IMPROVING TEACHING EFFECTIVENESS IN CHEMICAL ENGINEERING EDUCATION

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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

Newcastle University

UNIVERSITÉ DE LORRAINE

U.PORTO

INTERNATIONAL BALKAN UNIVERSITY

STU
SLOVENSKÁ TECHNICKÁ UNIVERZITA V BRATISLAVE

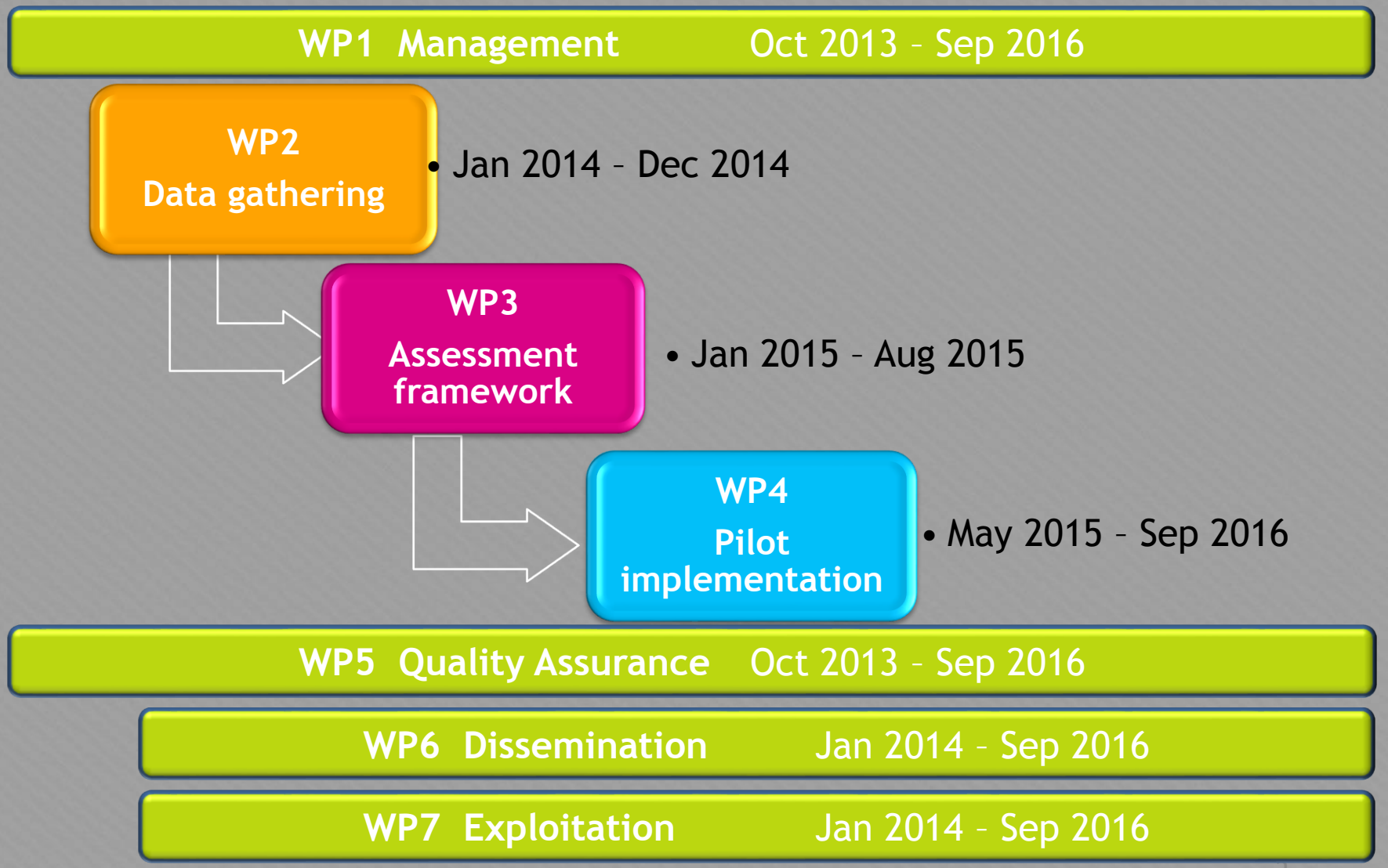
technische universität dortmund

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

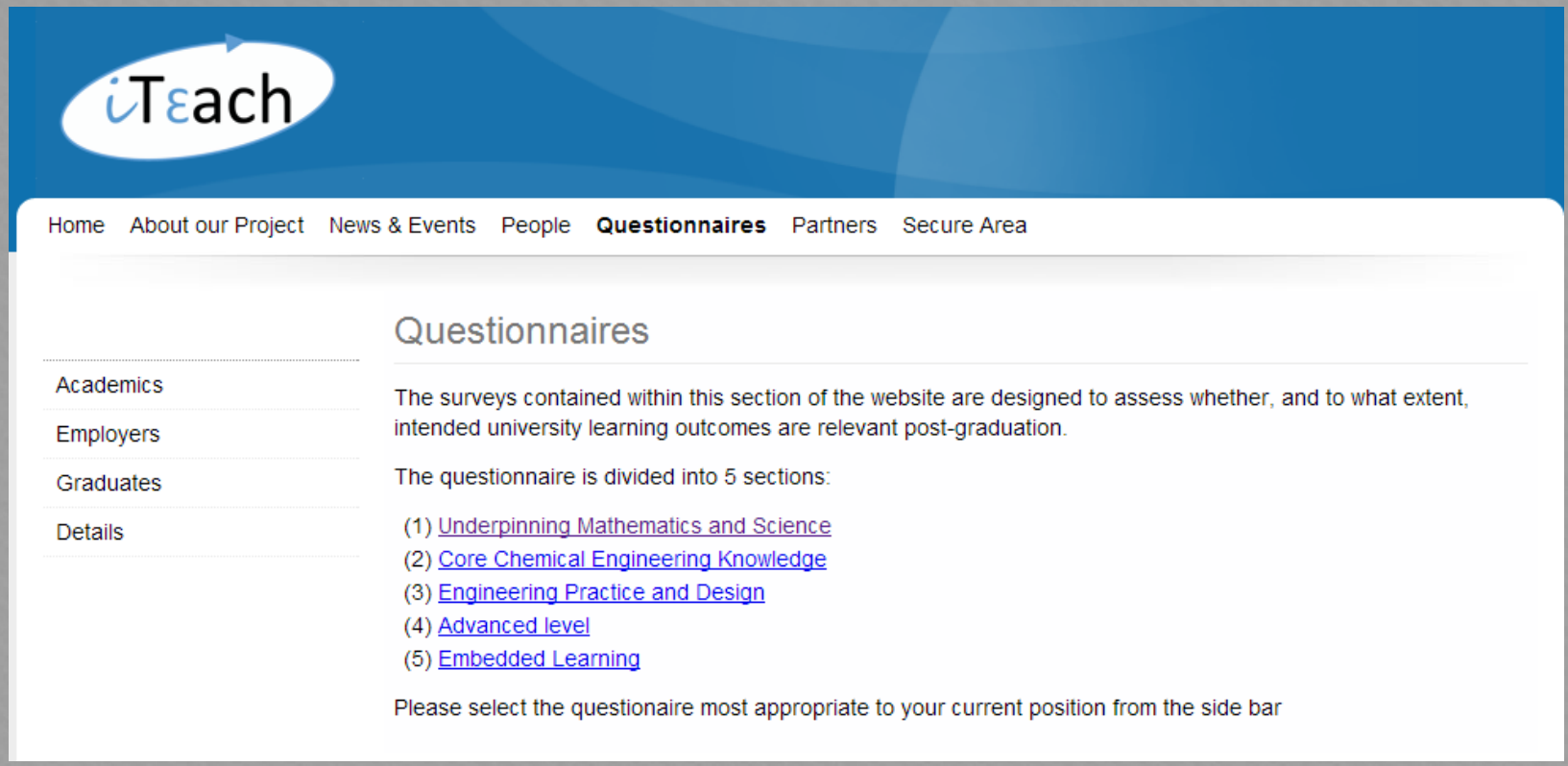


WP 2 : DATA GATHERING

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



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.

