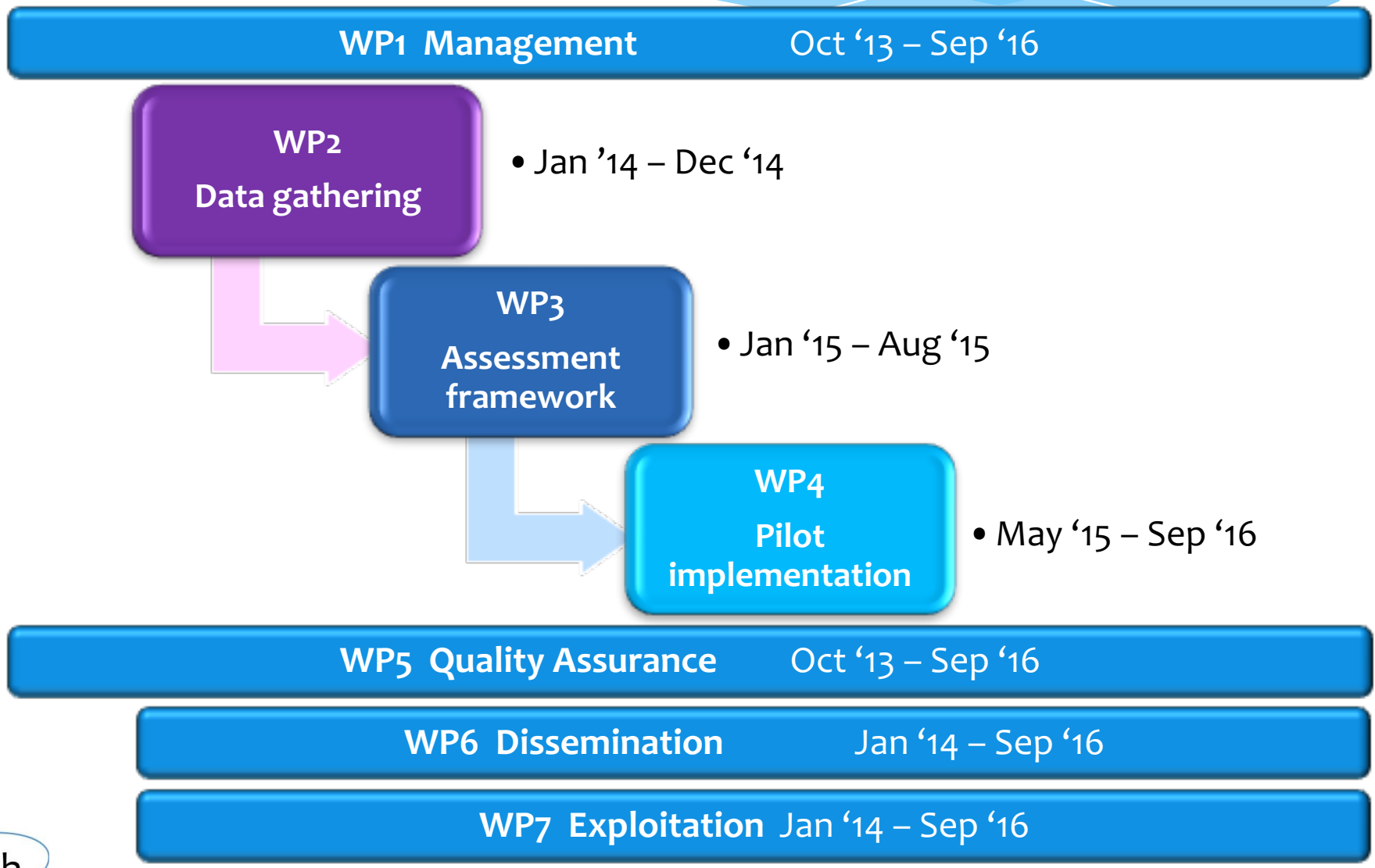
OBJECTIVES

1. Review the learning outcomes of a chemical engineering education.
2. Promote closer involvement of employer organisations in chemical engineering curriculum formation by carrying out focus groups.
3. Establish state-of-the art in assessing the effectiveness of teaching of core chemical engineering knowledge.
4. Define various indicators of the effectiveness of teaching in chemical engineering higher education.

OBJECTIVES

5. Investigate in more depth methods of effectively acquiring employability competencies.
6. Use decision making technology and multi-objective optimisation to identify the most appropriate evaluation methods.
7. Test the framework at partner institutions focusing on various pedagogic methodologies.

