



IMPROVING TEACHING EFFECTIVENESS IN CHEMICAL ENGINEERING EDUCATION

J. Glassey¹, E. Schaer², A. Porjazoska Kujundziski³, V. Meshko³,
L. M. Madeira⁴, M. Polakovic⁵, N. Kockmann⁶

¹Newcastle University, Newcastle upon Tyne, United Kingdom,

²Université de Lorraine, UL Nancy, France,

³International Balkan University (IBU),

⁴Faculdade de Engenharia da Universidade do Porto, Porto,
Portugal,

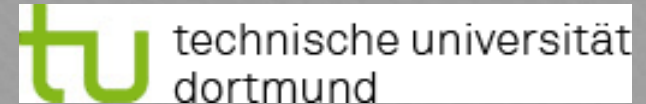
⁵Slovak Technical University, Bratislava, Slovakia,

⁶TU Dortmund University, BCI, Dortmund, Germany

PROJECT OBJECTIVES

- 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

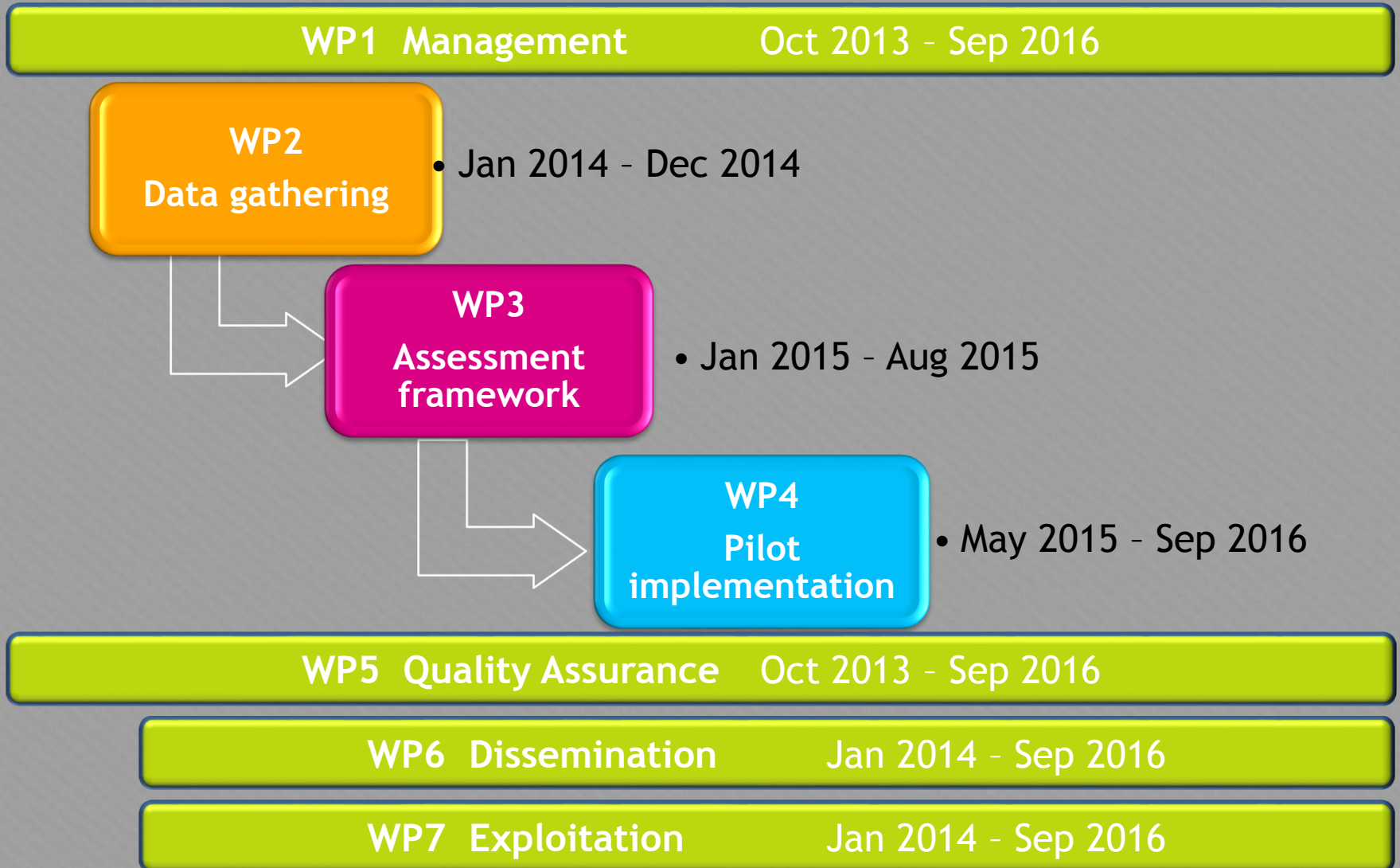


16 associate partners formally signed up, representing professional institutions, employers, HEIs