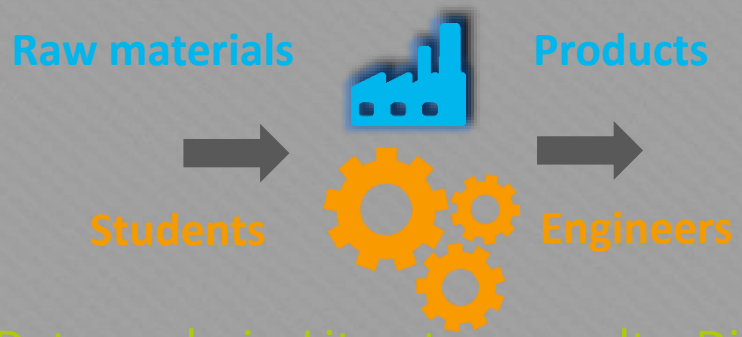
- The analysis re-enforced the initial findings of the questionnaires.
- It also indicated the concerns regarding the validity and the robustness of the current methods of assessing the effectiveness of delivery…
- Although no specific suggestions for better means were introduced.

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



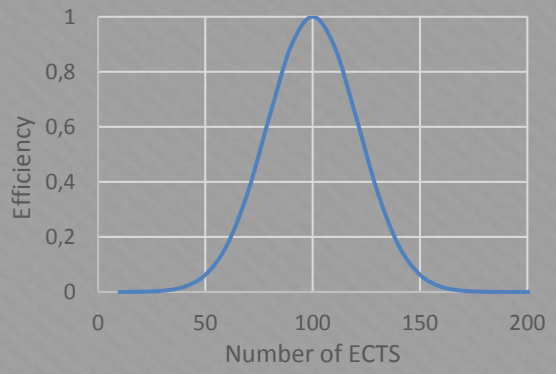
Using WP2 Results, Data analysis, Literature results, Discussions with Stakeholders, Decision matrix…

Definition of 160 parameters, gathered in 7 global indicators :

