

# IMPROVING TEACHING EFFECTIVENESS IN CHEMICAL ENGINEERING EDUCATION

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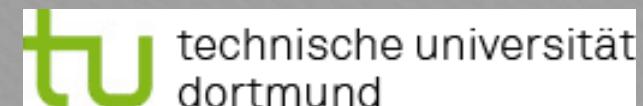
# PROJECT OBJECTIVES

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- 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](http://www.iteach-chemeng.eu)

# CONSORTIUM PARTNERS

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

# PROJECT OUTLINES

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1. Review the **learning outcomes** of a chemical engineering training,
2. Promote **closer involvement of employer organisations** in chemical engineering curriculum by carrying out focus groups,
3. Establish state-of-the art in **assessing the effectiveness** of teaching of chemical engineering skills and knowledge,
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,
7. **Test the framework** at partner institutions focusing on various pedagogic methodologies.

# PROJECT OVERVIEW

## WP1 Management

Oct 2013 - Sep 2016

## WP2 Data gathering

• Jan 2014 - Dec 2014

## WP3 Assessment framework

• Jan 2015 - Aug 2015

## WP4 Pilot implementation

• May 2015 - Sep 2016

## WP5 Quality Assurance

Oct 2013 - Sep 2016

## WP6 Dissemination

Jan 2014 - Sep 2016

## WP7 Exploitation

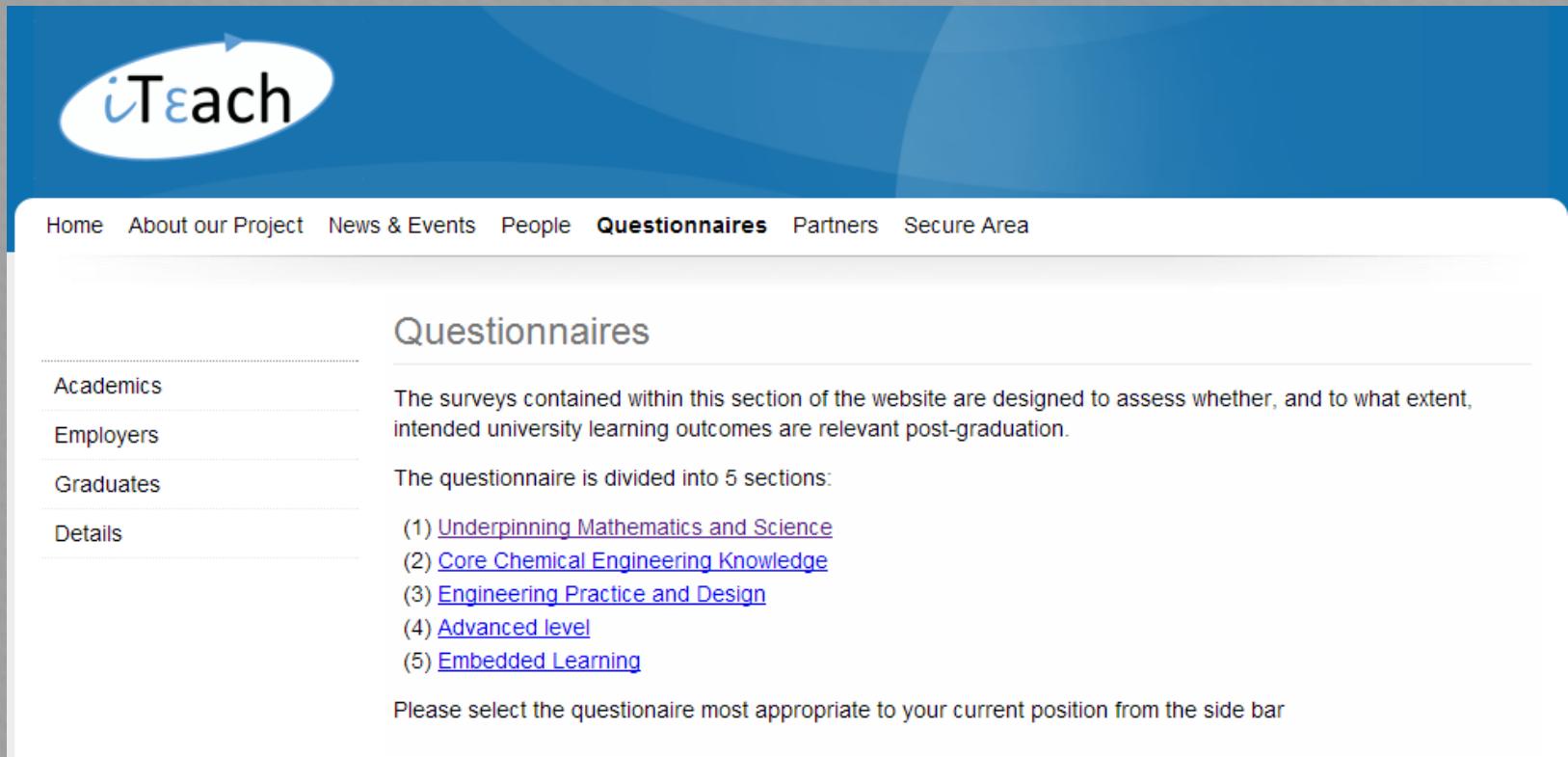
Jan 2014 - Sep 2016

## WP 2 : DATA GATHERING

1. Review the learning outcomes of a chemical engineering training,
2. Promote closer involvement of employer organisations in chemical engineering curriculum by carrying out focus groups,
3. Establish state-of-the art in assessing the effectiveness of teaching of chemical engineering skills and knowledge,

# WP2 : DATA COLLECTION

- Gathering information on the **current state-of-the-art** in measuring **effectiveness of teaching** and perceptions from **academics**, **employers** and recent **graduates**



The image shows a screenshot of the iTTeach website. The header features the iTTeach logo with a blue arrow pointing right. The navigation menu includes links for Home, About our Project, News & Events, People, Questionnaires (which is the current page), Partners, and Secure Area. The main content area is titled 'Questionnaires'. On the left, there is a sidebar with links for Academics, Employers, Graduates, and Details. The main content area contains text about the surveys and a list of five questionnaire sections: Underpinning Mathematics and Science, Core Chemical Engineering Knowledge, Engineering Practice and Design, Advanced level, and Embedded Learning. A note at the bottom says to select the questionnaire most appropriate to your current position from the side bar.