PROJECT OUTLINES

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



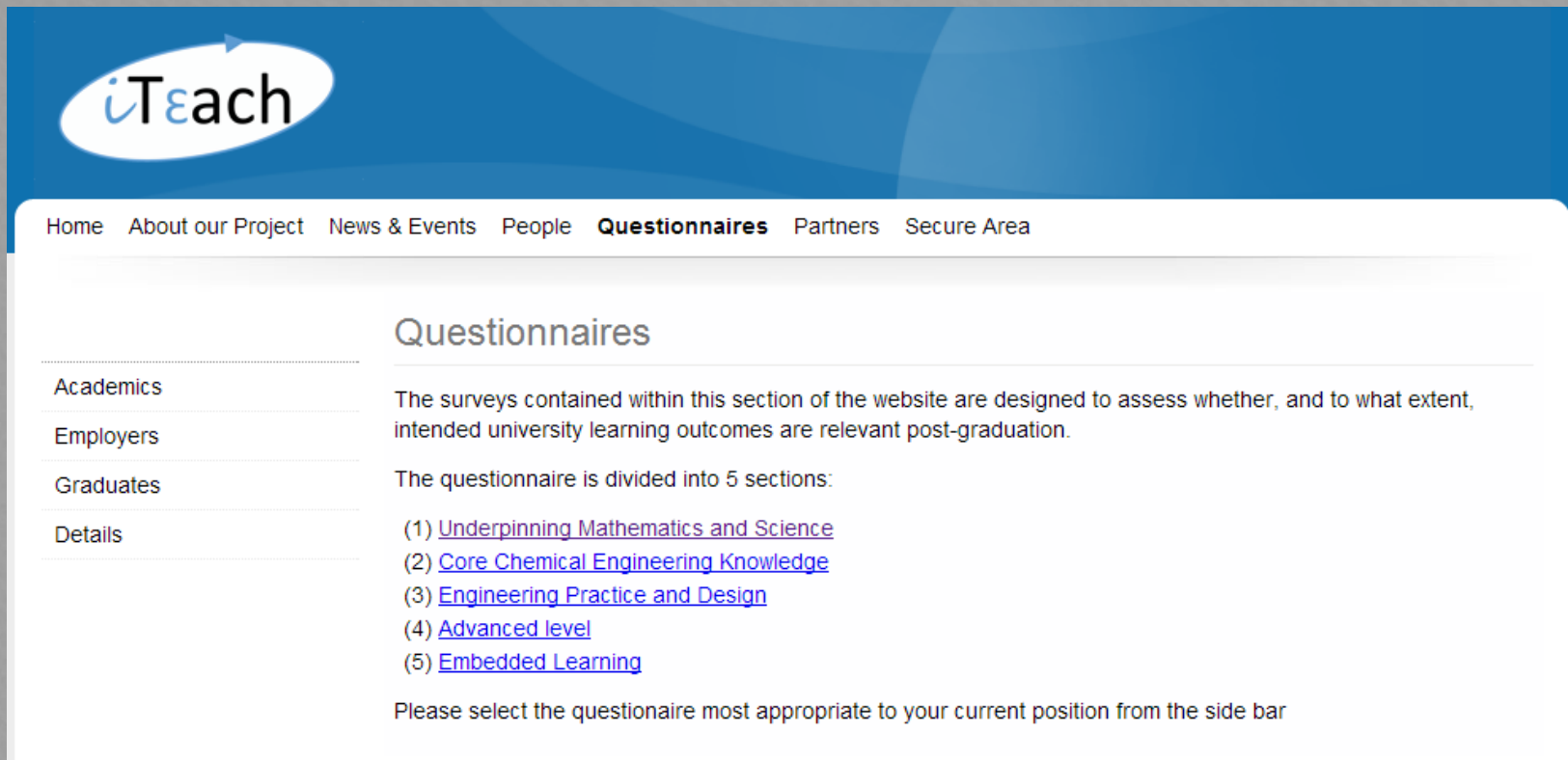


WP 2 : DATA GATHERING

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 screenshot shows the iTeach website interface. At the top left is the iTeach logo. A navigation menu includes Home, About our Project, News & Events, People, **Questionnaires**, Partners, and Secure Area. The main content area is titled "Questionnaires" and contains the following text:

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

On the left side of the page, there is a sidebar with a list of categories: Academics, Employers, Graduates, and Details.

WP2 : DATA ANALYSIS

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

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**.

