Efficiency of teaching core knowledge and employability competencies in chemical engineering education

Prof Jarka Glassey
School of Chemical Engineering and Advanced Materials
Newcastle University, England
jarka.glassey@ncl.ac.uk

Newcastle University

iTeach

ChemEng Education

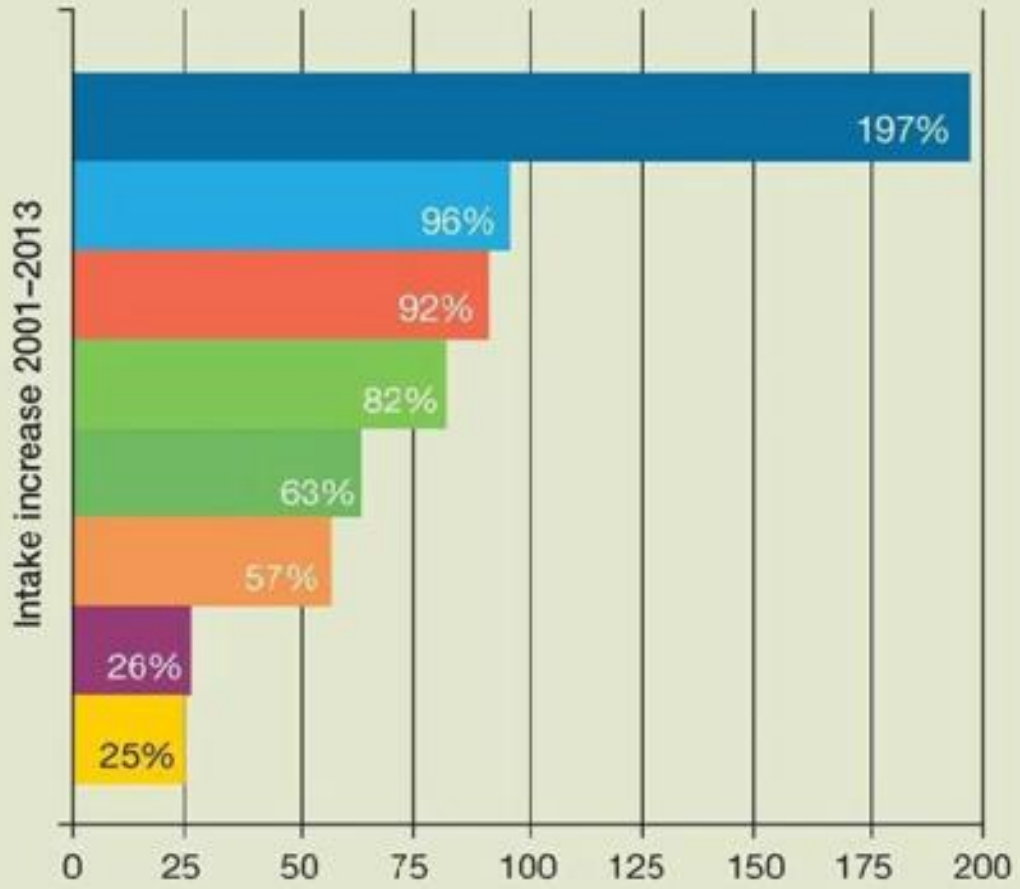
At a (relatively) recent ChemEng Matters workshop we were asked to define **'why we do this'**

"We do this because the world needs people to safely and sustainably create the products and processes that make better stuff, from ordinary stuff without making bad stuff. This is done through continuous improvement that enhances quality of life for all."

Education challenges

Source: adapted from UCA

Figure 1: growth in UK student intake by subject



Student figures

- Chemical engineering (940–2,790)
- Maths (4,006–7,685)
- Mechanical engineering (3,726–7,139)
- Physics (2,612–4,745)
- Civil engineering (2,362–3,863)
- Chemistry (3,059–4,811)
- Electrical/electronic engineering (3,557–4,468)
- Biology (4,697–5,890)

Drivers

IChemE Technical Roadmap, 2012

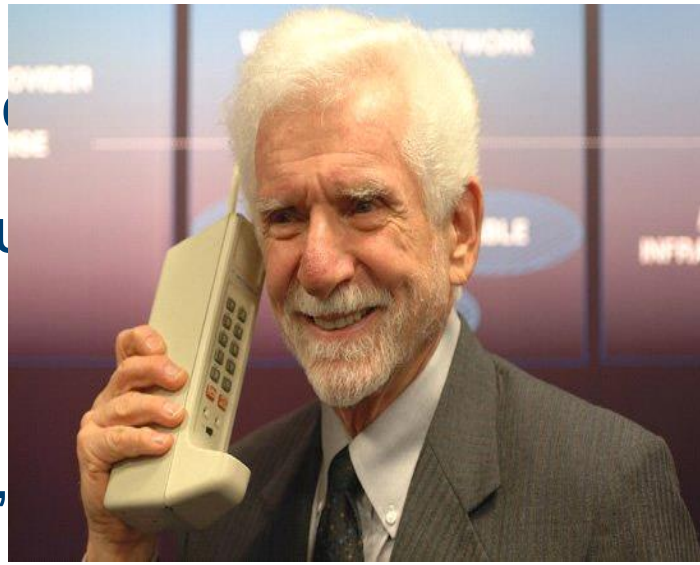
Education challenges

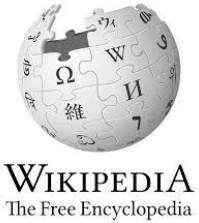
- How do we ensure ‘quality experience’ for the increasing student numbers?
- Lab provision, tutorials, placement pr

old’ numerou

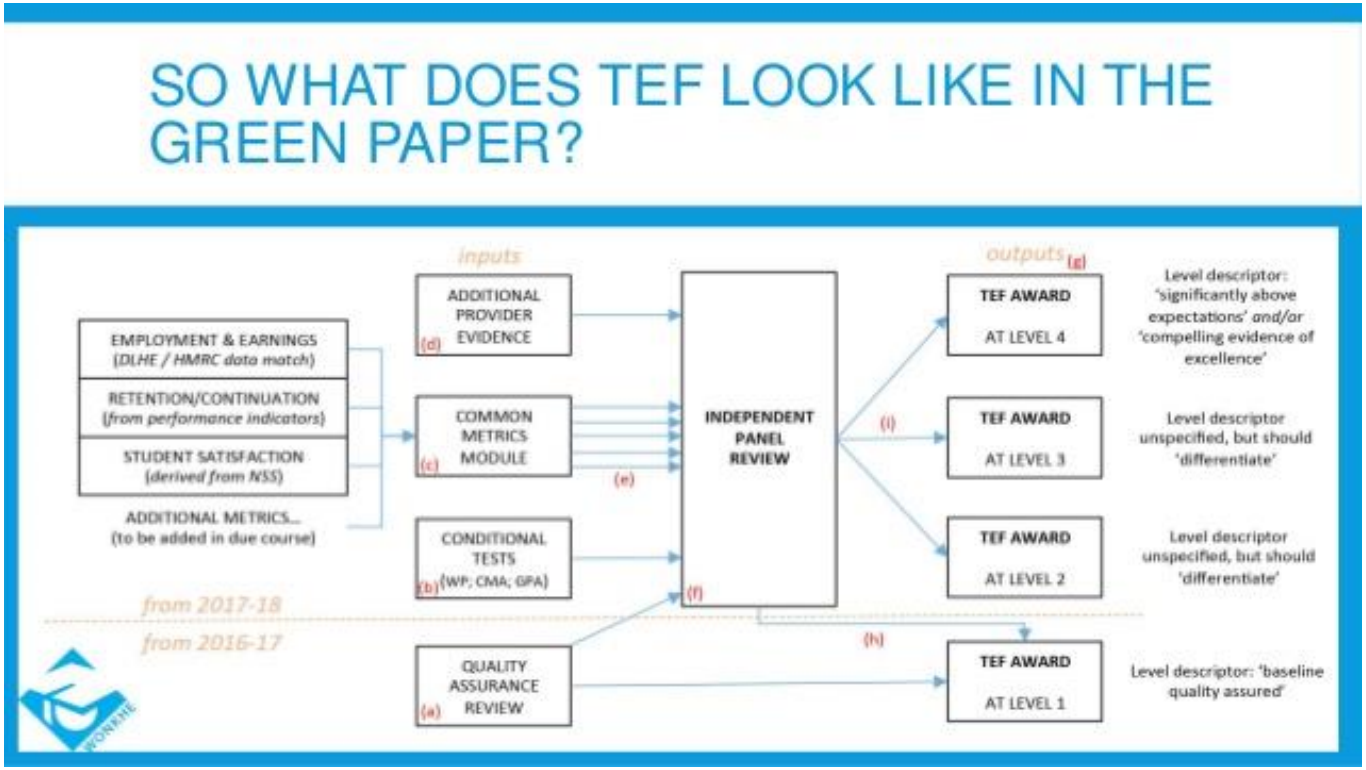
arter’ things

xpectations,





and of course TEF



https://www.heacademy.ac.uk/blog/tef-consultation-implementation-professor-stephanie-marshall-hea