Project overview



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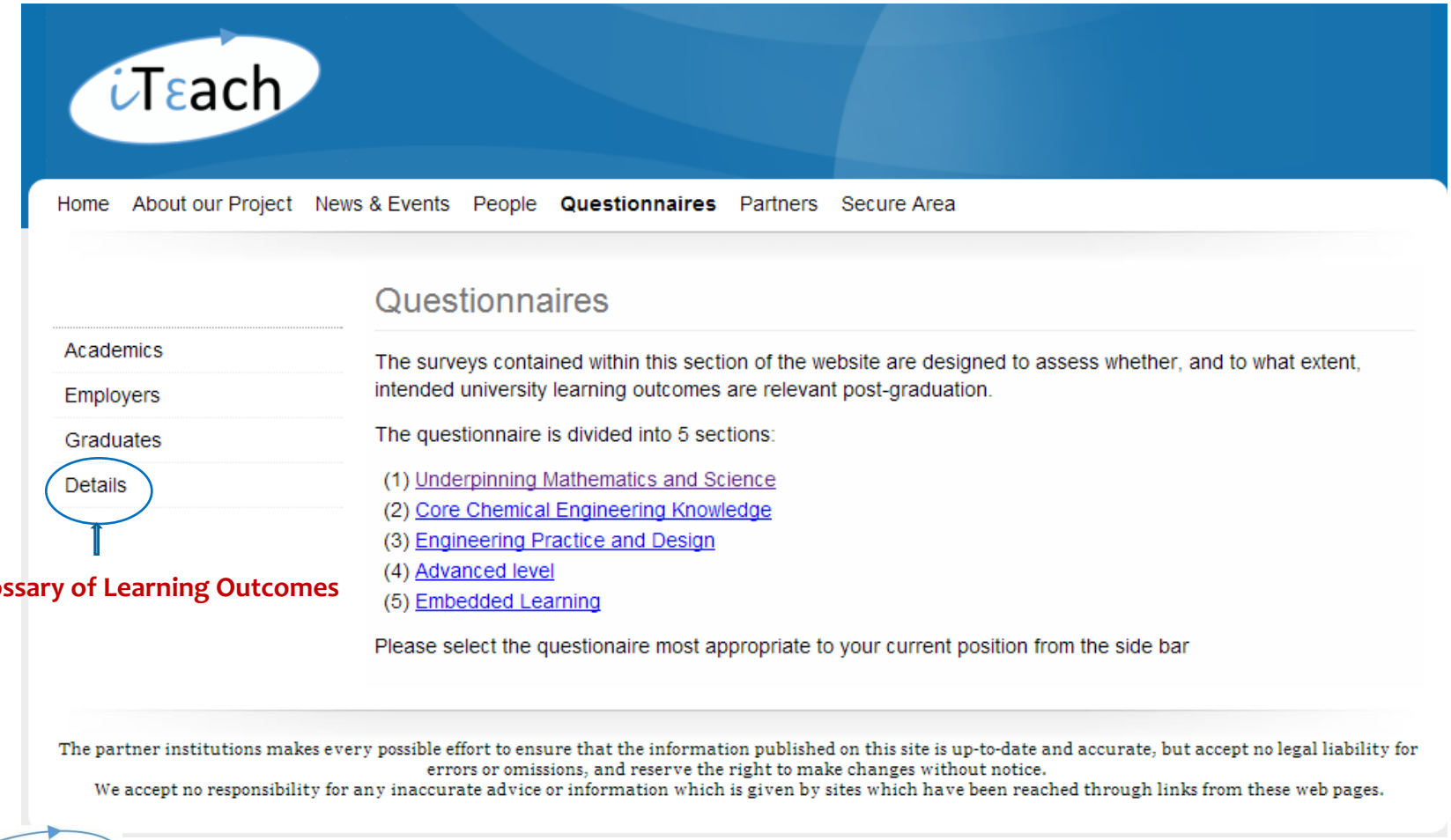
Data collection methodology

- Questionnaires
- Focus groups



Glossary of Learning Outcomes

Data analysis methodology

Quantitative statistical data analysis

✓Measures of central tendency (M, SD, Min, Max) and frequency counts were calculated for all Likert-scale type questions.

✓Frequency counts were conducted for single-choice answers.