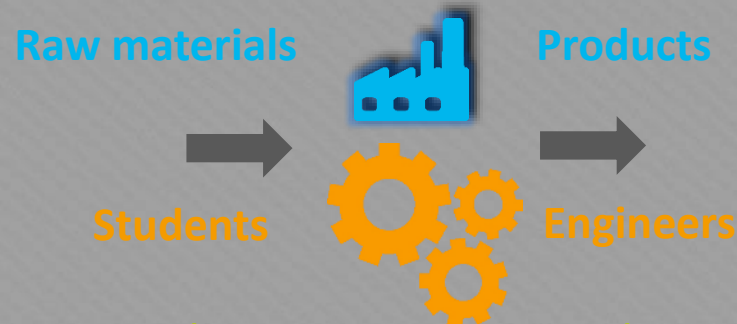


WP 3 : ASSESSMENT FRAMEWORK

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,

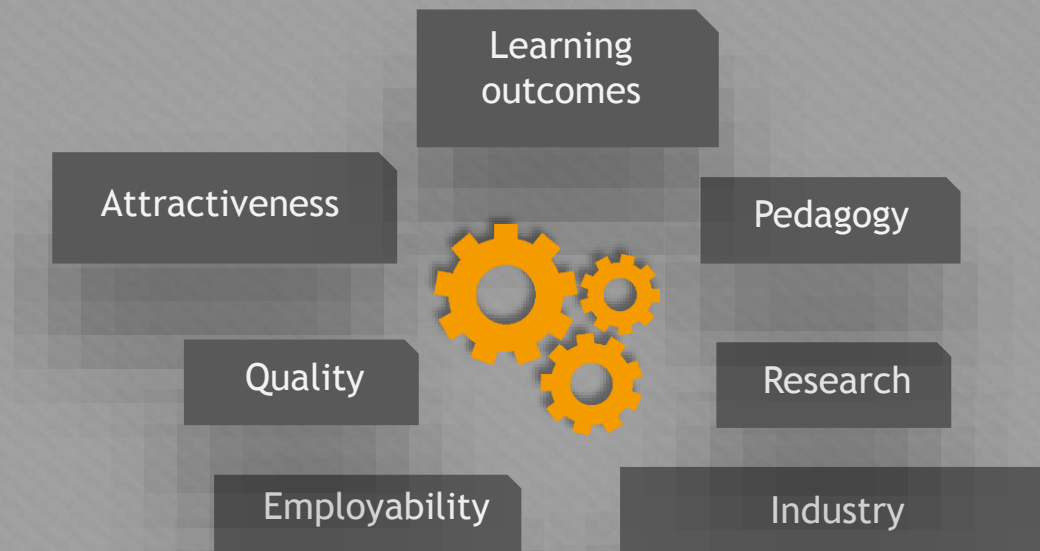
EVALUATION OF A WHOLE FORMATION

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 :

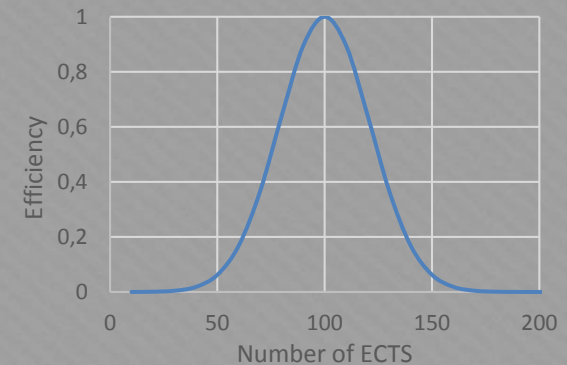


EVALUATION OF A WHOLE FORMATION

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

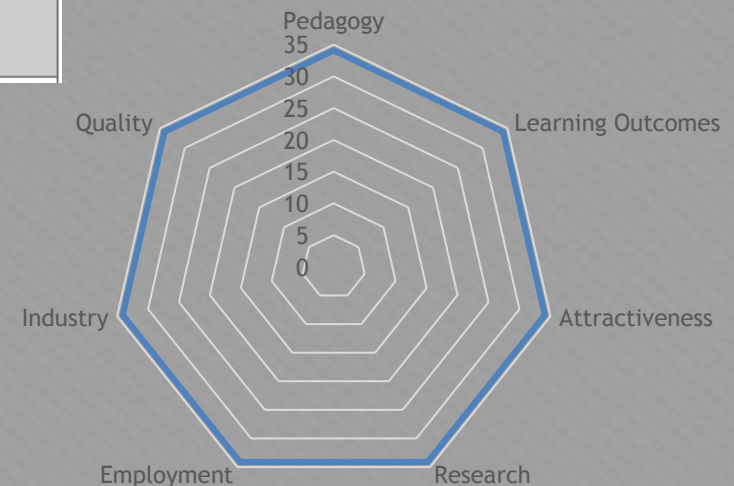
Example, for **pedagogy** :

| <u>Teaching</u> | | <u>Mean value</u> | <u>Standard Deviation</u> | <u>Score</u> |
|-----------------|---|-------------------|---------------------------|--|
| | 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 | $e = 10 \exp\left(-\left(\frac{v - \mu}{\sigma}\right)^2\right)$ |