Effectiveness and efficiency

Jarka Glassey

Newcastle University

Eric Schaer

UNIVERSITÉ DE LORRAINE

Verka Meshko

INTERNATIONAL BALKAN UNIVERSITY

Luis Miguel Madeira

U.PORTO

Milan Polakovic

STU

SLOVENSKÁ TECHNICKÁ UNIVERZITA V BRATISLAVE

Norbert Kockmann

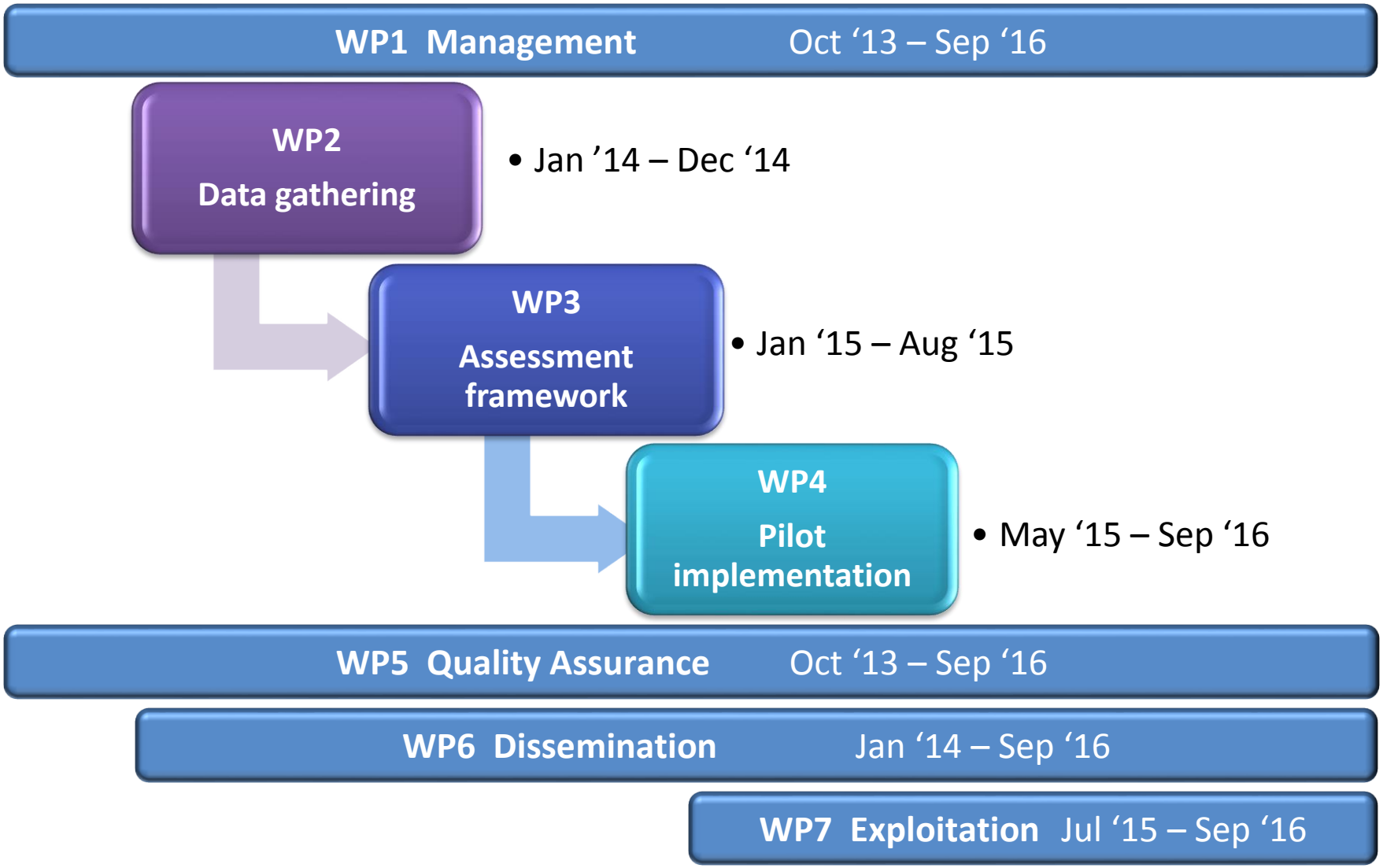
technische universität dortmund

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

iTeach aim

- develop a framework which will support the assessment of teaching effectiveness (efficiency) in delivering not only core chemical engineering knowledge, but also core employability competencies.
- More detail on www.iteach-chemeng.eu

Project overview

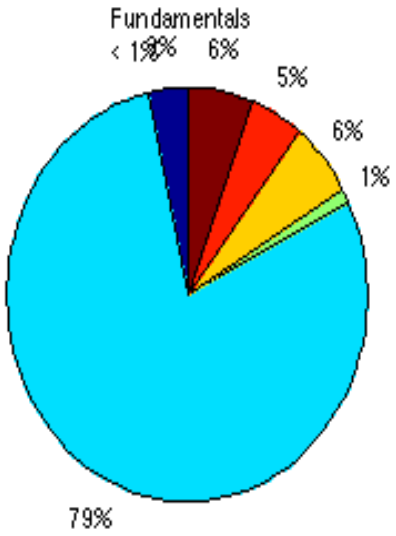


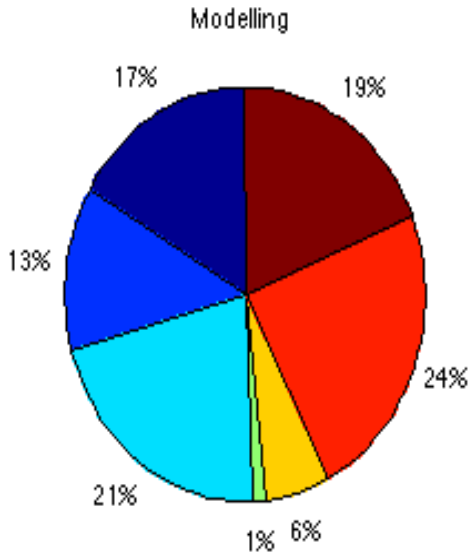
Effectiveness

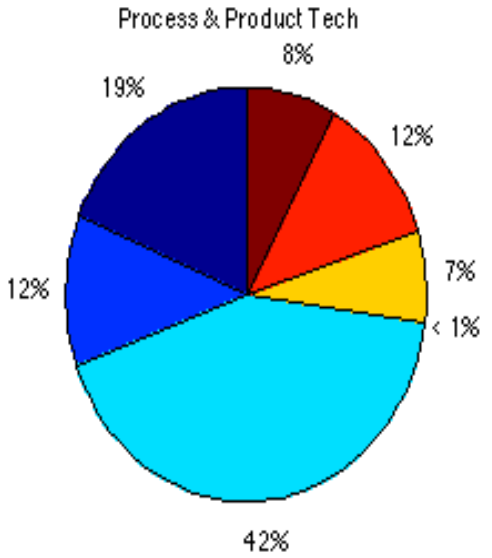
- Review of various (inter)national CE accreditation requirements
- List of learning outcomes (LO) collated
- Survey sent to academics, industrialists and graduates on the importance of knowledge, skill and competency areas (> 260 valid responses)
- Clear agreement of all groups on the LO with only minor differences based on geographical or sectoral variations
- Importance of fundamentals, but also core competencies

