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

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.
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

WP1 Management  Oct ‘13 – Sep ‘16

WP2 Data gathering

• Jan ’14 – Dec ‘14

WP3 Assessment framework

• Jan ’15 – Aug ‘15

WP4 Pilot implementation

• May ‘15 – Sep ‘16

WP5 Quality Assurance  Oct ‘13 – Sep ‘16

WP6 Dissemination  Jan ‘14 – Sep ‘16

WP7 Exploitation  Jan ‘14 – Sep ‘16
Data collection methodology
- Questionnaires
- Focus groups

Glossary of Learning Outcomes

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.
A.P. Kujundziski

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

Inlet/raw materials → Production processes → Outlet/Products

Effectiveness of Education

1. Attractiveness
2. Pedagogy
3. Quality of management
4. Learning outcomes
5. Relation with industry
6. Relation with research
7. Employment

A.P. Kujundziski
### QUANTIFICATION OF INDICATORS

The effectiveness, $e$, the value of ECTS for a given teaching method, $v$, the average value and $\sigma$, the standard deviation can be calculated using the following equations:

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

<table>
<thead>
<tr>
<th>Pedagogy</th>
<th>Mean value</th>
<th>Standard Deviation</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours (or ECTS) of classical lectures</td>
<td>100</td>
<td>30</td>
<td>$e = 12\exp\left(-\left(\frac{V - \mu}{\sigma}\right)^2\right)$</td>
</tr>
<tr>
<td>Hours (or ECTS) of tutorials</td>
<td>50</td>
<td>30</td>
<td>$e = 12\exp\left(-\left(\frac{V - \mu}{\sigma}\right)^2\right)$</td>
</tr>
<tr>
<td>Hours (or ECTS) of labs</td>
<td>50</td>
<td>30</td>
<td>$e = 12\exp\left(-\left(\frac{V - \mu}{\sigma}\right)^2\right)$</td>
</tr>
<tr>
<td>Hours (or ECTS) of Problem &amp; Project Based Learnings</td>
<td>50</td>
<td>30</td>
<td>$e = 12\exp\left(-\left(\frac{V - \mu}{\sigma}\right)^2\right)$</td>
</tr>
<tr>
<td>Hours (or ECTS) of NTICs</td>
<td>50</td>
<td>30</td>
<td>$e = 12\exp\left(-\left(\frac{V - \mu}{\sigma}\right)^2\right)$</td>
</tr>
</tbody>
</table>

**Maximum score for teaching**: 60

**Total 300**
Global indicators

Teaching effectiveness
Proposed framework

Pedagogical objectives
Delivered knowledge
(what is taught)

Retention of knowledge/competencies from course to applications. The vertical axis reflects the knowledge retention.

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.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Academics</th>
<th>Graduates&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Employers</th>
<th>Students</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Strategic nature of the course/discipline</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>(2A+G+2E)/5</td>
</tr>
<tr>
<td>2. Relevance of the proposed formation</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>(2A+G+E+S)/5</td>
</tr>
<tr>
<td>3. Pedagogical relevance of the teaching approach</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>(2A+2G+S)/5</td>
</tr>
<tr>
<td>4. Perception of relevance of the pedagogical approach</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>S</td>
</tr>
<tr>
<td>6. Evaluation of transfer</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>(A+2G+2E)/5</td>
</tr>
</tbody>
</table>

<sup>1</sup>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
Traditional lectures
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

http://www.iteach-chemeng.eu