**iTTeach**

Home About our Project News & Events People **Questionnaires** Partners Secure Area

## Questionnaires

Academics

Employers

Graduates

Details

The surveys contained within this section of the website are designed to assess whether, and to what extent, intended university learning outcomes are relevant post-graduation.

The questionnaire is divided into 5 sections:

- (1) [Underpinning Mathematics and Science](#)
- (2) [Core Chemical Engineering Knowledge](#)
- (3) [Engineering Practice and Design](#)
- (4) [Advanced level](#)
- (5) [Embedded Learning](#)

Please select the questionnaire most appropriate to your current position from the side bar

# WP2 : DATA ANALYSIS

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Univariate statistical analysis of the results indicates a high degree of consistency in the responses between various geographical areas of Europe in terms of the significance of areas of knowledge and employment competencies.

Predominant method of delivering identified as

- traditional lectures for the vast majority of knowledge areas
- alternative project/case based and practical approaches to the delivery of employability competencies.

Multivariate data analysis, indicated only a slight difference in the responses of the employers from those of the academics and graduates.

- The different perceptions of the importance of the engineering practice and design knowledge,
- the differences in the underpinning and core CE knowledge and advanced CE knowledge at masters level,
- some differences in the employability competencies.

# WP2 : DATA ANALYSIS

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The analysis of **free text responses** indicated that :

- The **current means of assessing effectiveness** in the **academic environment** center around **examination performance and student satisfaction** **questionnaires** with more **project based assessment** and **presentations** for the **employability competencies**.
- From the **employer perspective**, the assessment methods include **CV and references**, **performance** during the interview and **assessment centers** as well as '**on-the-job**' performance during probation periods.

The initial results were used for **focus group discussions** to clarify the importance of various factors for their inclusion into the assessment framework.

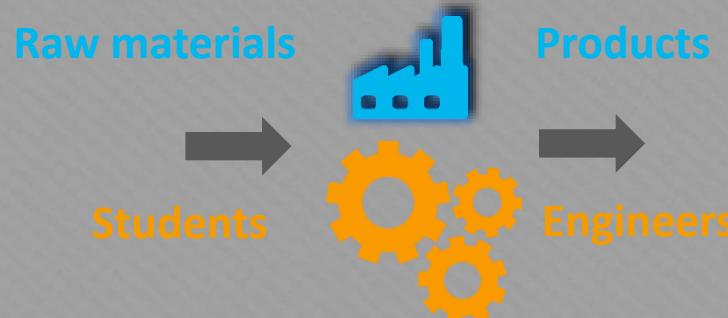
- The analysis **re-enforced the initial findings** of the questionnaires.
- It also indicated the **concerns** regarding the **validity and the robustness** of the current methods of assessing the effectiveness of delivery...
- Although **no specific suggestions** for better means were introduced.