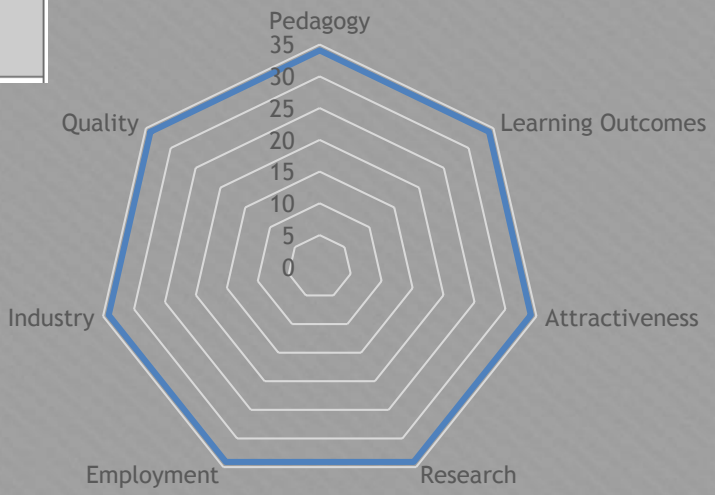
EVALUATION OF A WHOLE FORMATION

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

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	$e = 10 \exp\left(-\left(\frac{v-\mu}{\sigma}\right)^2\right)$



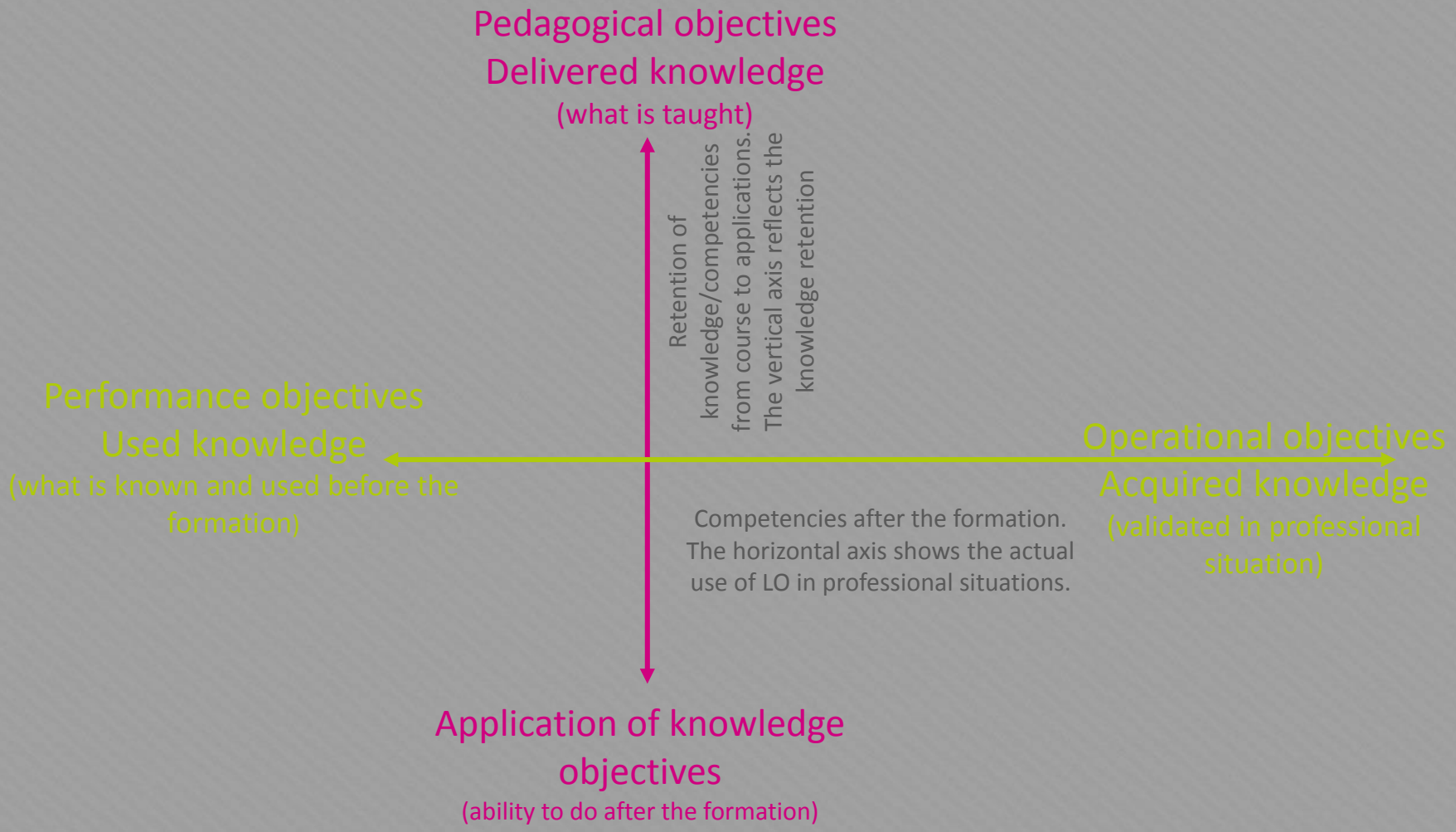
Score of each indicator (on 300) divided by the cost of formation, related to the national average salary.