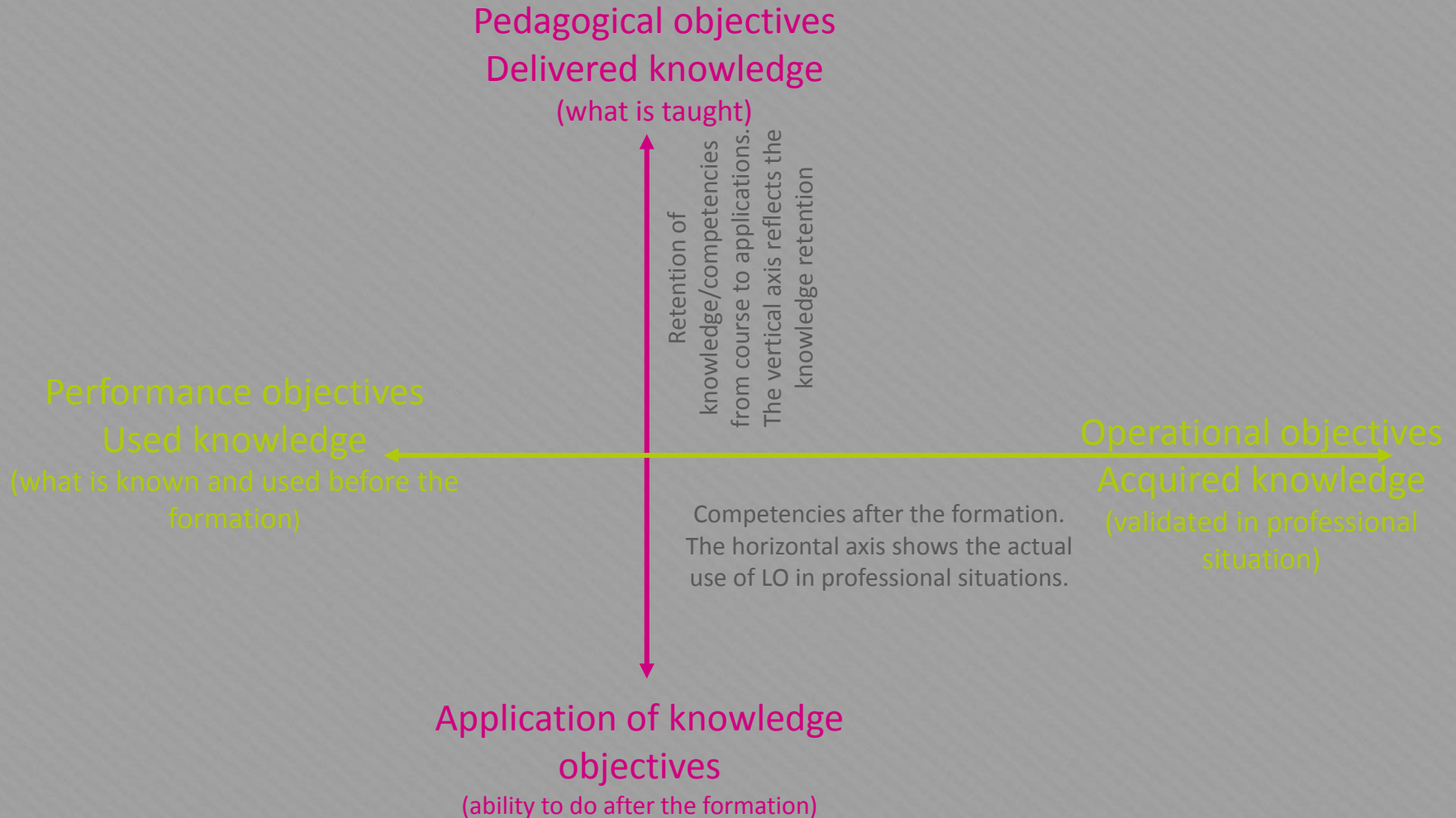
Score of each indicator (on 300) divided by the **cost of formation**, related to the national average salary.

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

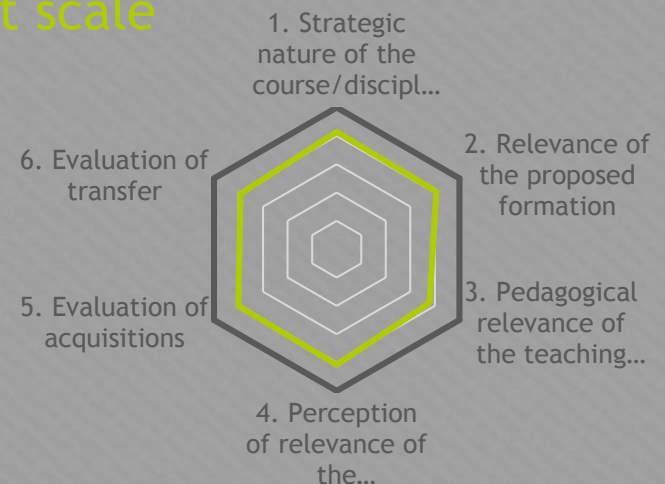
Definition of 6 metrics,

- 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.





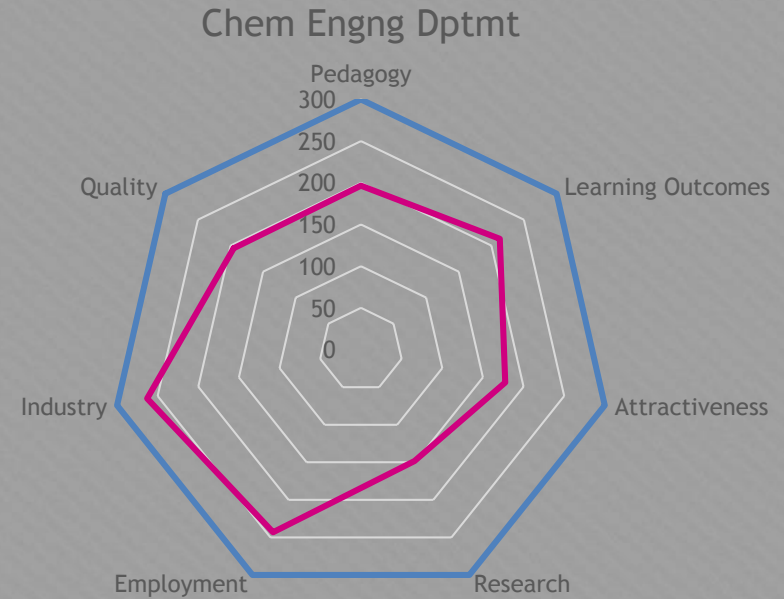
WP 4 : PILOT IMPLEMENTATION

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)