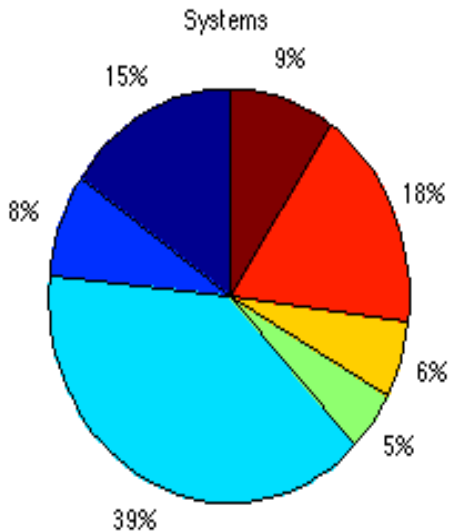
Predominant methods of delivery

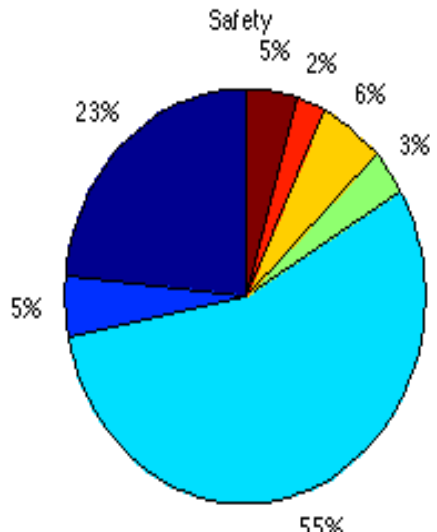
Current position

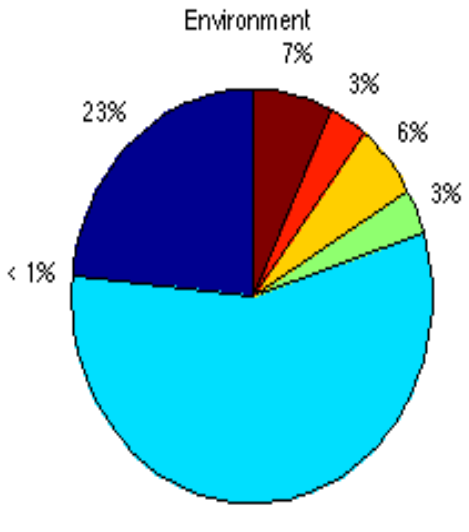










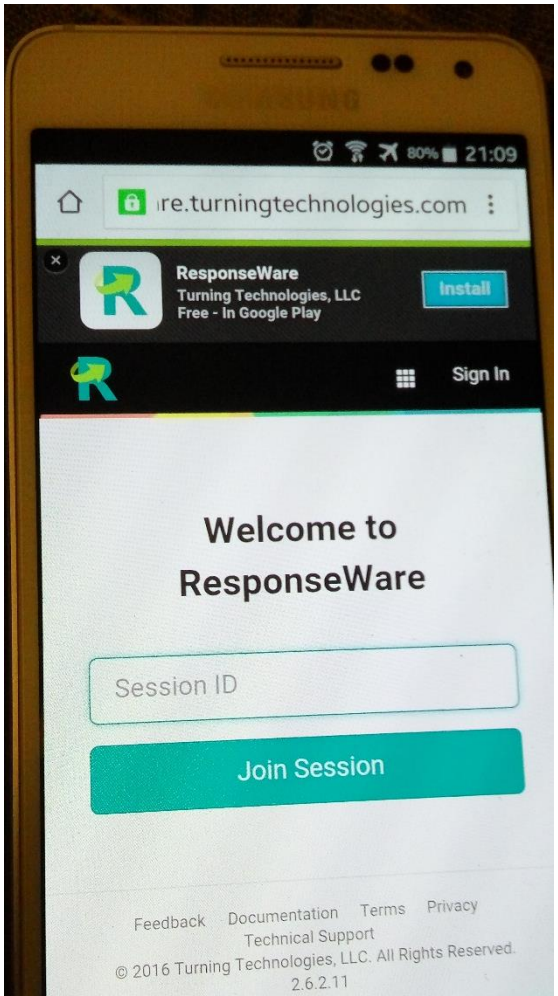


Some examples - flipped lectures

- Growing literature evidence on their effectiveness
- Example of using this approach in Stage 4 Bioreactor engineering module
- Only 4 tutor led lectures
- Groups of students selecting a topic, finding a journal article, learning the principles, critically evaluating the results/research
- 15 min presentation to the whole class

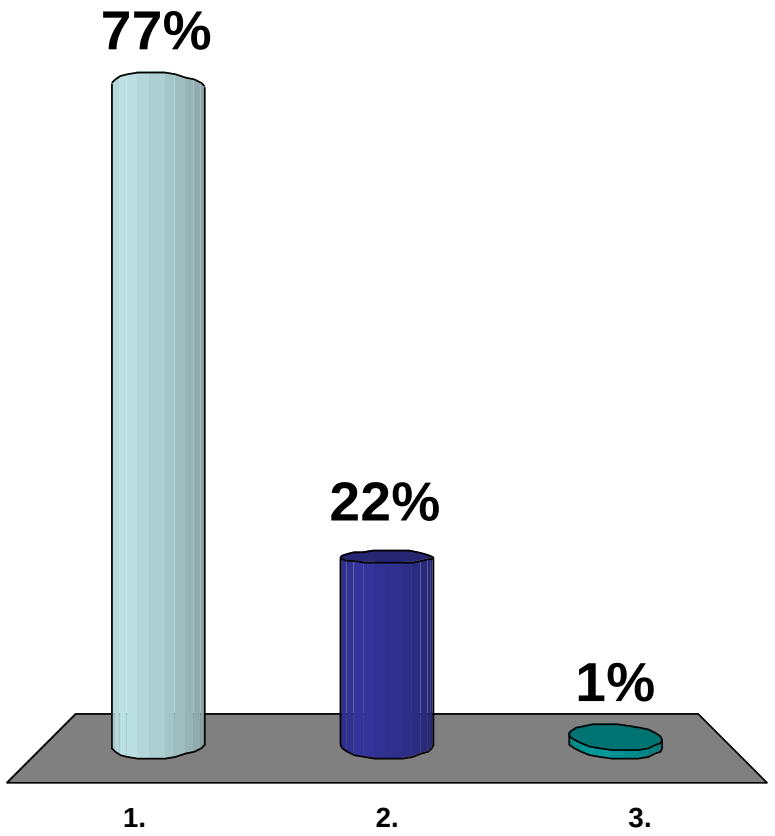
Engagment in lectures

- Expectation raising - ‘Why’ questions at the start
- Use of electronic voting



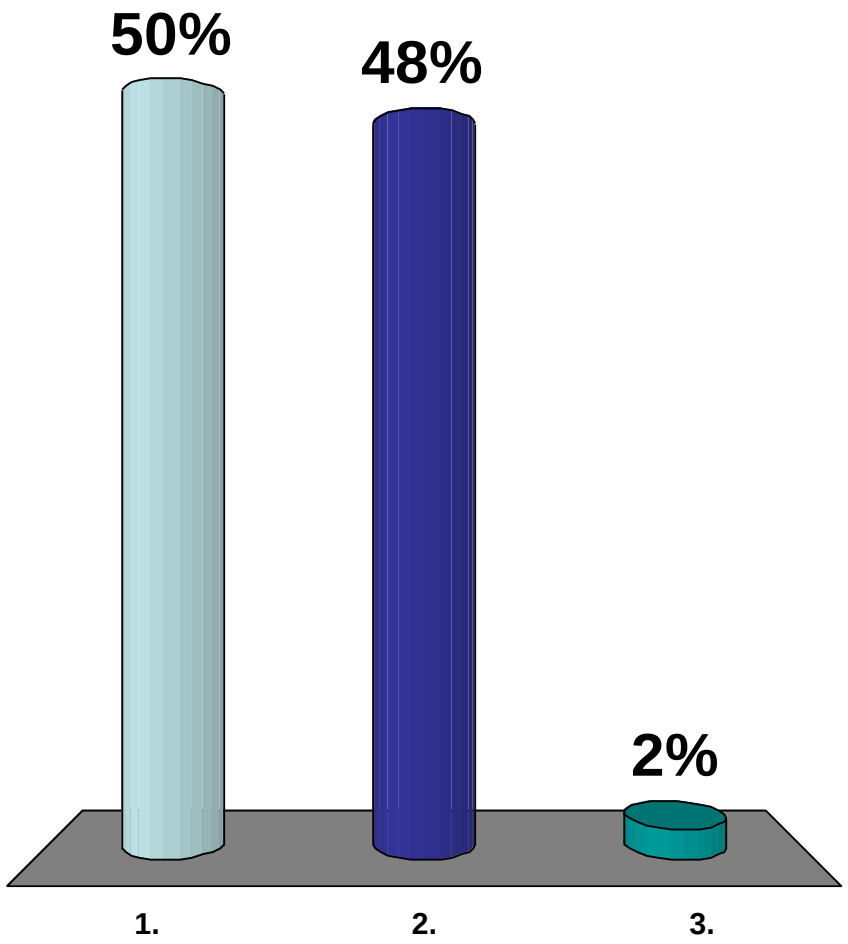
If activities of two enzymes are: E_1 = 0.05 kat and E_2 = 500 U is the activity:

1. $E_1 > E_2$
2. $E_1 < E_2$
3. $E_1 = E_2$



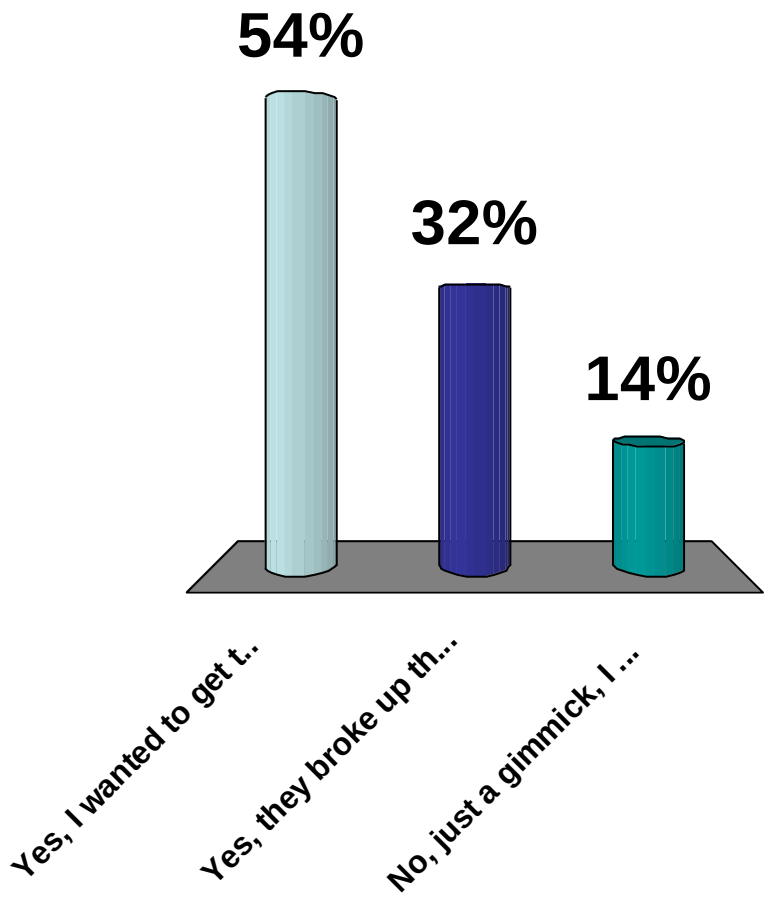
Given that 10^{-6} is the required sterility level and 10^{11} initial conc. of contaminants, D at 120 ^{0}C = 1.5 min, F =

1. 15 min
2. ✓ 25.5 min
3. 16.5 min



The clickers concentrated my attention

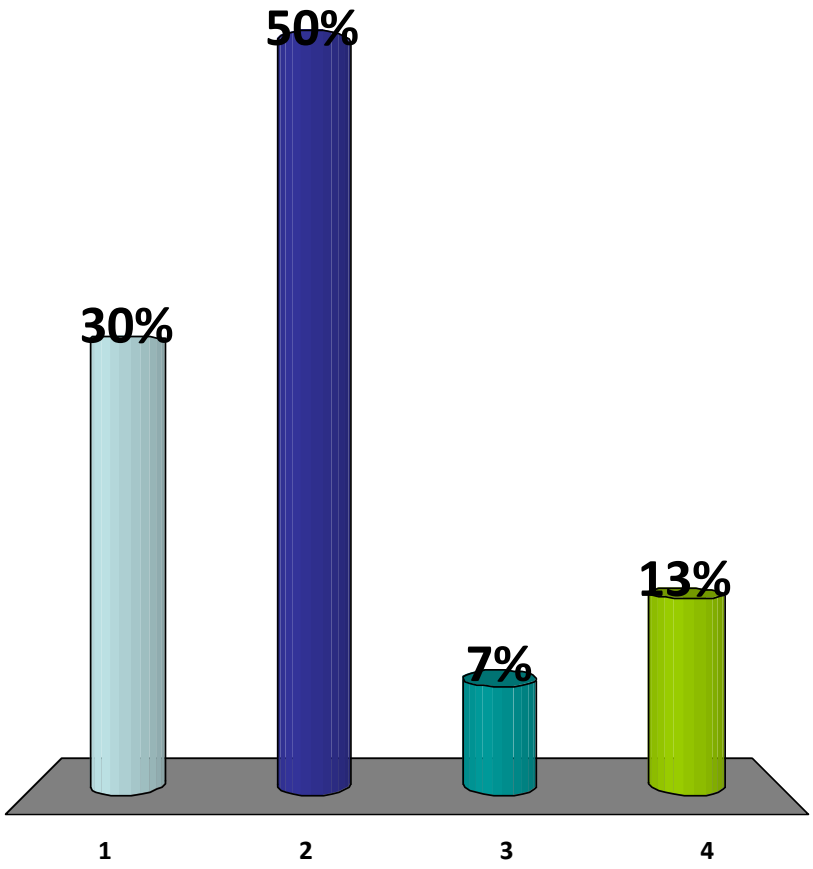
1. Yes, I wanted to get the answers right
2. Yes, they broke up the lecture, but I'm not bothered whether I get the answers right
3. No, just a gimmick, I pay attention anyway



n = 63, Stage 3

Seeing the question responses of the rest of the group helps me to gauge my performance

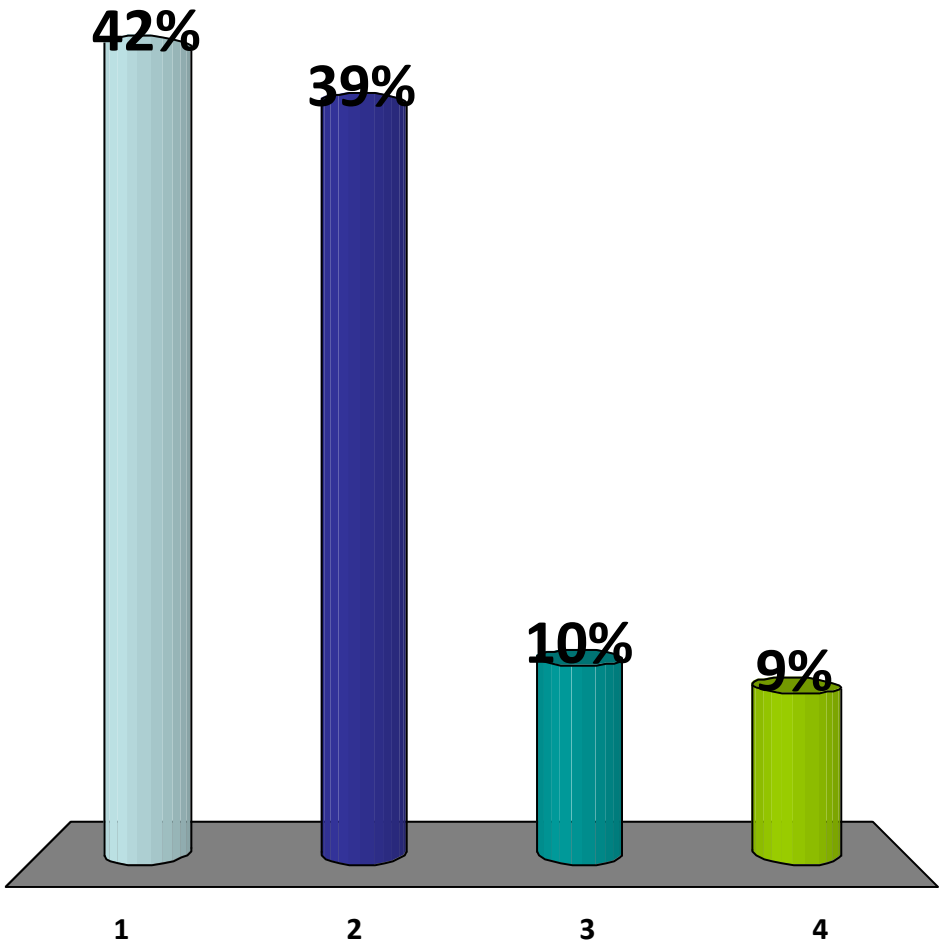
1. Strongly Agree
2. Agree
3. Disagree
4. Strongly Disagree



n = 136, Stage 1

I would like to see this software used in more of my lectures

1. Strongly Agree
2. Agree
3. Disagree
4. Strongly Disagree



n = 136, Stage 1

Efficiency

- Academics

- Industry

Proposed metrics

Assessment of the efficiency of individual pedagogical approaches:

1. Strategic nature of the course
2. Implementation of the course within the programme
3. Pedagogical relevance of the proposed intervention
4. Student perception of the pedagogical approach
5. Knowledge/skills acquired
6. Ability to apply/transfer the acquired knowledge/skills to professional practice