✓Group comparison was carried out after classifying the responses geographically using United Nations Geoscheme for Europe, created by the UN Statistics Division http://millenniumindicators.un.org/unsd/methods/m49/m49regin.htm

✓Independent-samples t-tests conducted for all Likert-scale type questions - differences between geographical regions, position and company size.

➢ Multivariate Data Analysis (MVDA) methods.

Data analysis methodology

Qualitative data
Focus group - semi-structured interviews

- ✓ **Responses (free text) to questions have been analysed by NVivo software**

  Identified a number of predominant themes/patterns and frequencies of occurrence in each questionnaire

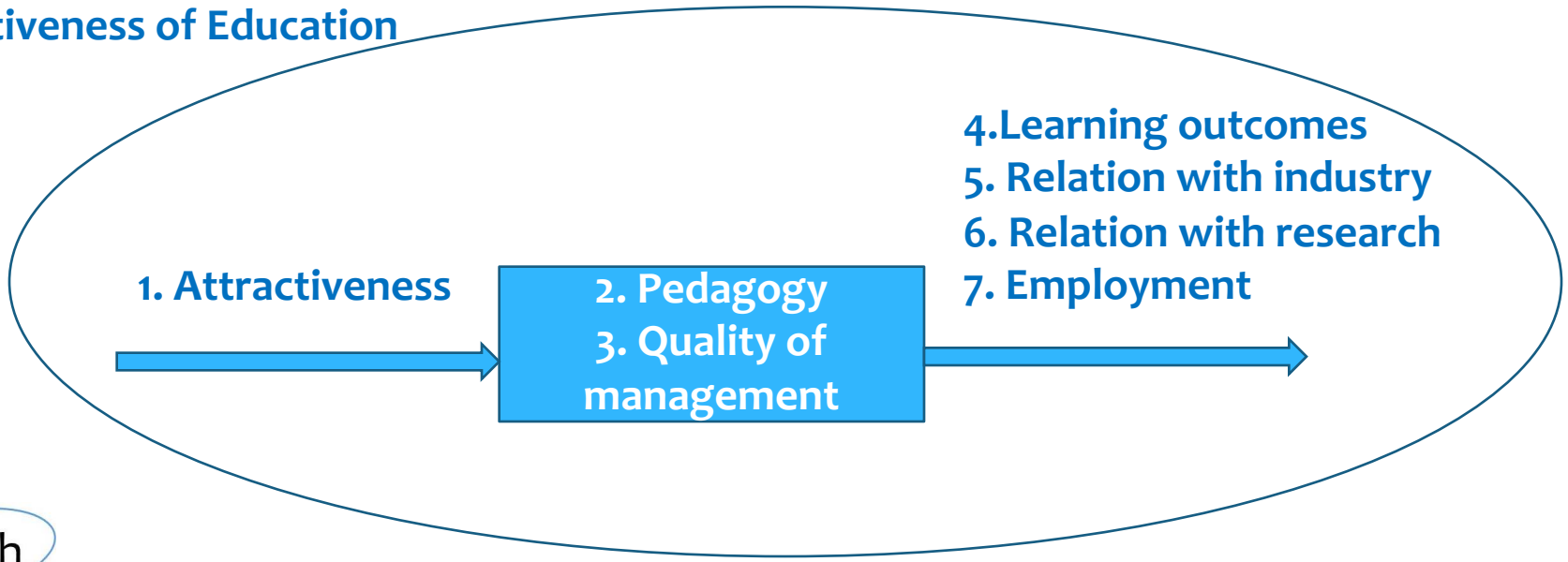
- ✓ **Carried out on the results of focus group interviews.**

Assessment framework

>160 parameters; 7 Indicators

Industry/Education

Effectiveness of Education



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QUANTIFICATION OF INDICATORS