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

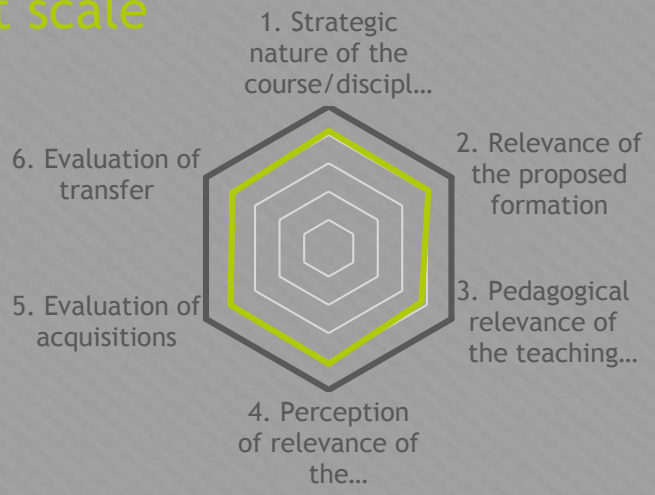
Definition of 6 metrics,

- 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.



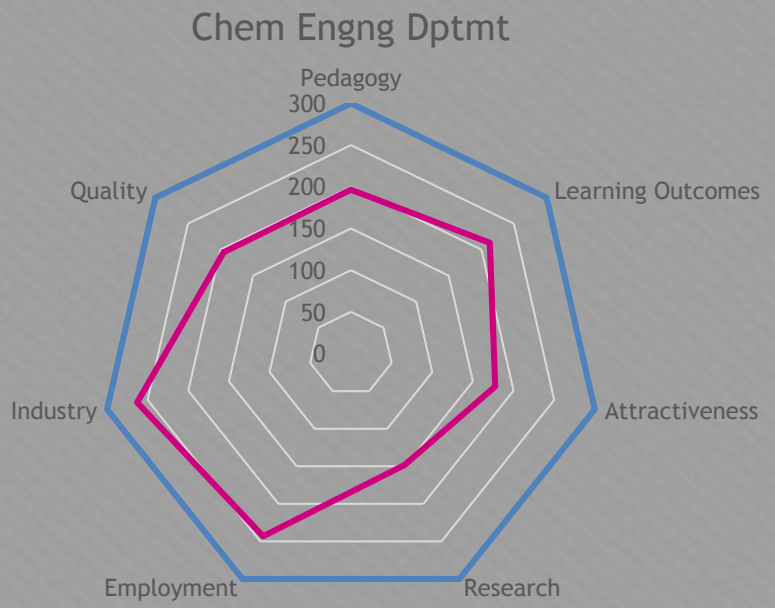
WP 4 : PILOT IMPLEMENTATION

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)

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

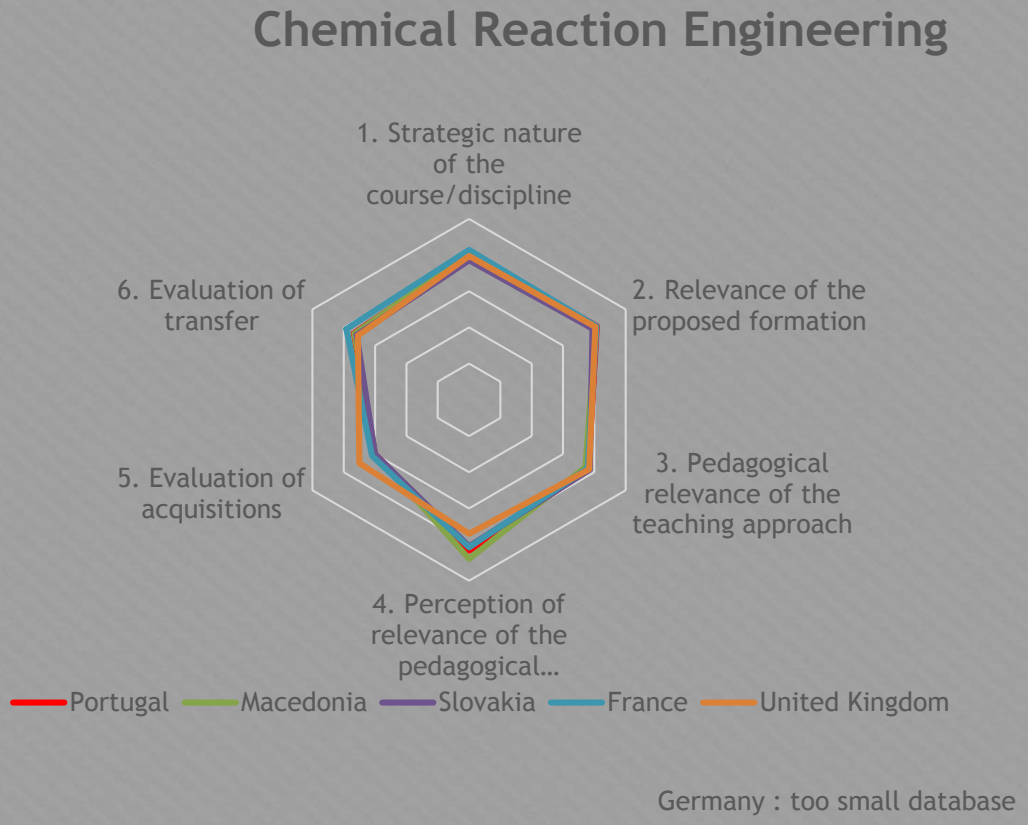
- Academics,
- Graduates,
- Students,
- Employers

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 !