WP4 – Framework piloting

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

Quantification of metrics

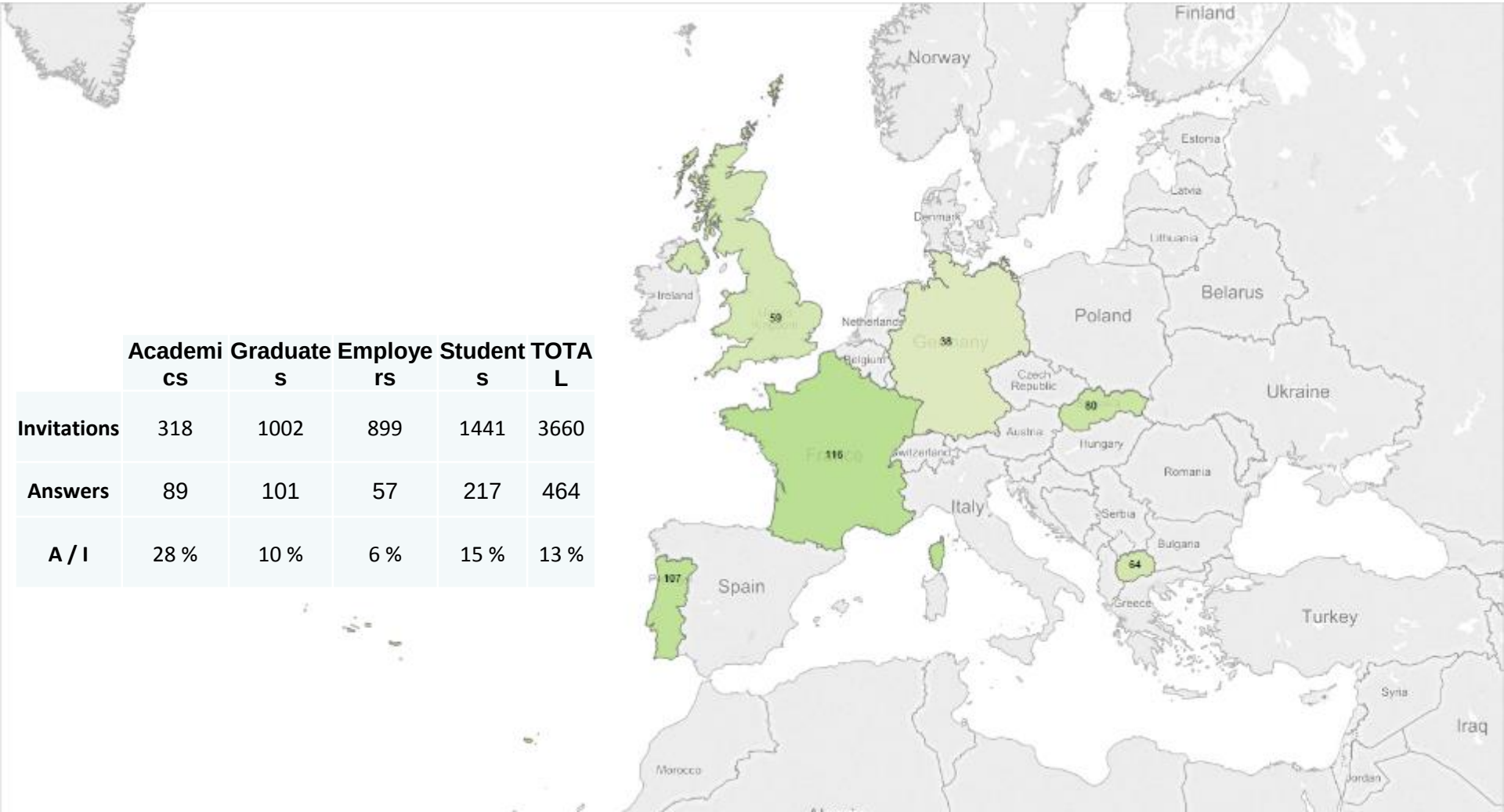
Metric	Formula
1. Strategic nature of the course/discipline	(2A+G+2E)/5
2. Relevance of the proposed formation	(2A+G+E+S)/5
3. Pedagogical relevance of the teaching approach	(2A+2G+S)/5
4. Perception of relevance of the pedagogical approach	S
5. Evaluation of the acquisitions	N.A.
6. Evaluation of transfer	(A+2G+2E)/5

A = Academics, G = Graduates, E = Employers, S = Students

Pilot implementation – initial results

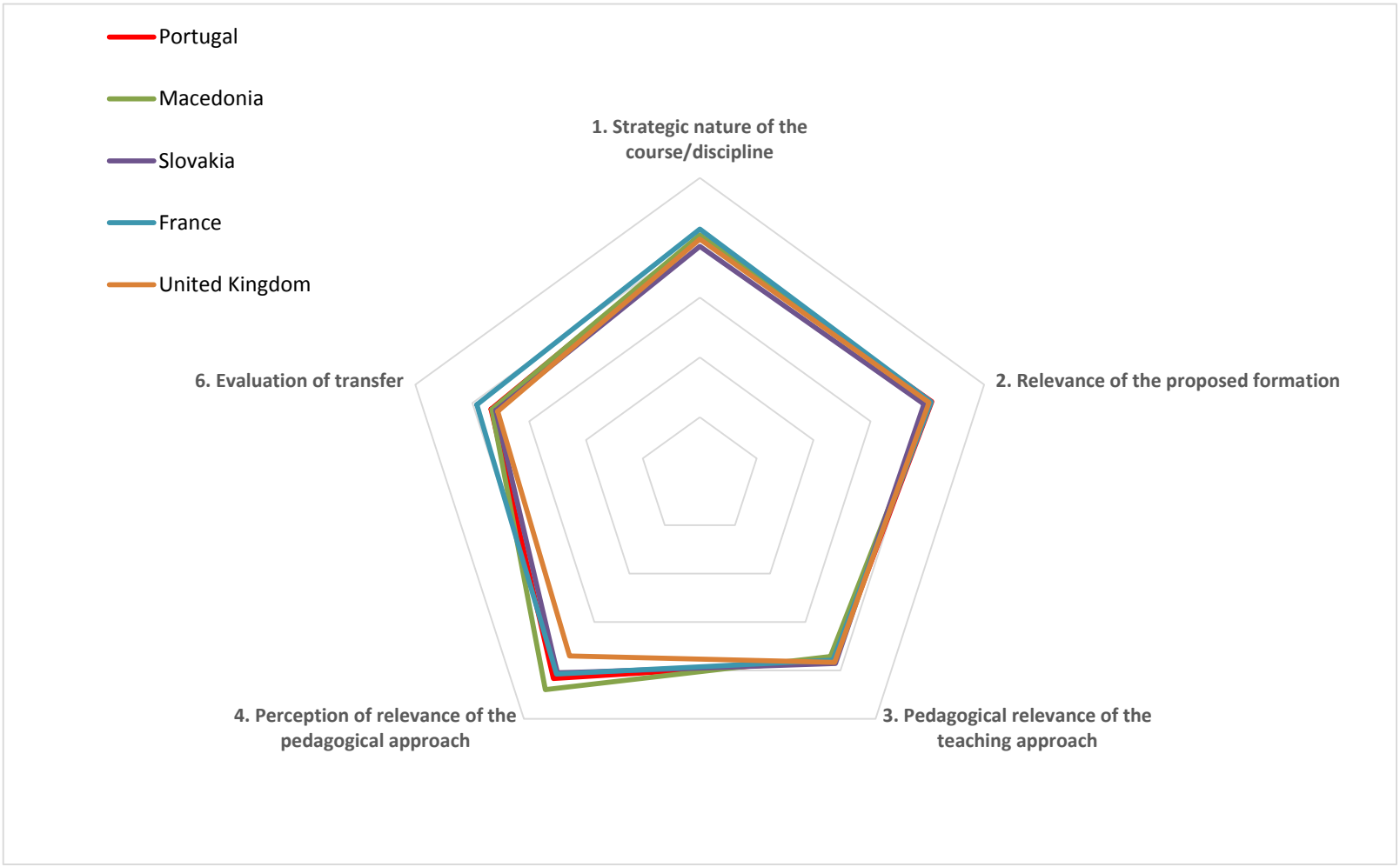
Chemical Reaction Engineering (1st Semester) – Total nr. of responses

	Academics	Graduates	Employers	Students	TOTAL
Invitations	318	1002	899	1441	3660
Answers	89	101	57	217	464
A / I	28 %	10 %	6 %	15 %	13 %