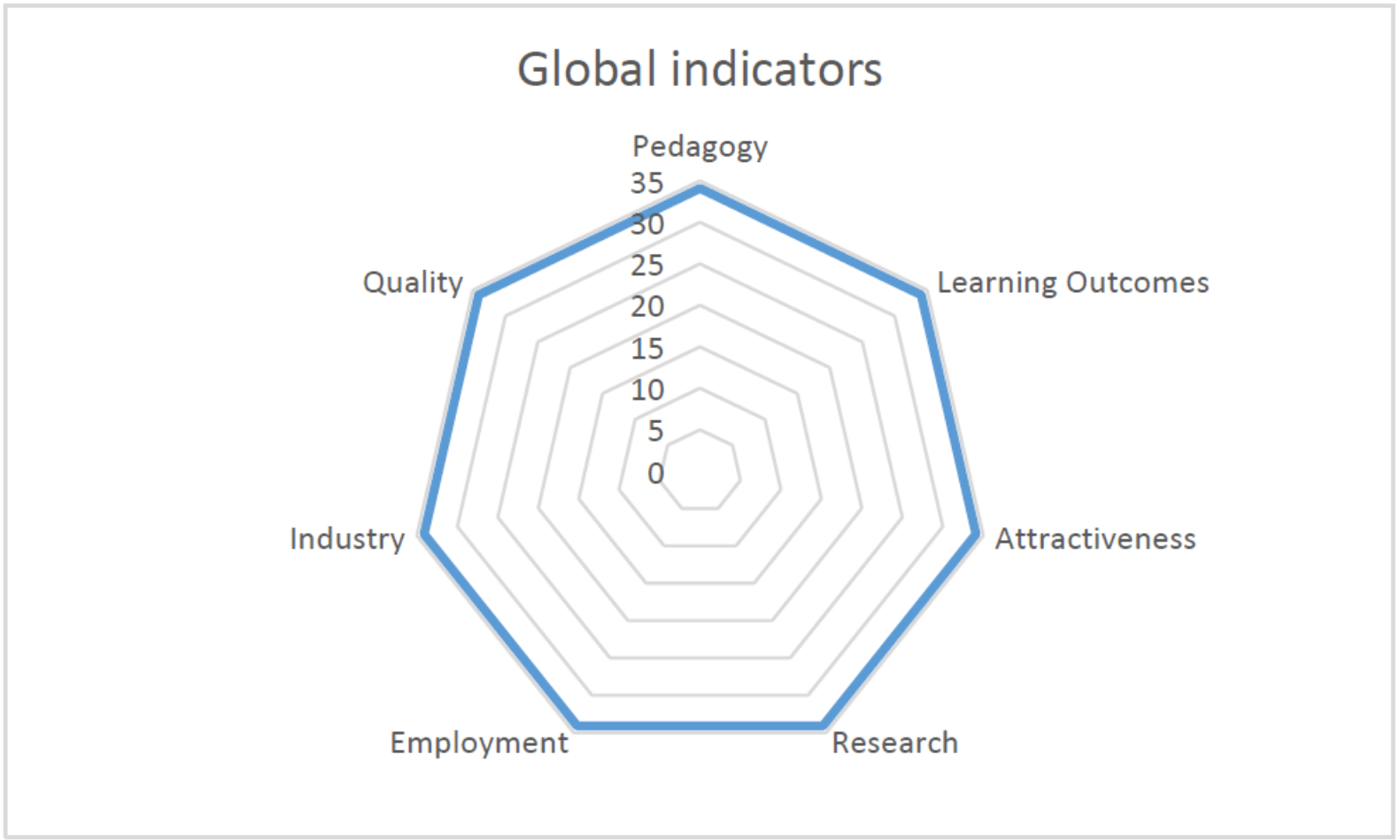
$$e = \exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$$

e- effectiveness,
v -the value of ECTS for a given teaching method,
μ the average value and
σ the standard deviation

Pedagogy

Teaching		Mean value	Standard Deviation	Score
	Hours (or ECTS) of classical lectures	100	30	$e = 12\exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
	Hours (or ECTS) of tutorials	50	30	$e = 12\exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
	Hours (or ECTS) of labs	50	30	$e = 12\exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
	Hours (or ECTS) of Problem & Project Based Learnings	50	30	$e = 12\exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
	Hours (or ECTS) of NTICs	50	30	$e = 12\exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
				Maximum score for teaching : 60

		y	n	10/0
		y	n	10/0
		100	10	$e = 10\exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
	Number of students/teachers	5	5	$e = 10\exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
	Percentage of permanent teachers	100	10	$e = 10\exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$
	Pedagogical formation	y	n	10/0
				Maximum score for teaching availability: 60
				Total 300