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

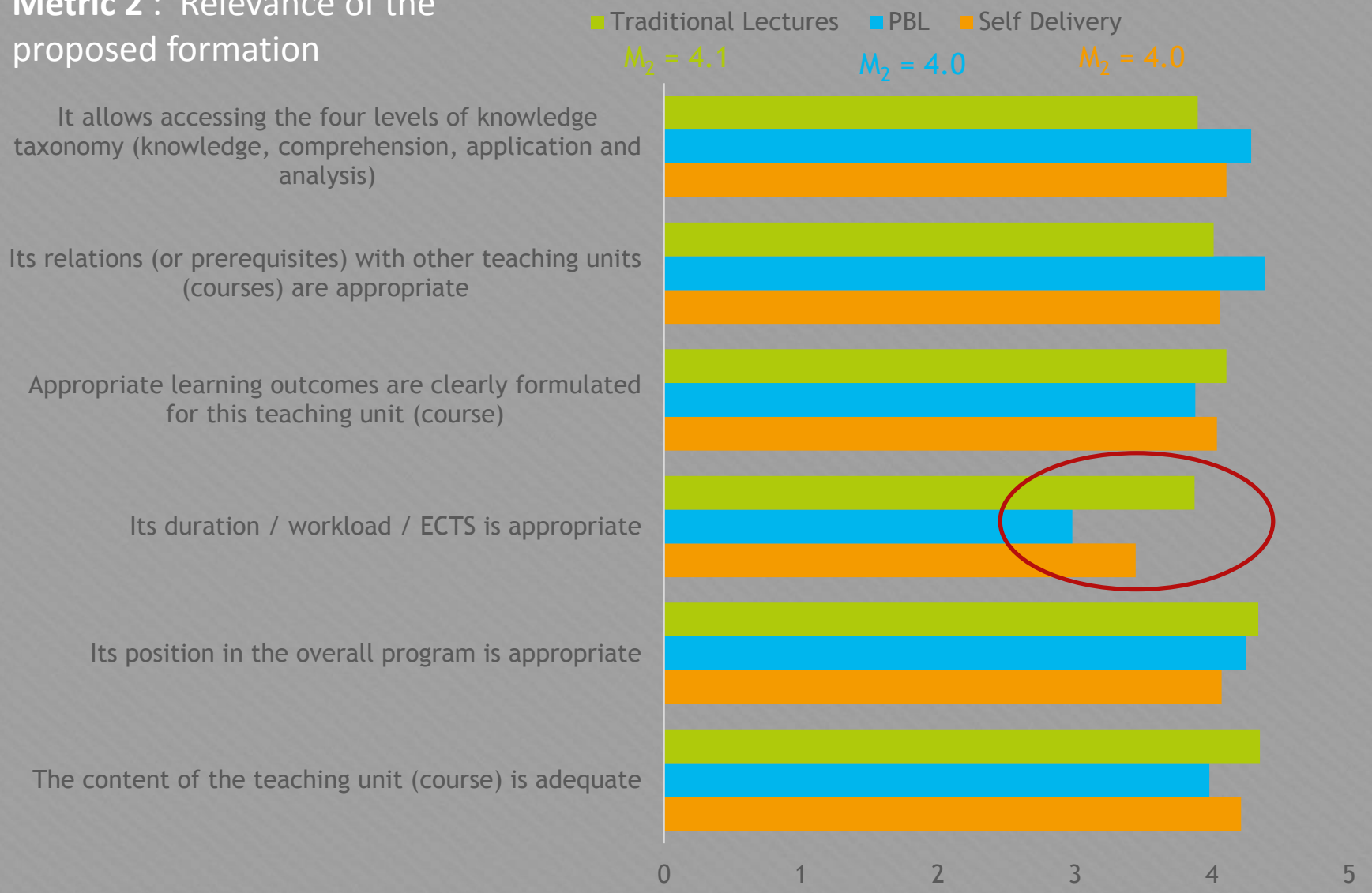
Heat Exchangers in self-delivery : Autoformation, and then Problem Based Learning applied to the design of an heat exchanger