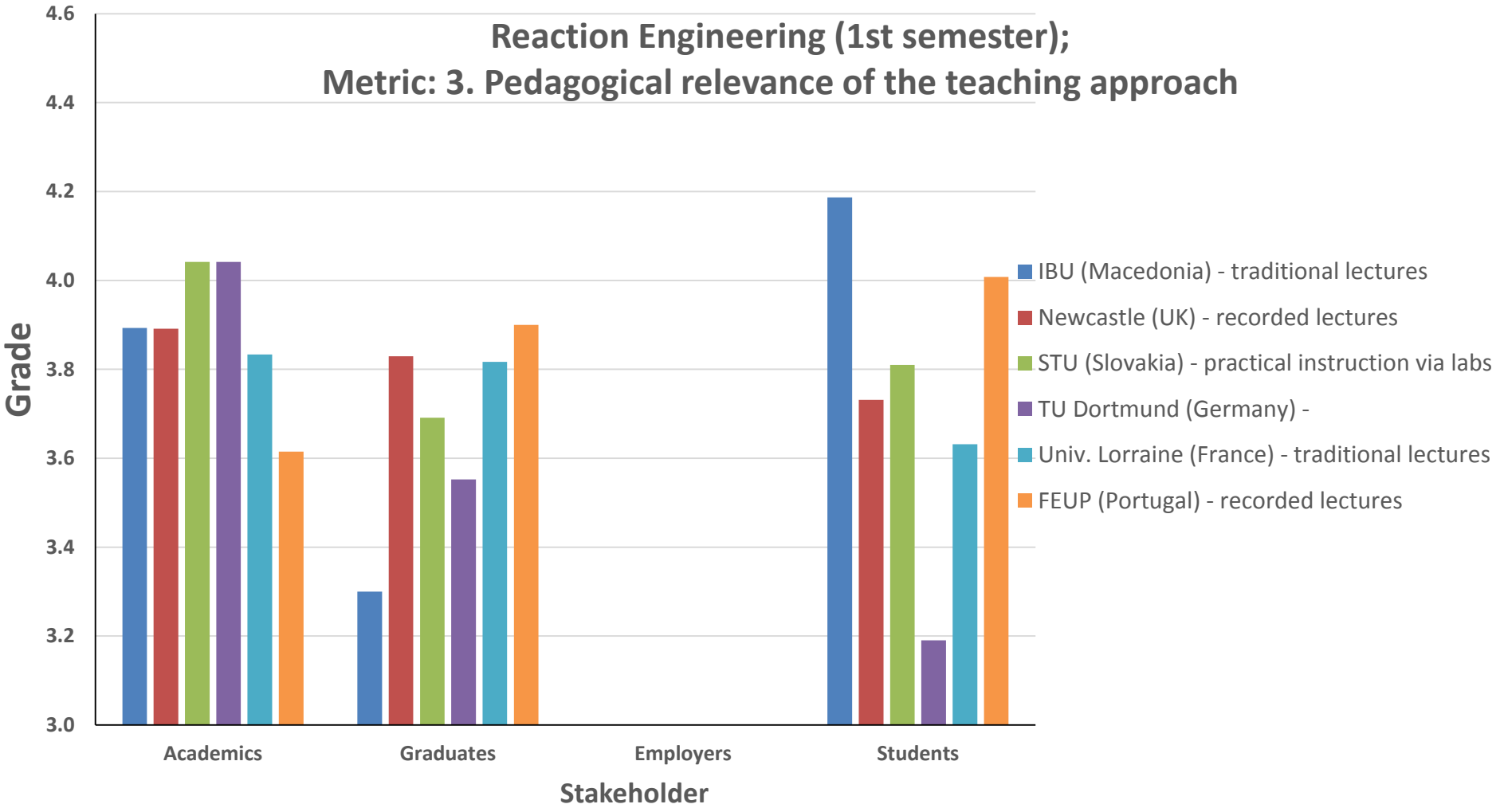
Pilot implementation – initial results (2)

Chemical Reaction Engineering (1st Semester)



Pilot implementation – initial results (3)

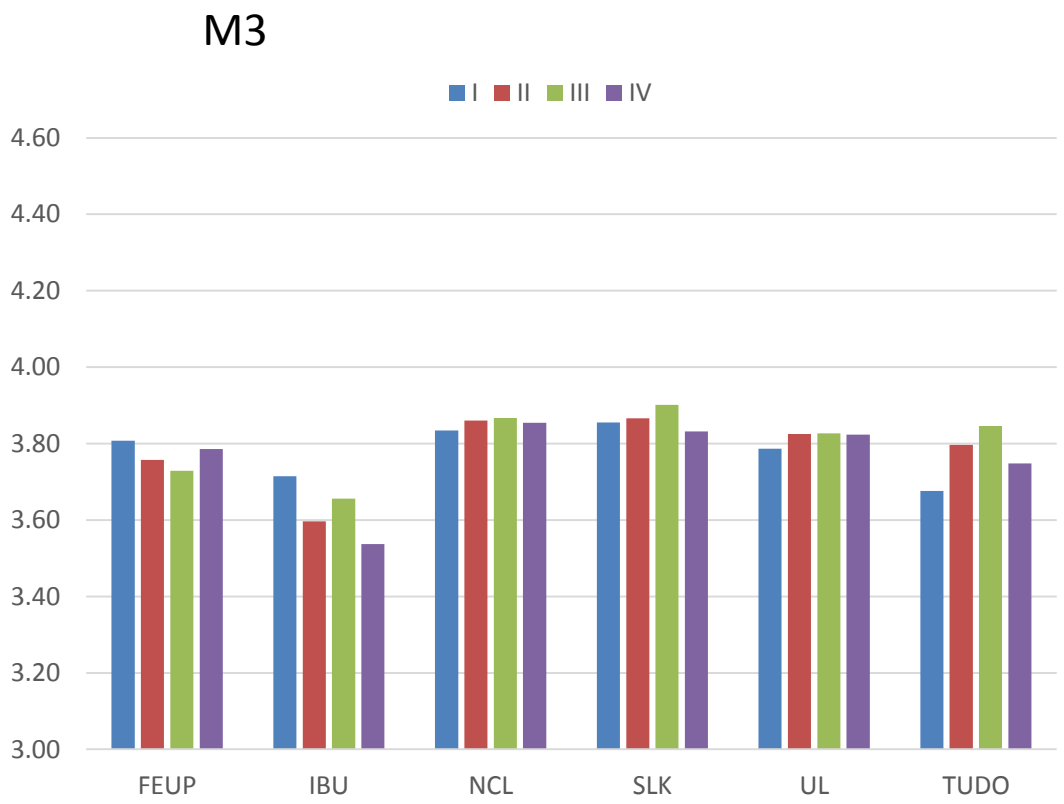
Chemical Reaction Engineering (1st Semester)



Sdensitivity analysis

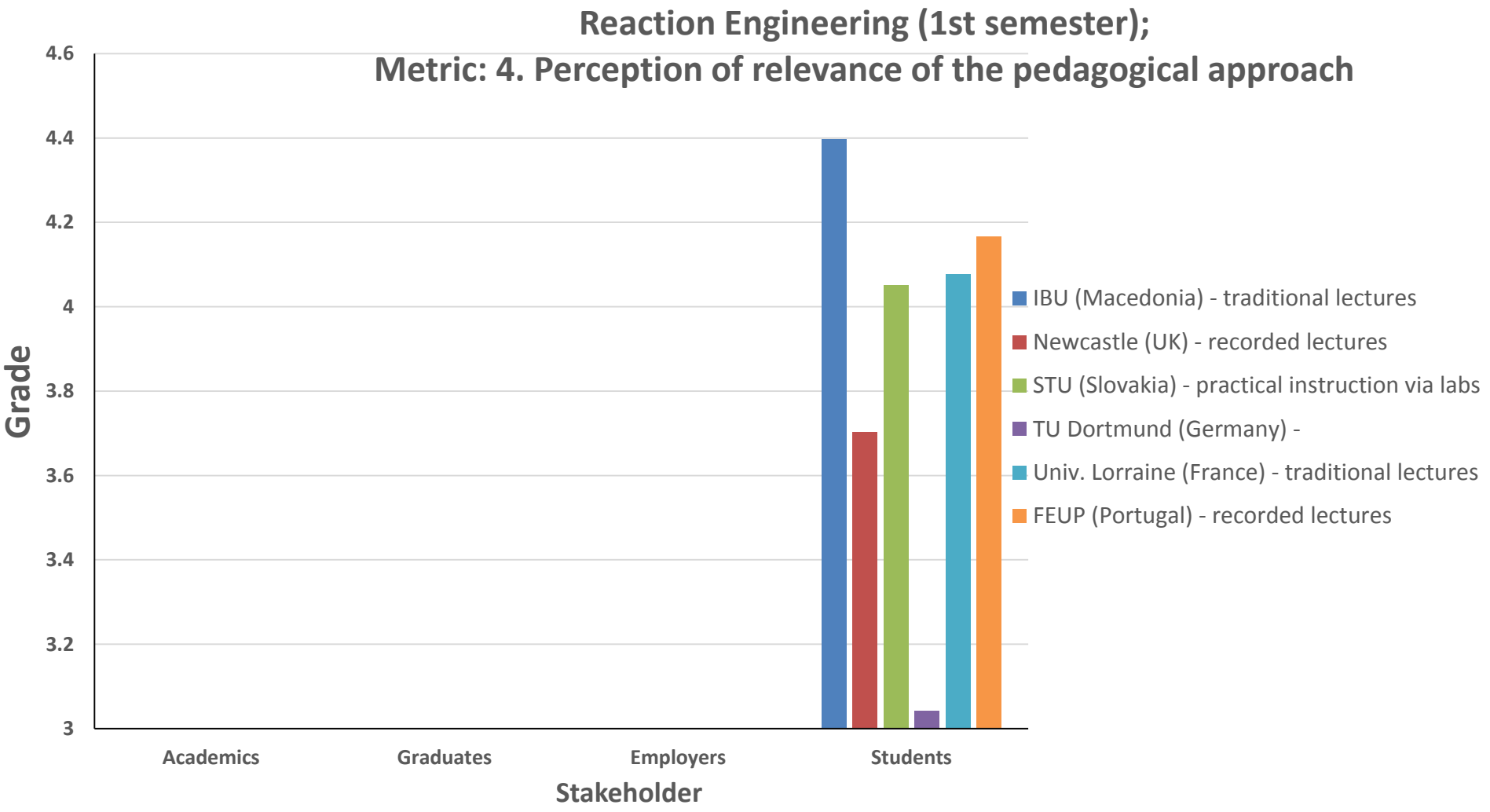
Chemical Reaction Engineering (1st Semester)