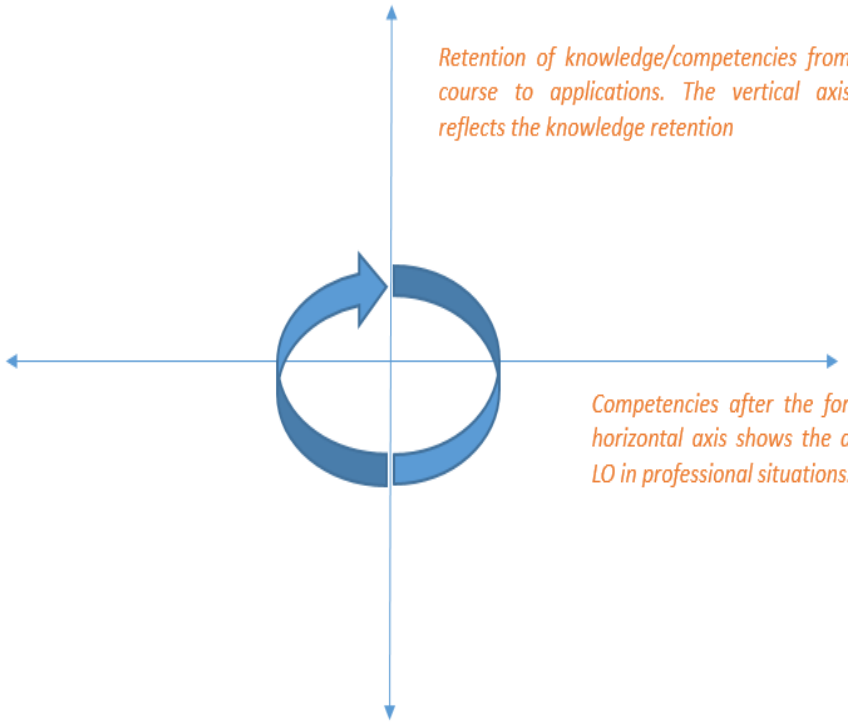
Teaching effectiveness

Proposed framework

Pedagogical objectives

Delivered knowledge

(what is taught)



Performance objectives

Used knowledge

(what is known and used before the formation)

Operational objectives

Acquired knowledge

(validated in professional situation)

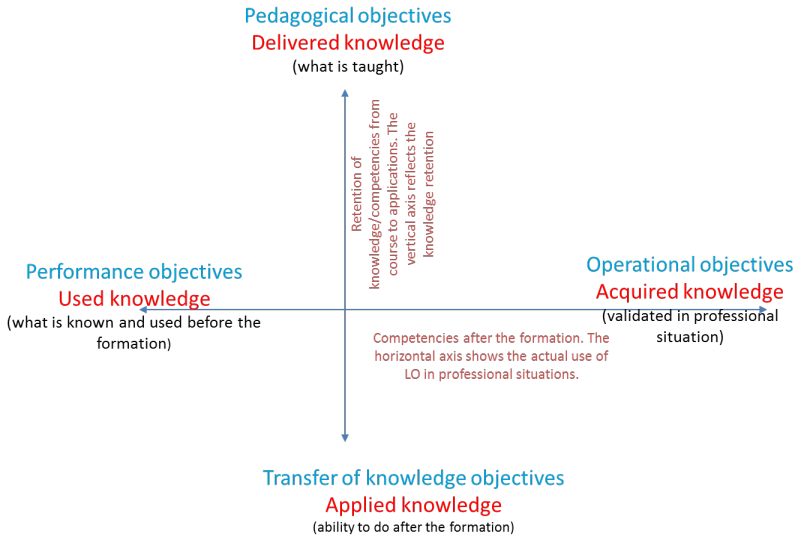
Transfer of knowledge objectives

Applied knowledge

(ability to do after the formation)