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~~

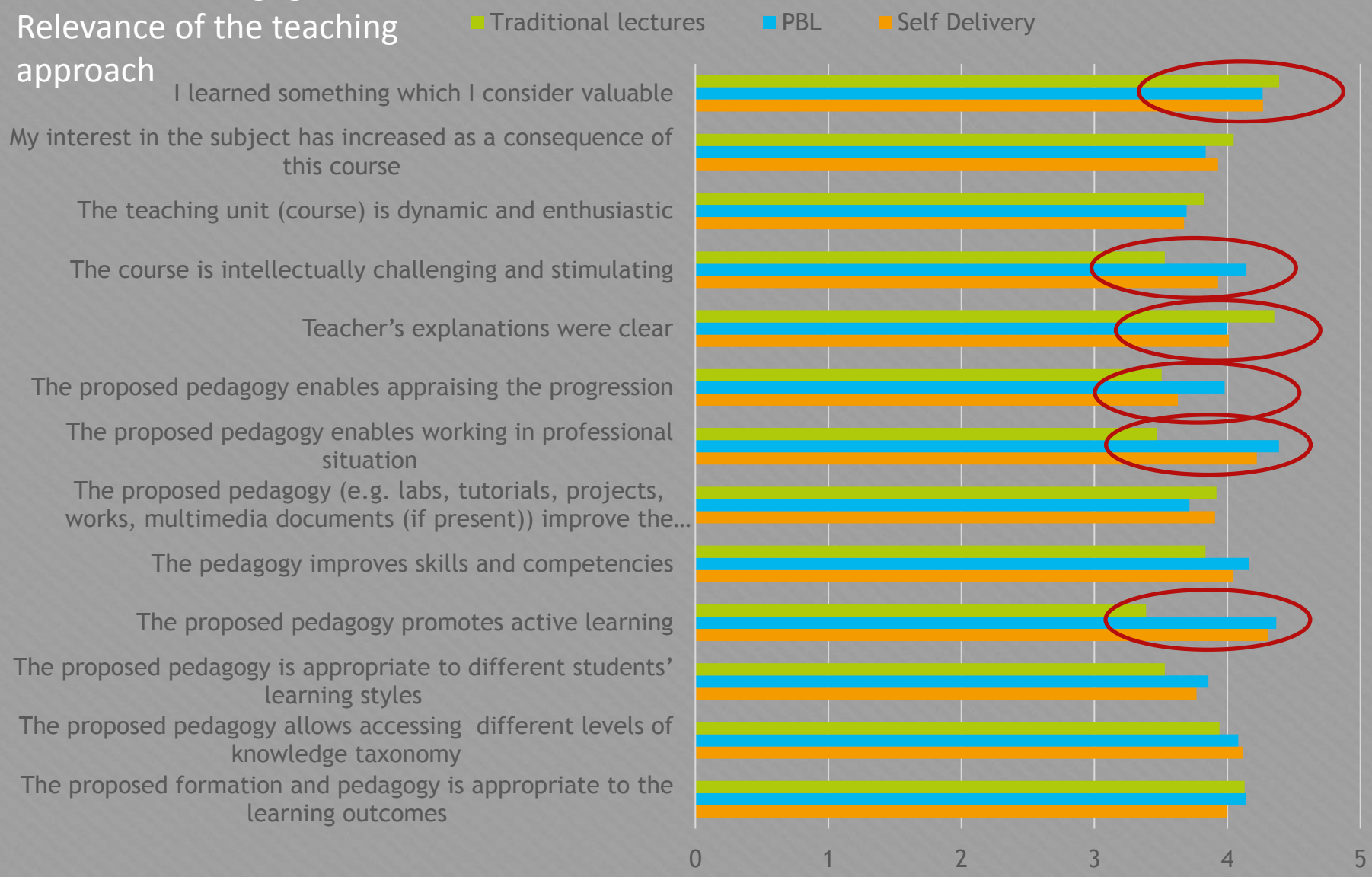
EVALUATION OF DIFFERENT MODULES

Metric 2 : Relevance of the proposed formation



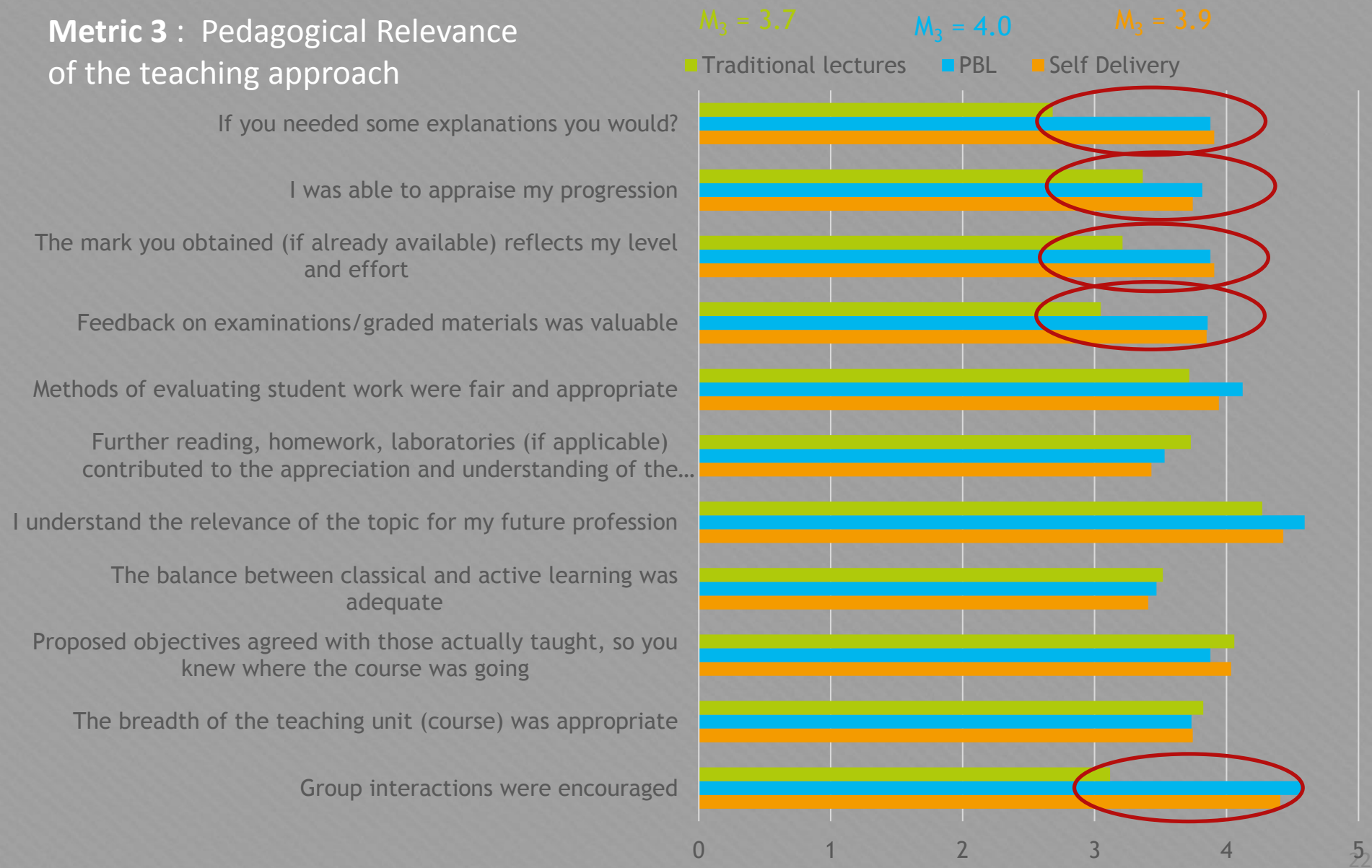
EVALUATION OF DIFFERENT MODULES

Metric 3 : Pedagogical Relevance of the teaching approach