## 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 :

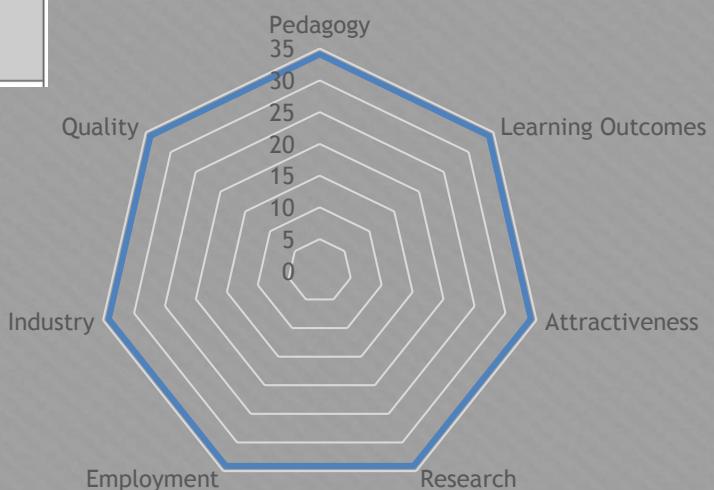
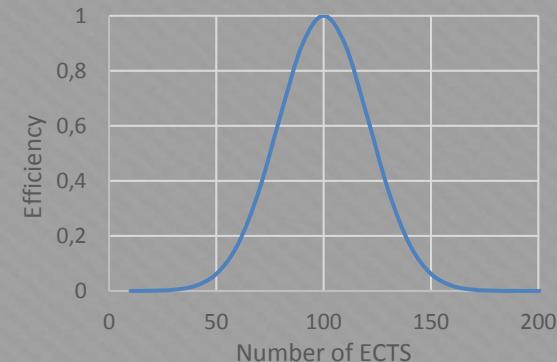


# EVALUATION OF A WHOLE FORMATION

**Quantification of each parameter** : Discussions within the consortium, with stakeholders, recommendations of the EFCE...  
Example, for **pedagogy** :

Teaching		Mean value	Standard Deviation	Score
	ECTS of classical lectures	100	30	$e = 10 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$
	ECTS of tutorials	50	30	$e = 10 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$
	ECTS of labs	50	30	$e = 10 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$
	ECTS of Problem & Project Based Learnings	50	30	$e = 10 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$
	ECTS of NTICs	50	30	$e = 10 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$