Framework metrics for individual unit/course

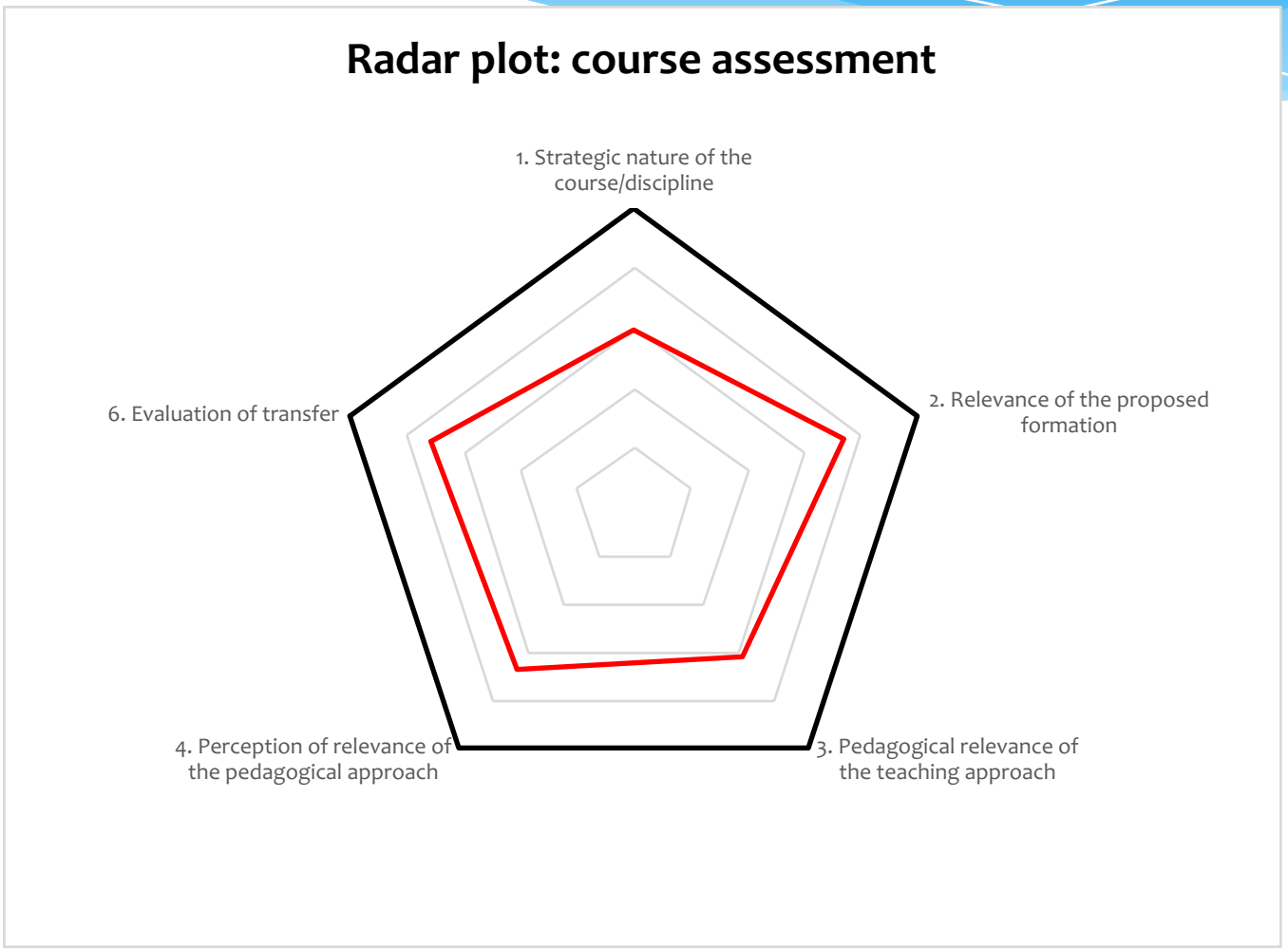
- Strategic nature of the course/discipline;
- Relevance of the proposed formation;
- Pedagogical relevance of the teaching approach;
- Perception of relevance of the pedagogical approach;
- Evaluation of acquisitions and;
- Evaluation of transfer.



Assessment framework's metrics and stakeholders.

Metric	Academics	Graduates[1]	Employers	Students	Formula
1. Strategic nature of the course/discipline	X	X	X		(2A+G+2E)/5
2. Relevance of the proposed formation	X	X	X	X	(2A+G+E+S)/5
3. Pedagogical relevance of the teaching approach	X	X		X	(2A+2G+S)/5
4. Perception of relevance of the pedagogical approach				X	S
6. Evaluation of transfer	X	X	X		(A+2G+2E)/5

[1]Graduates are those which concluded a 5-year program in Chemical Engineering in the last 5 years.



Evaluative image of a formation (in black: ideal profile; in red the real profile)