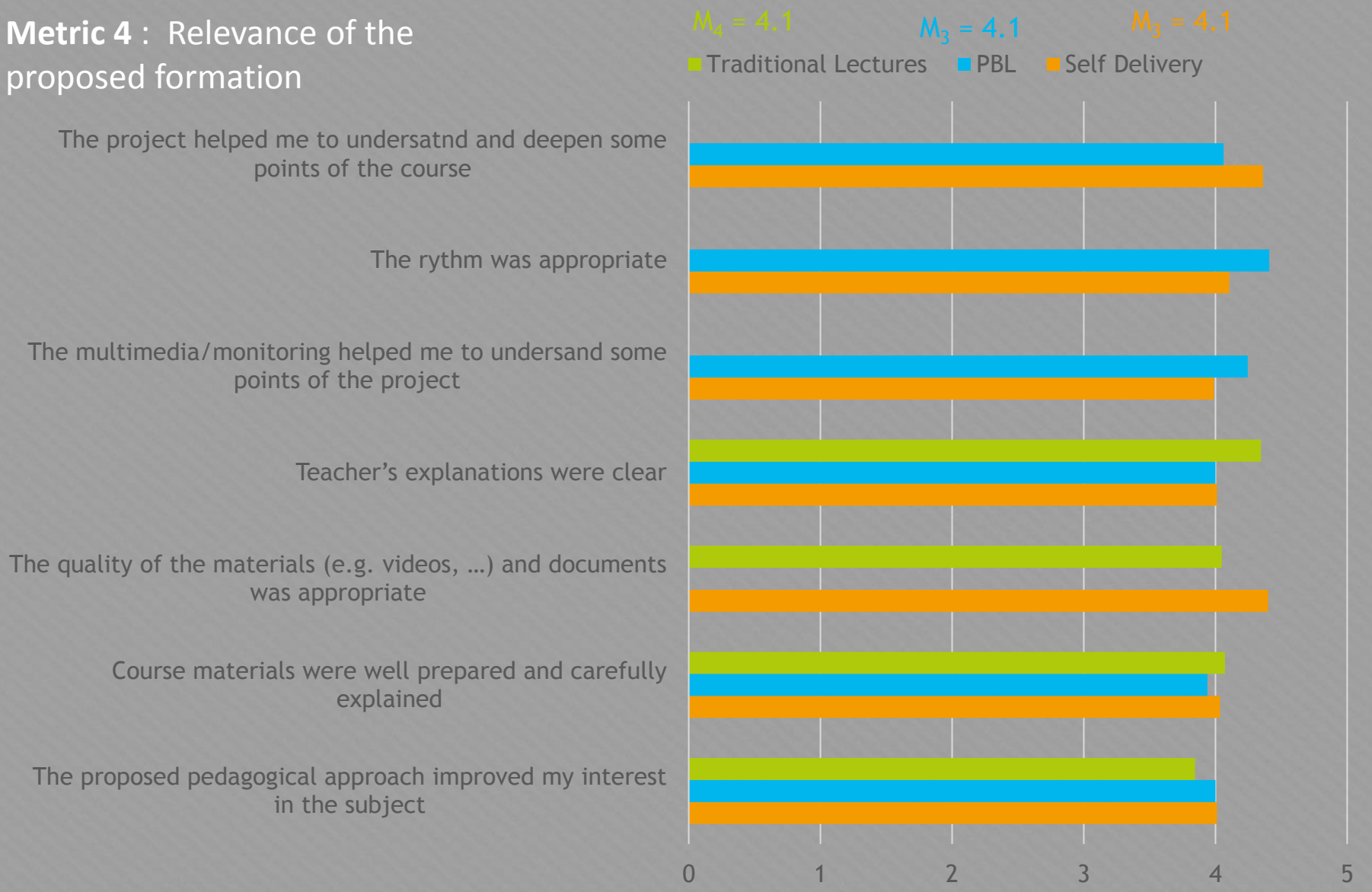
EVALUATION OF DIFFERENT MODULES

Metric 3 : Pedagogical Relevance of the teaching approach



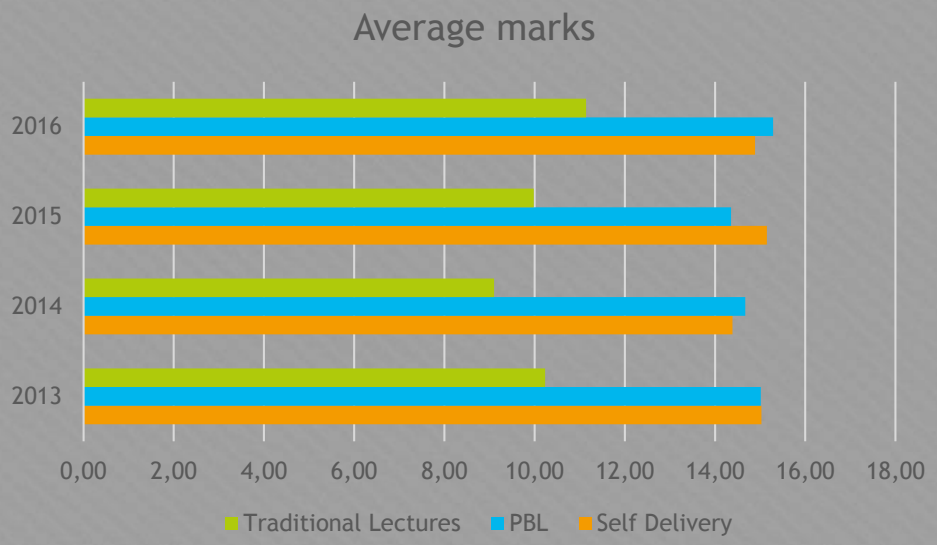
EVALUATION OF DIFFERENT MODULES

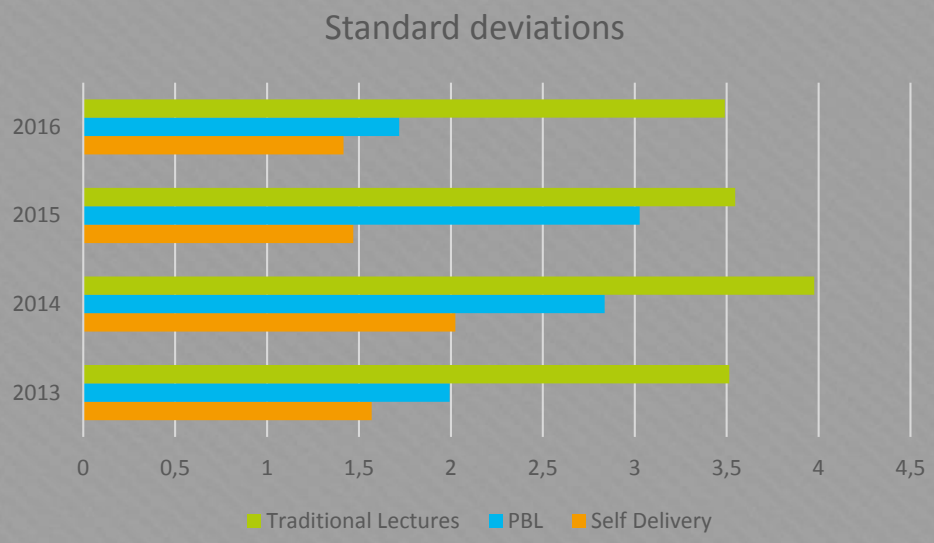
Metric 4 : Relevance of the proposed formation



EVALUATION OF DIFFERENT MODULES

Metric 5 : Evaluation of acquisitions





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

iTeach

THANK YOU FOR YOUR ATTENTION

http://www.iteach-chemeng.eu

Final iTeach conference
tomorrow, Tuesday 30 august