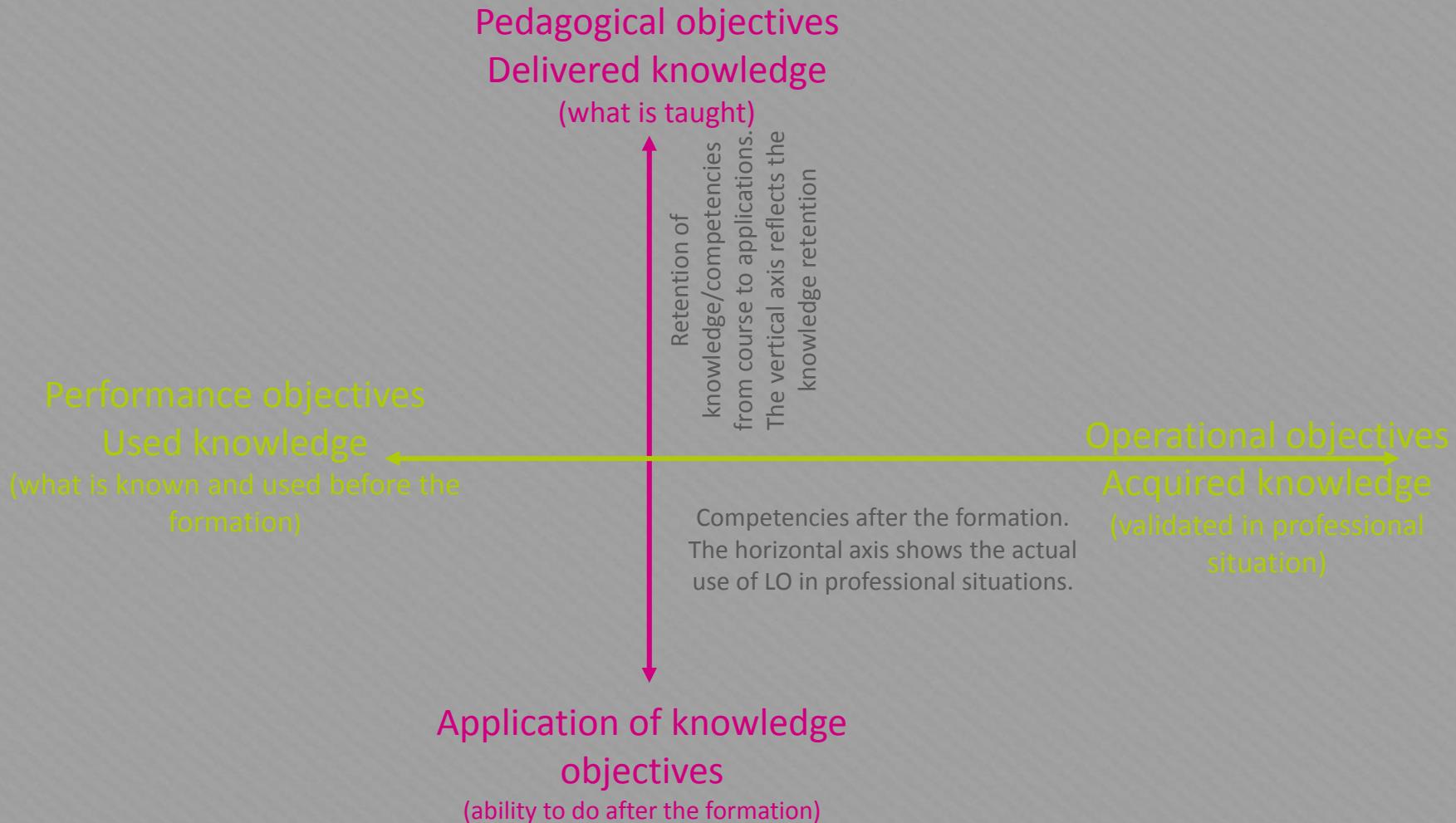
Score of each indicator (on 300) divided by the **cost of formation**, related to the national average salary.



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

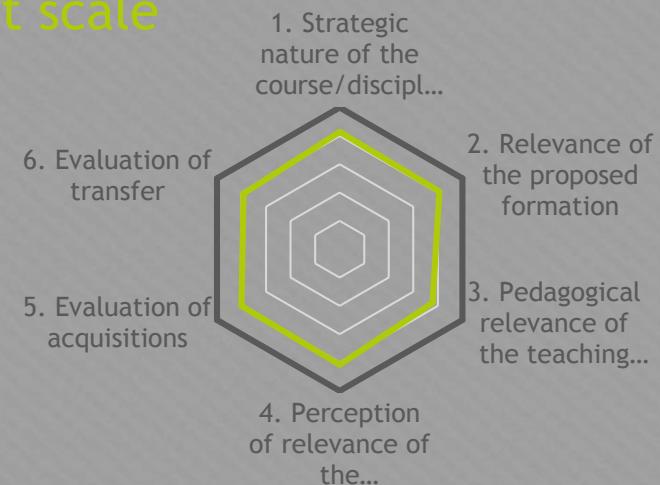
Definition of 6 metrics,

- $M_1$  : 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**

According to different weights.