Proposed pedagogical approaches

P1(UNEW) – recorded lectures, problem based learning

P2 (UL) – problem based learning, self-instruction delivery

P3 (IBU) – work-based learning, traditional lectures

P4 (FEUP) – recorded lectures, practical instruction via labs

P5 (STU) – traditional lectures, practical instruction via labs

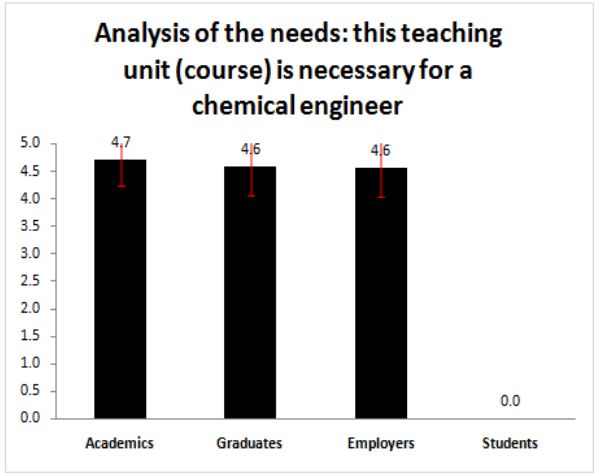
P6 (TUDO) - work-based learning, problem based learning

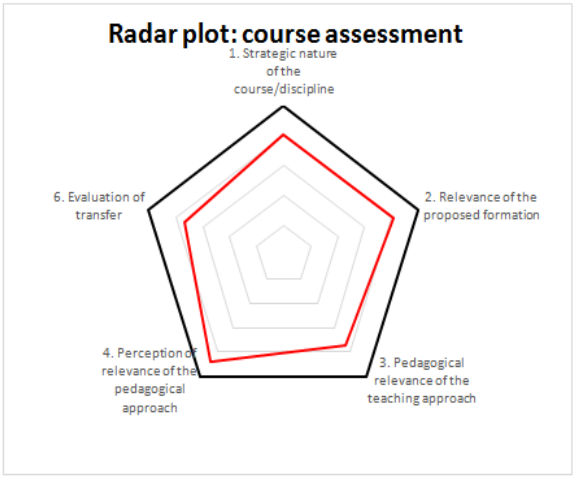
Metric	Grade				Overall Grade	Formula
	Academics	Graduates	Employers	Students		
1. Strategic nature of the course/discipline	4.1	3.7	4.1		**4.0**	(2A+G+2E)/5
2. Relevance of the proposed formation	4.1	3.6	4.2	4.3	**4.0**	(2A+G+E+S)/5
3. Pedagogical relevance of the teaching approach	3.9	3.3		4.2	**3.7**	(2A+2G+S)/5
4. Perception of relevance of the pedagogical approach				4.4	**4.4**	S
6. Evaluation of transfer	4.0	3.4	3.7		**3.7**	(A+2G+2E)/5

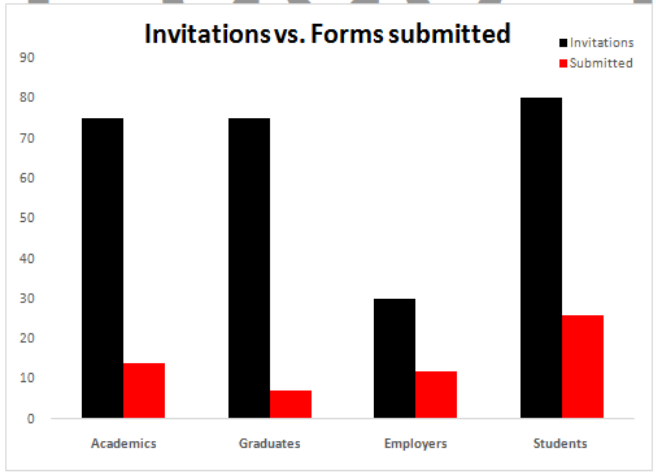
Stakeholder	(A) Nr. Invitations sent	(B) Nr. Forms submitted	(C) Nr. Questions	(D) Nr. answers	B /A x 100	D /(BxC) x 100
Academics	75	14	33	461	18.7	99.8
Graduates	75	7	33	366	9.3	158.4
Employers	30	12	25	173	40.0	57.7
Students	80	26	36	1079	32.5	115.3