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

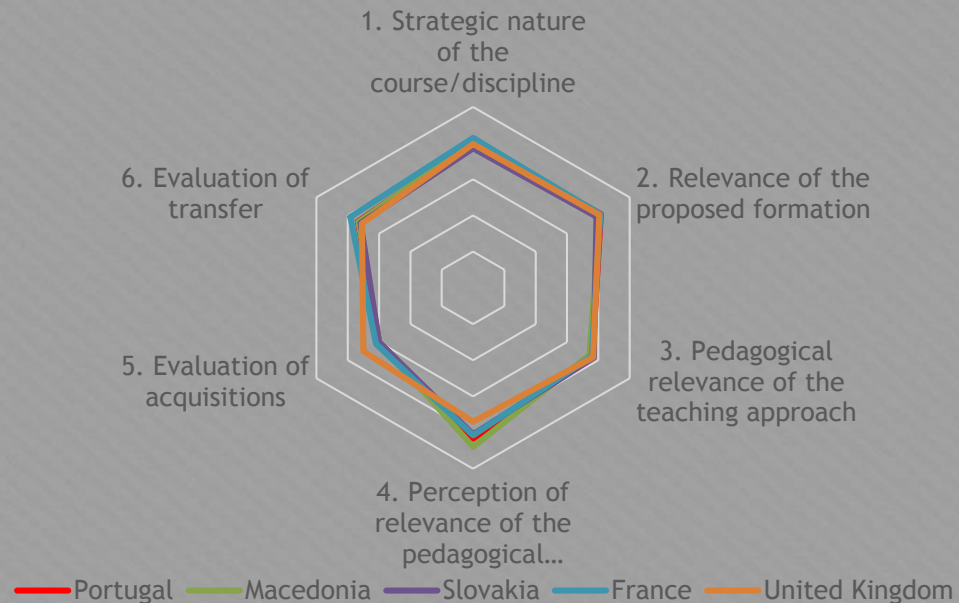
- Academics, 1 : Strongly disagree
- Graduates, 2 : Disagree
- Students, 3 : Neither agree or disagree
- Employers 4 : Agree
- 5 : Strongly agree

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

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

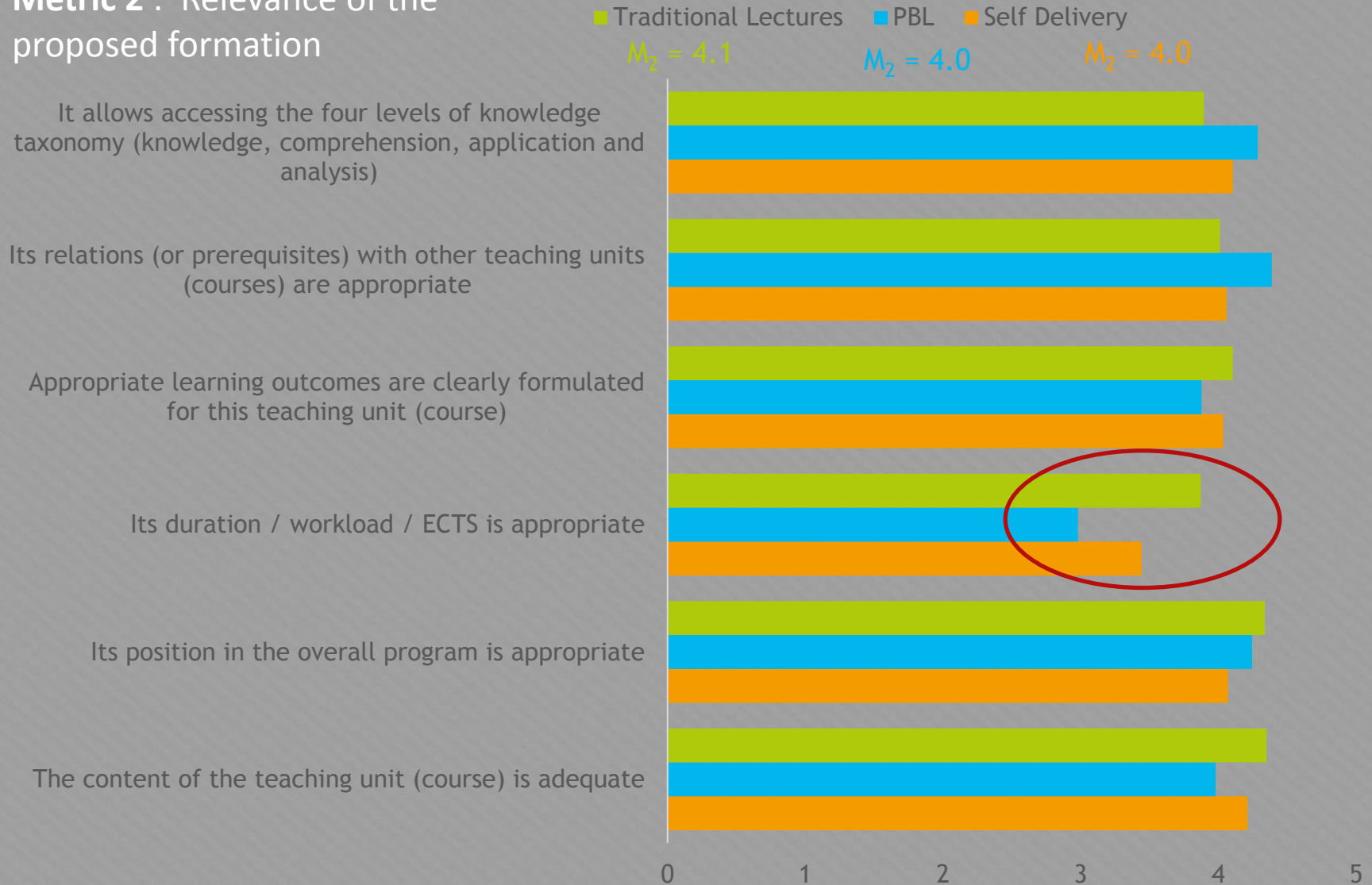
Heat Exchangers in self-delivery : Autoformation, and then
Problem Based Learning applied to the
design of an heat exchanger