Metric	Scenarios															
	I (default)				II				III				IV			
	A	G	E	S	A	G	E	S	A	G	E	S	A	G	E	S
3. Pedagogical relevance of the teaching approach	2	2	0	1	2.5	2.5	0	0	3	2	0	0	2	3	0	0

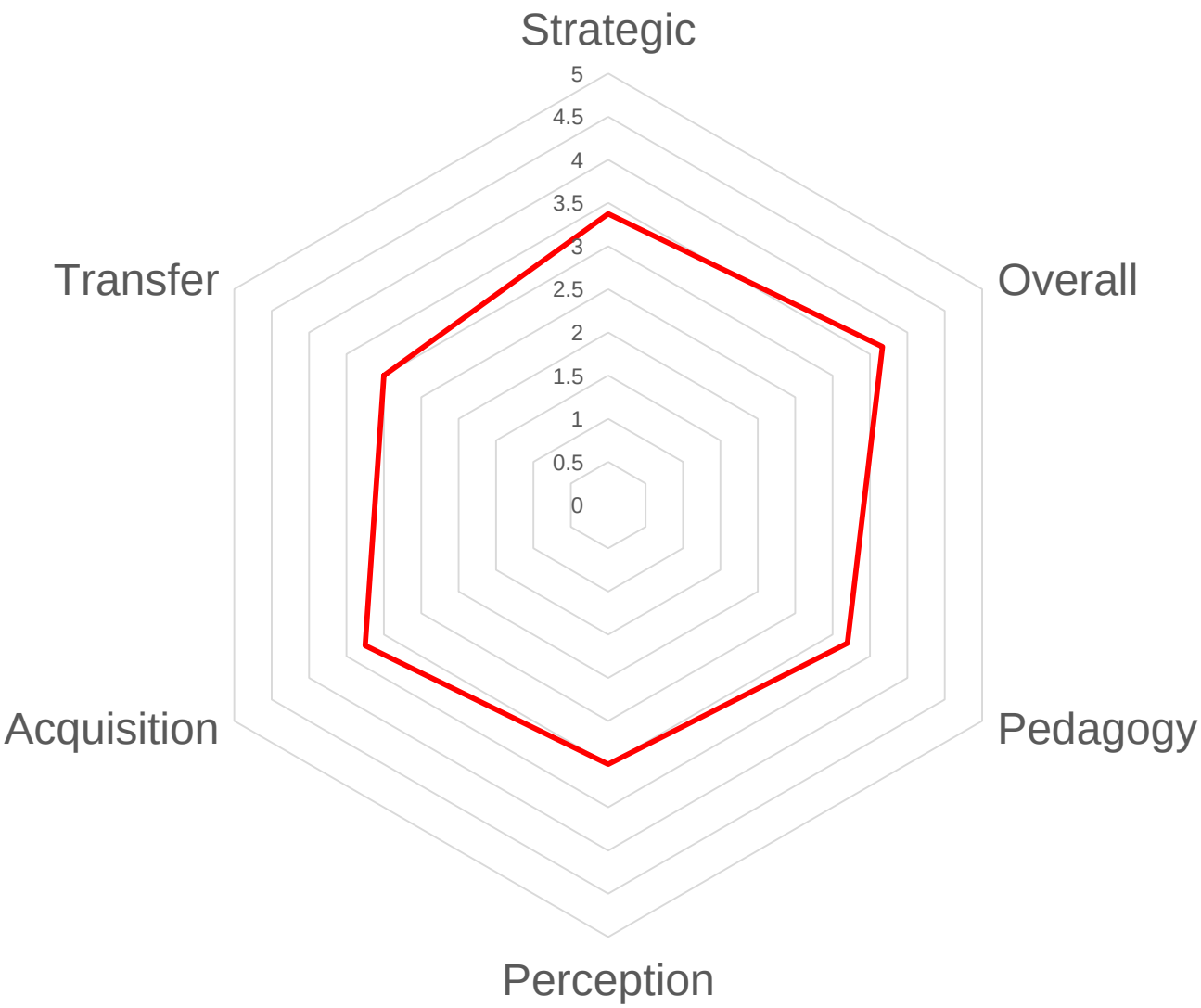


Pilot implementation – initial results (4)

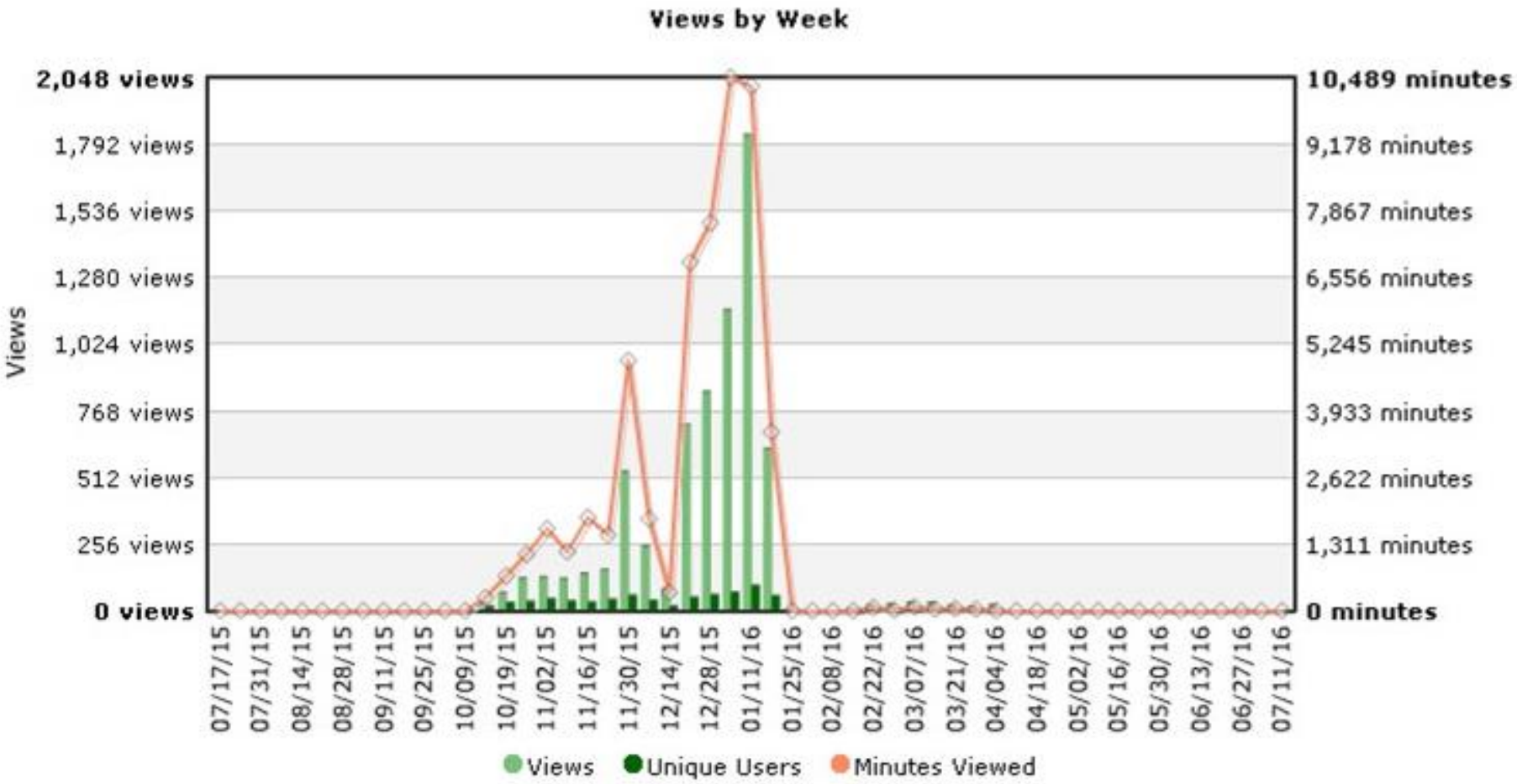
Chemical Reaction Engineering (1st Semester)