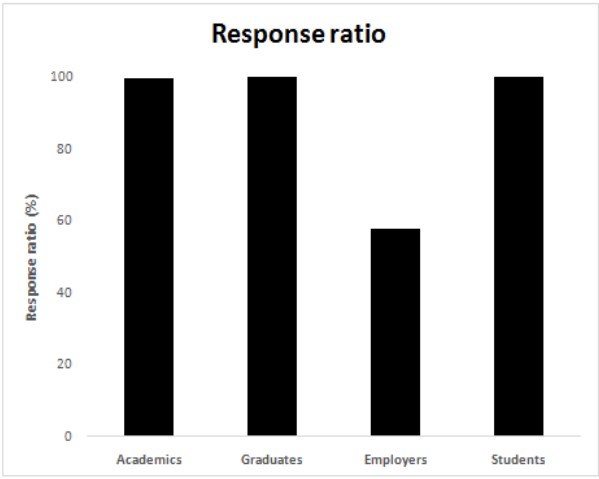
SELECT QUESTION

1.1





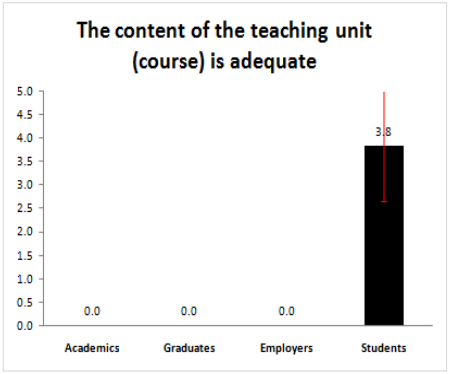




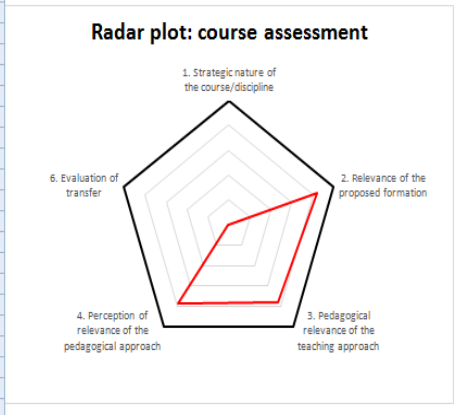
Traditional lectures

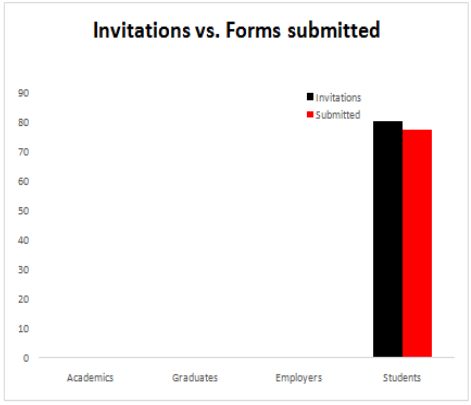
Metric	Grade				Overall Grade
	Academics	Graduates	Employers	Students	
1. Strategic nature of the course/discipline	#DIV/0!	#DIV/0!	#DIV/0!		**#DIV/0!**
2. Relevance of the proposed formation	#DIV/0!	#DIV/0!	#DIV/0!	4.2	**4.2**
3. Pedagogical relevance of the teaching approach	#DIV/0!	#DIV/0!		3.8	**3.8**
4. Perception of relevance of the pedagogical approach				3.9	**3.9**
6. Evaluation of transfer	#DIV/0!	#DIV/0!	#DIV/0!		**#DIV/0!**

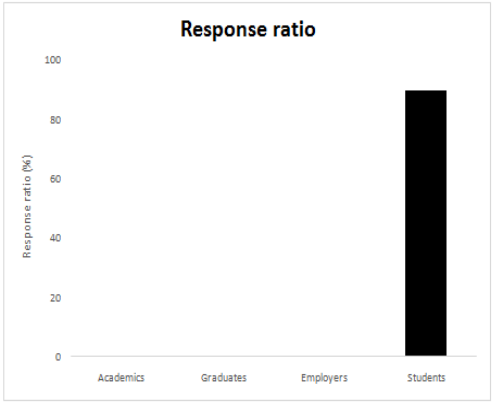
SELECT QUESTION
2.1



Stakeholder	(A) Nr. Invitations sent	(B) Nr. Forms submitted	(C) Nr. Questions	(D) Nr. answers	B /A x 100	D /(BxC) x 100
Academics	0	0	0	0	#DIV/0!	#DIV/0!
Graduates	0	0	0	0	#DIV/0!	#DIV/0!
Employers	0	0	0	0	#DIV/0!	#DIV/0!
Students	80	77	36	2486	96.3	89.7







Work-based learning

CONCLUSIONS

- Two frameworks for the assessment of teaching effectiveness have been developed.
- The first one is related to the effectiveness of a whole formation.
- The second one is assigned to a single teaching unit.
- Although the focus of this project is oriented toward chemical engineering formation, the concepts and approaches could be applied to other areas of higher education.

THANK YOU

for your attention

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