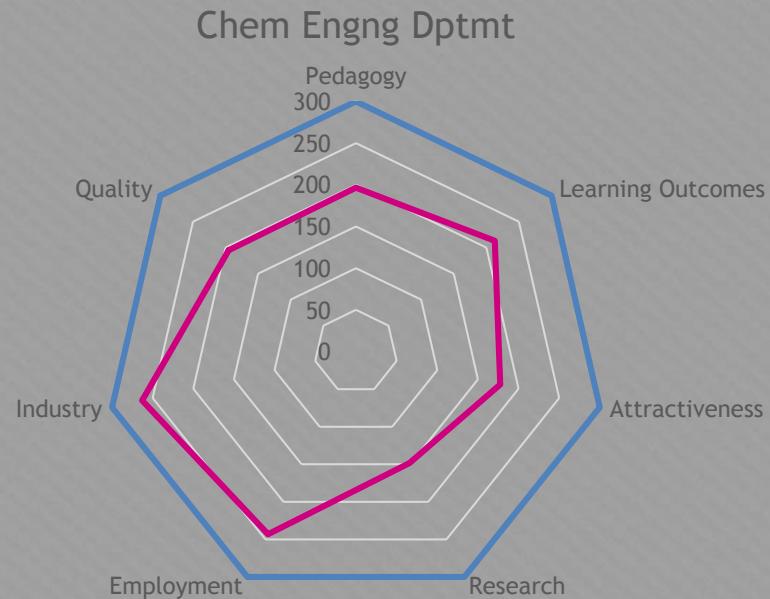
## WP 4 : PILOT IMPLEMENTATION

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

# EVALUATION OF A WHOLE FORMATION

Application of the framework to a  
*virtual* Chemical Engineering  
Formation

Calculation of scores (on 300) of each  
global indicator, not related to the  
average cost and salary.



Gives an indication of **improvements areas** :

Relations with Research, Attractiveness

Gives also an indication of **strengths** :

Relations with Industry, Employment

Difficulty in assessing all the 160 parameters...

# EVALUATION OF A SINGLE MODULE (1/2)

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Applied to the course of Chemical Reaction Engineering I (basic CRE) in different countries, using different pedagogical approaches :

- P1(UNEW) - recorded lectures, problem based learning
- P2 (UL) - problem based learning, traditional lectures
- 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

Metrics assessed by different (national) stakeholders using Lickert scale

- Academics,
- Graduates,
- Students,
- Employers

1 : Strongly disagree

2 : Disagree

3 : Neither agree or disagree

4 : Agree

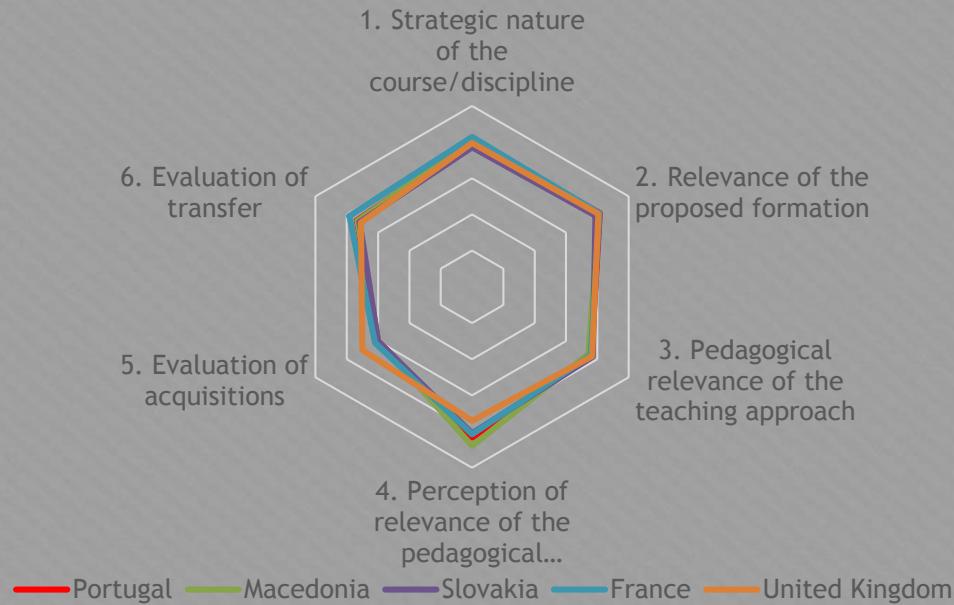
5 : Strongly agree

# EVALUATION OF A SINGLE MODULE (2/2)

Global results :

Detailed results  
presented tomorrow at  
The iTeach Final  
Conference !

## Chemical Reaction Engineering



Germany : too small database

Not so much differences in Metrics 1, 2, 3, 4 & 6...

Great difficulties in receiving feedback to our surveys...  
Only students were "forced" (in face to face positions) to fulfill the (paper) surveys.