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



EVALUATION OF DIFFERENT MODULES

Metric 3 : Pedagogical

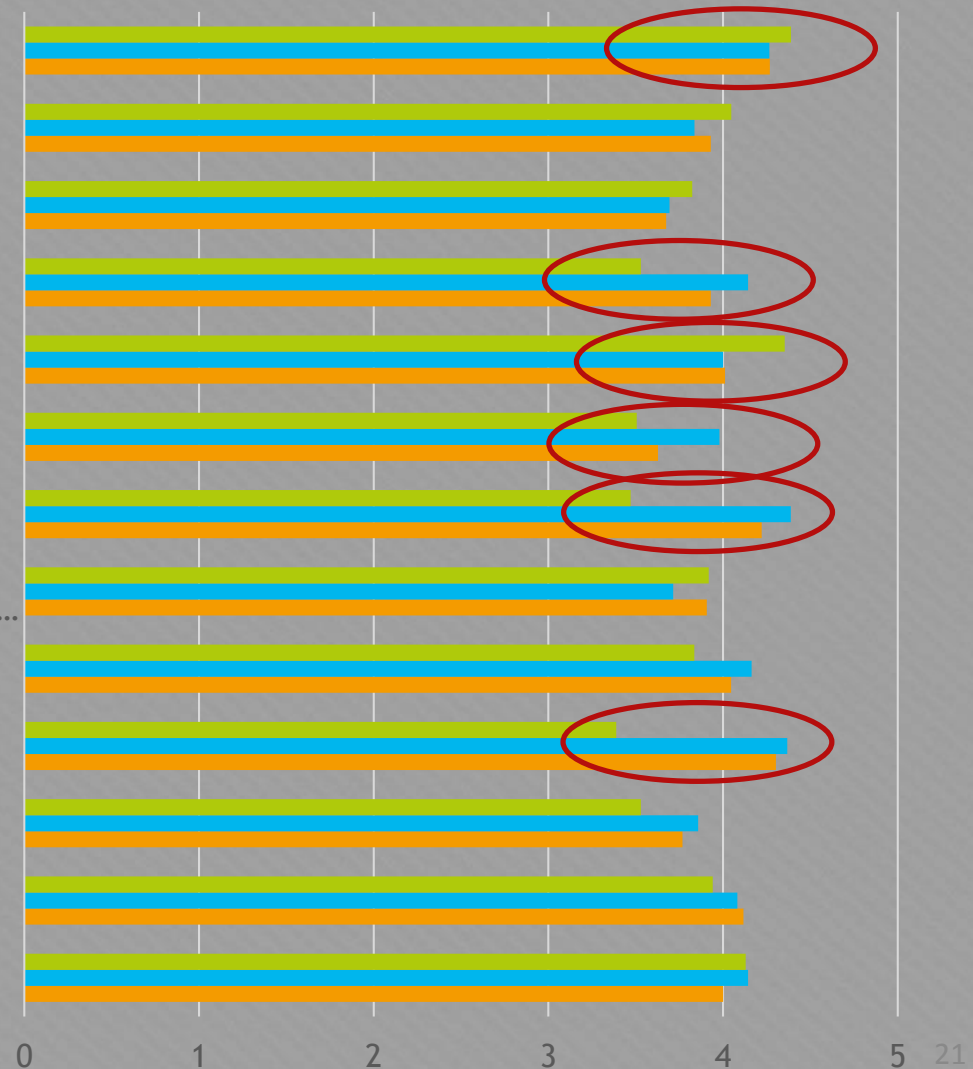
Relevance of the teaching approach

■ 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

$M_3 = 3.7$ $M_3 = 4.0$ $M_3 = 3.9$
■ Traditional lectures ■ PBL ■ Self Delivery

If you needed some explanations you would?

I was able to appraise my progression

The mark you obtained (if already available) reflects my level
and effort

Feedback on examinations/graded materials was valuable

Methods of evaluating student work were fair and appropriate

Further reading, homework, laboratories (if applicable)
contributed to the appreciation and understanding of the...