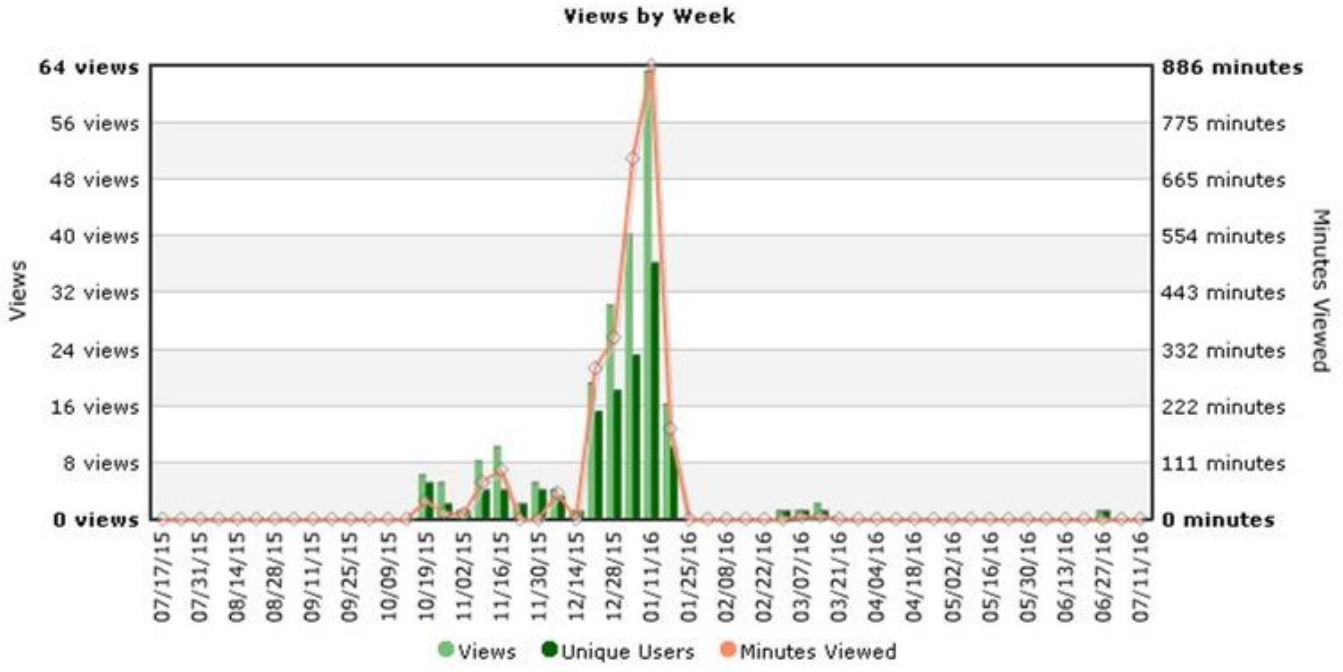
Further work



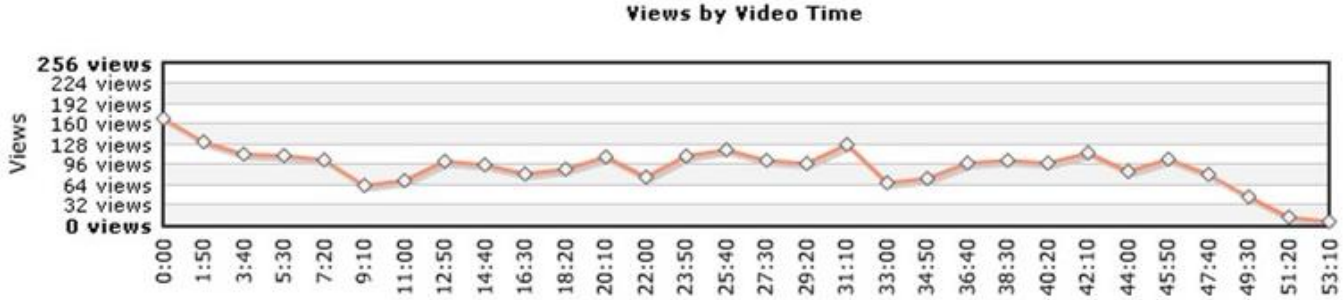
In-depth analysis



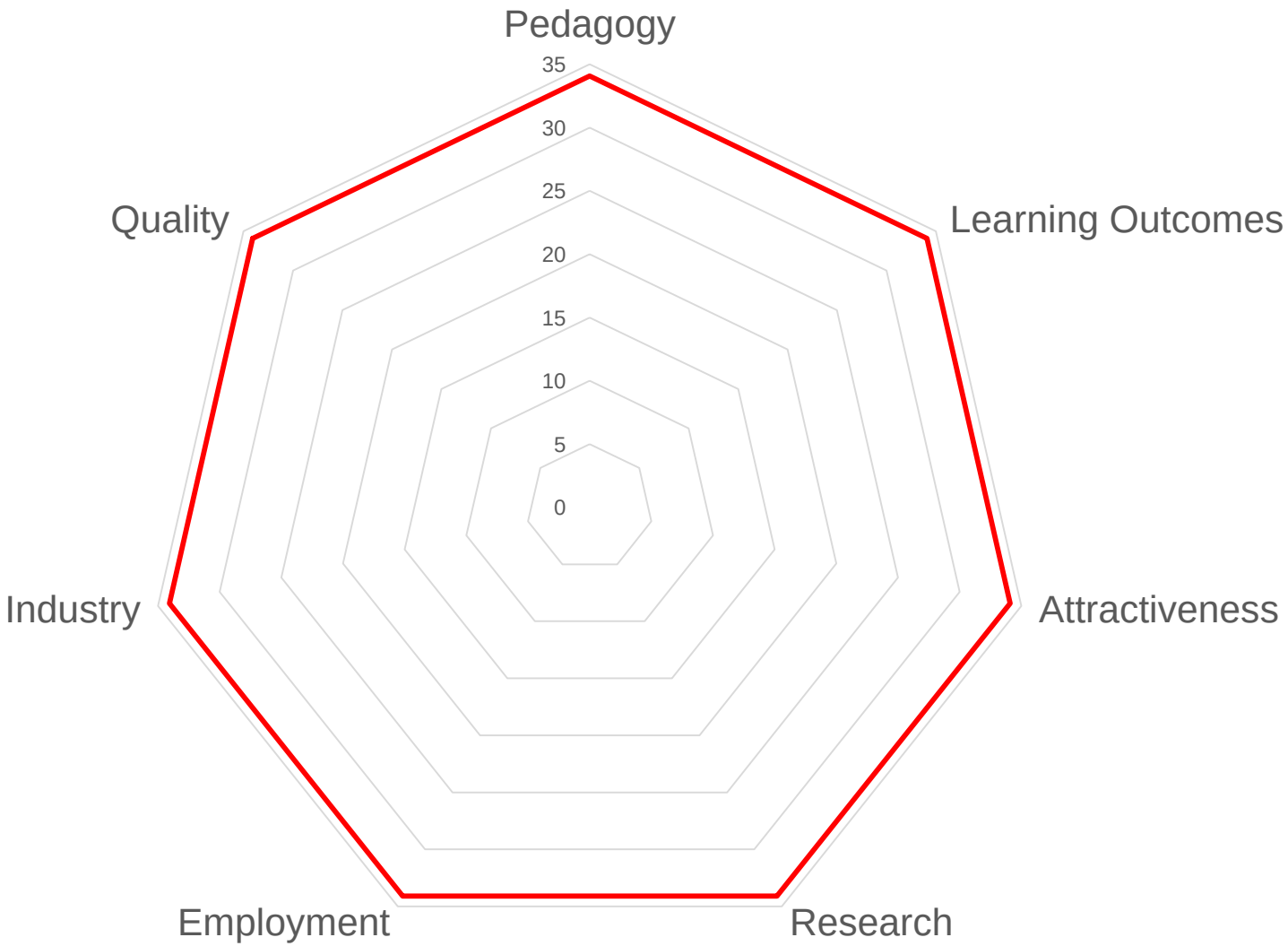
In-depth analysis



Download



Evaluation of whole formation



Concluding remarks

- Societal, economic and demographical changes introducing additional challenges to CE education
- Importance of fundamentals and employability competencies
- Need to measure efficiency of pedagogical interventions
- Global professional formation evaluation
- Involvement of all stakeholders throughout the whole process

Acknowledgements

- All iTeach consortium partners, associate partners and colleagues involved in the collection and data analysis
- All respondents to the questionnaires and focus groups
- Education, Audiovisual and Culture Executive Agency, Project No. 539959-LLP-1-2013-UK_ERASMUS-EQR

Education and Culture DG

Lifelong Learning Programme