# EVALUATION OF DIFFERENT MODULES

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Application of the framework to the evaluation of different modules and different pedagogical approaches, in a same university, for the same cohort of students

CRE I, in traditional teaching : Courses, tutorials and final exam

CRE II, in Project Based Learning : Design of a catalytic reactor, final defense of the project

Heat Exchangers in self-delivery : Autoformation, and then Problem Based Learning applied to the design of an heat exchanger

Only students feedback described : Comparison of their detailed results for Metrics 2, 3, 4 & 5.

- M1 : Strategic nature of the course/discipline,
- M2 : Relevance of the proposed formation,
- M3 : Pedagogical relevance of the teaching approach,
- M4 : Perception of relevance of the pedagogical approach,
- M5 : Evaluation of acquisitions,
- M6 Evaluation of transfer

# EVALUATION OF DIFFERENT MODULES

## Metric 2 : Relevance of the proposed formation

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

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

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

Its duration / workload / ECTS is appropriate

Its position in the overall program is appropriate

The content of the teaching unit (course) is adequate

■ Traditional Lectures   ■ PBL   ■ Self Delivery  
 $M_2 = 4.1$     $M_2 = 4.0$     $M_2 = 4.0$



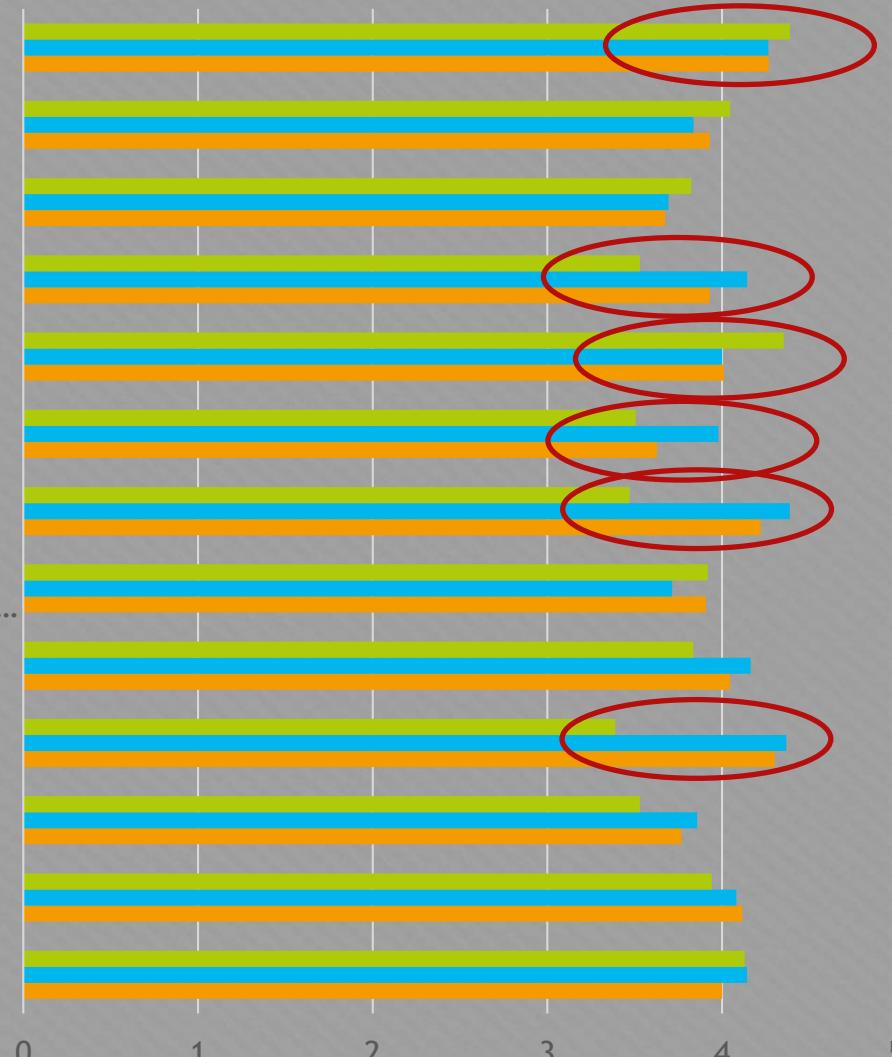
# EVALUATION OF DIFFERENT MODULES

## Metric 3 : Pedagogical

### Relevance of the teaching approach

■ Traditional lectures   ■ PBL   ■ Self Delivery

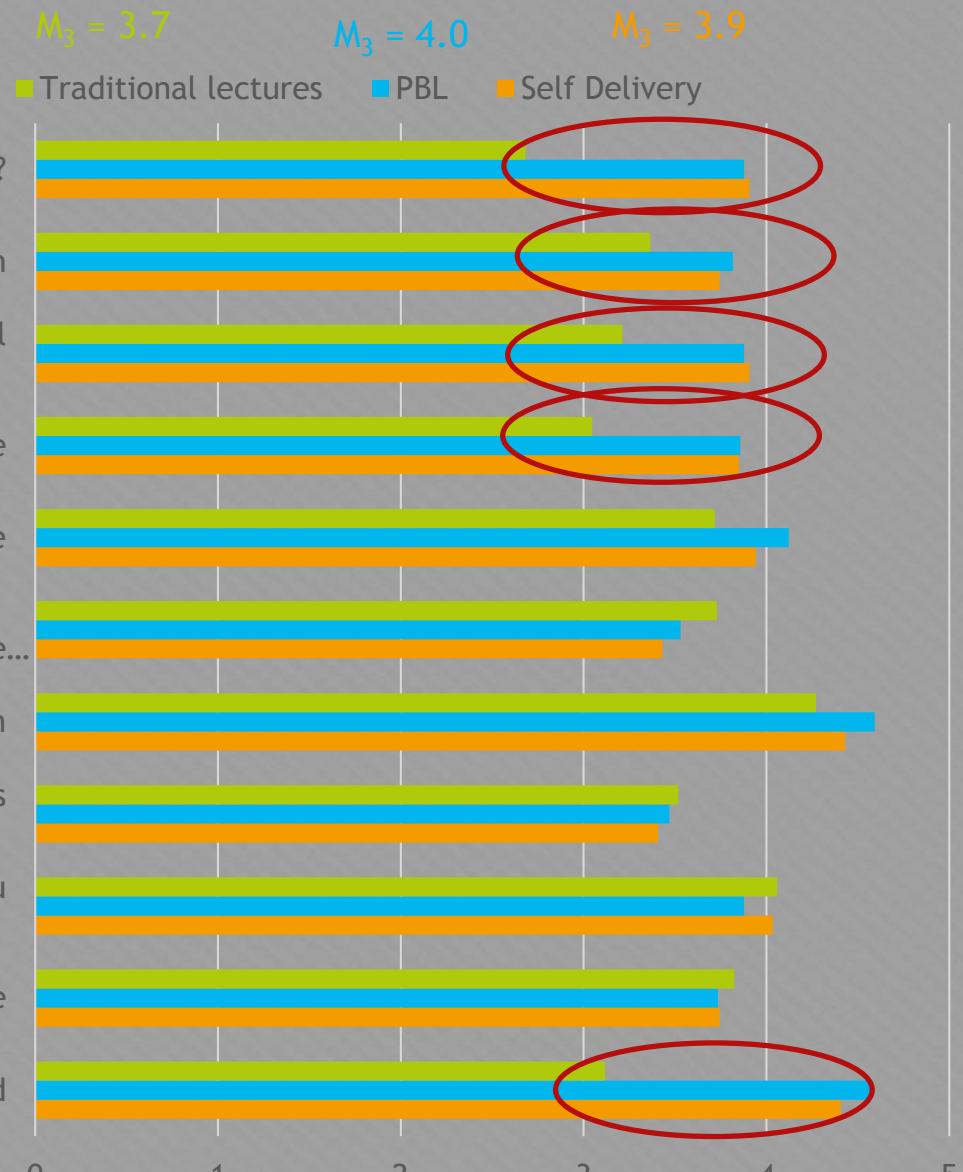
- I learned something which I consider valuable
- My interest in the subject has increased as a consequence of this course
- The teaching unit (course) is dynamic and enthusiastic
- The course is intellectually challenging and stimulating
- Teacher's explanations were clear
- The proposed pedagogy enables appraising the progression
- The proposed pedagogy enables working in professional situation
- The proposed pedagogy (e.g. labs, tutorials, projects, works, multimedia documents (if present)) improve the...
- The pedagogy improves skills and competencies
- The proposed pedagogy promotes active learning
- The proposed pedagogy is appropriate to different students' learning styles
- The proposed pedagogy allows accessing different levels of knowledge taxonomy
- The proposed formation and pedagogy is appropriate to the learning outcomes



# EVALUATION OF DIFFERENT MODULES

## Metric 3 : Pedagogical Relevance of the teaching approach

If you needed some explanations you would?