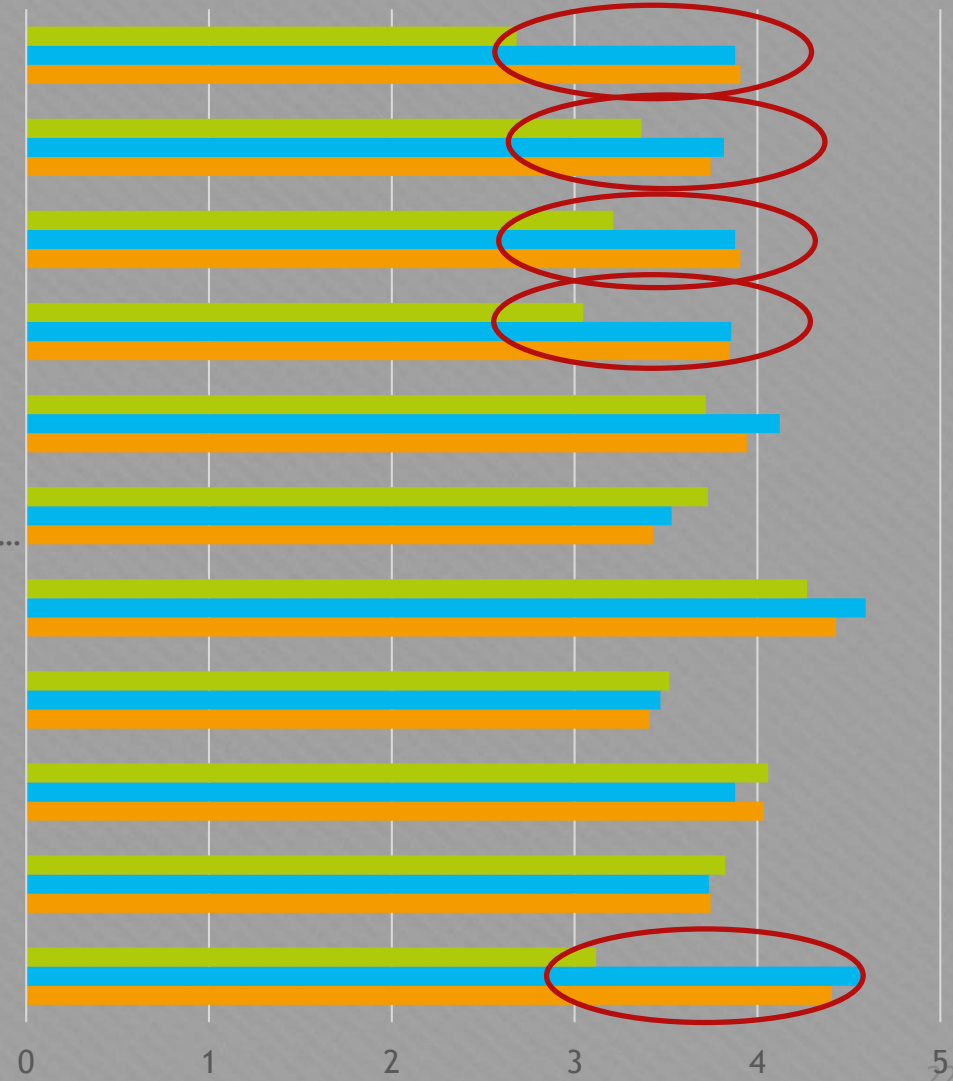
I understand the relevance of the topic for my future profession

The balance between classical and active learning was
adequate

Proposed objectives agreed with those actually taught, so you
knew where the course was going