The breadth of the teaching unit (course) was appropriate

Group interactions were encouraged

# EVALUATION OF DIFFERENT MODULES

## Metric 4 : Relevance of the proposed formation

The project helped me to undersatnd and deepen some points of the course

$M_4 = 4.1$   $M_3 = 4.1$   $M_3 = 4.1$   
■ Traditional Lectures ■ PBL ■ Self Delivery



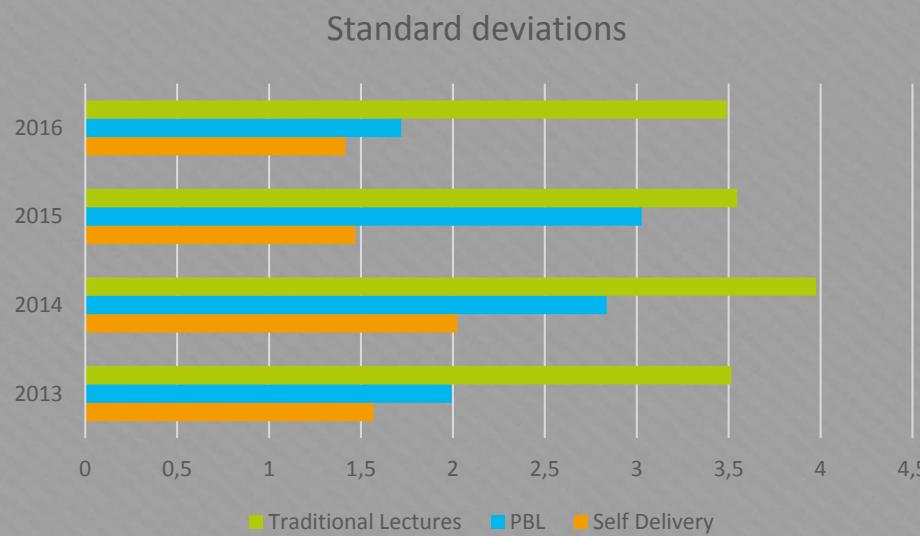
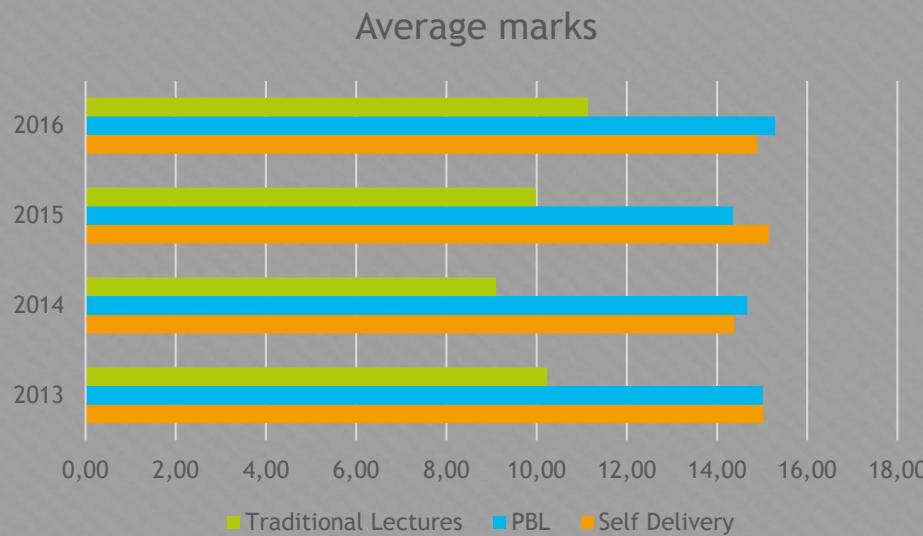
The quality of the materials (e.g. videos, ...) and documents was appropriate

Course materials were well prepared and carefully explained

The proposed pedagogical approach improved my interest in the subject

# EVALUATION OF DIFFERENT MODULES

**Metric 5 : Evaluation of acquisitions**



# CONCLUSIONS

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- European project for improvement and assessment of teaching effectiveness
- Two frameworks have been developed.
  - The first one is related to the effectiveness of a whole formation : strengths and improvements areas !
  - The second one is assigned to a single teaching unit : interest of PBL, self delivering, and classical teaching !
- 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

<http://www.iteach-chemeng.eu>

Final iTeach conference  
tomorrow, Tuesday 30 august