The breadth of the teaching unit (course) was appropriate

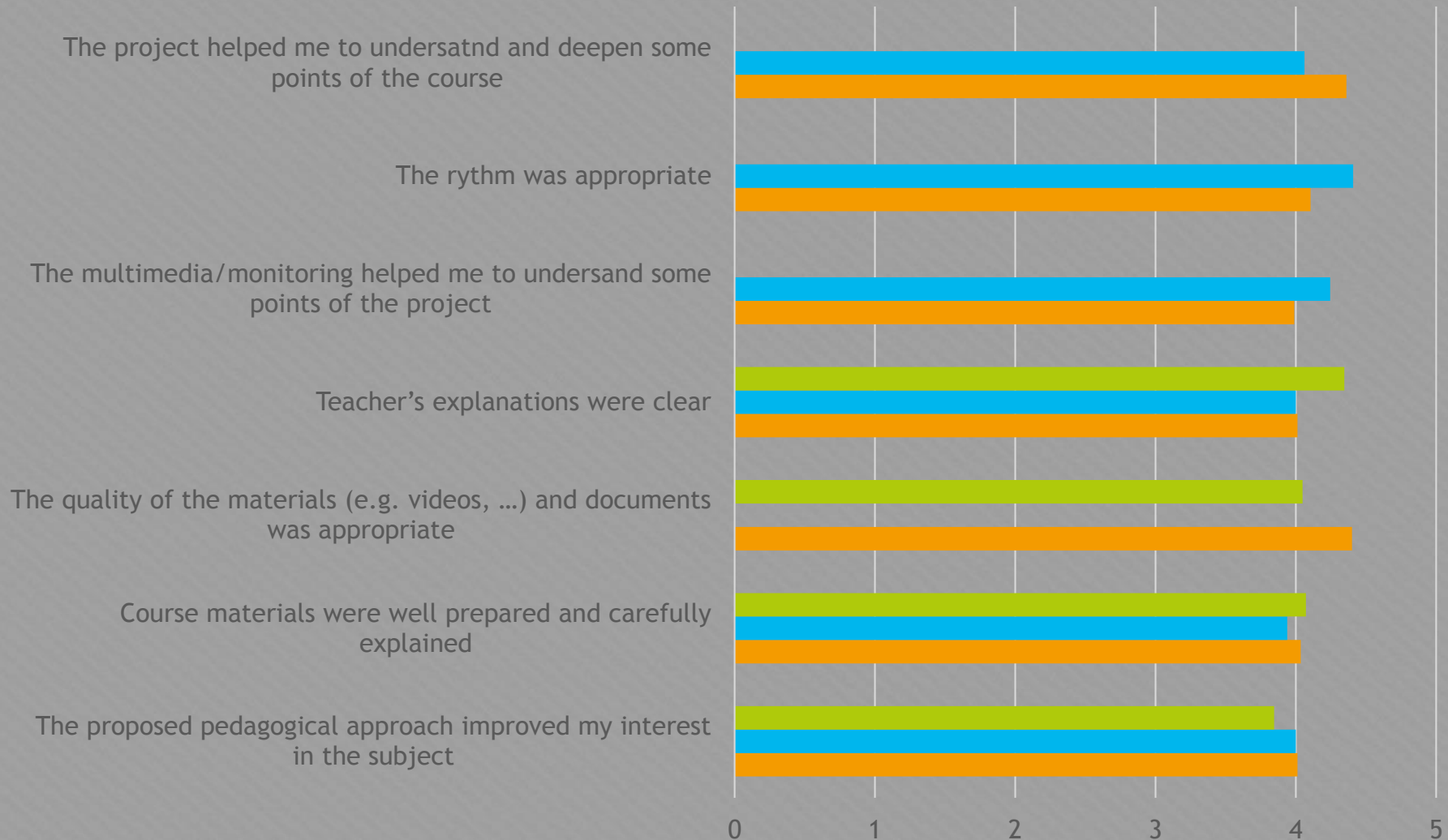
Group interactions were encouraged



EVALUATION OF DIFFERENT MODULES

Metric 4 : Relevance of the proposed formation

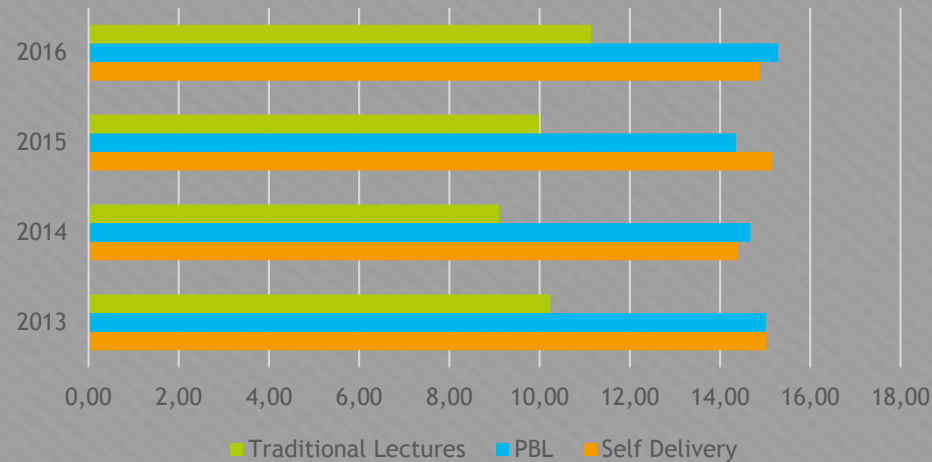
$M_4 = 4.1$ $M_3 = 4.1$ $M_3 = 4.1$
■ Traditional Lectures ■ PBL ■ Self Delivery



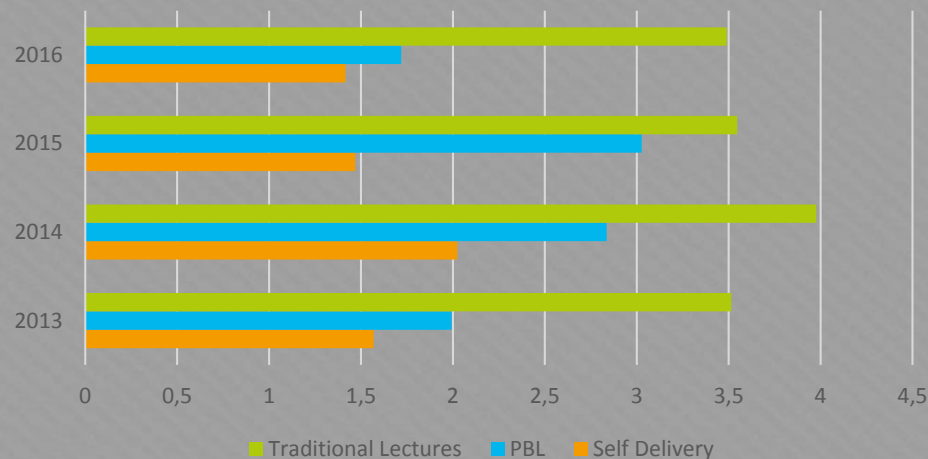
EVALUATION OF DIFFERENT MODULES

Metric 5 : Evaluation of acquisitions

Average marks



Standard deviations

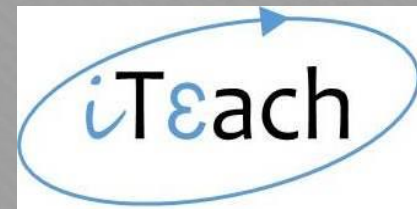


CONCLUSIONS

- 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.



Lifelong
Learning
Programme



THANK YOU FOR
YOUR ATTENTION

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

Final iTeach conference
tomorrow, Tuesday 30 august



CHISA 2016 PRAGUE
PRES 2016

27-31 AUGUST 2016
PRAGUE, CZECH REPUBLIC



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