Lifelong Learning Programme

Improving Teaching Effectiveness in Chemical Engineering Education

ITEACH

Step by step reference guide for assessment framework application

Deliverable 3.3.

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Contents

Executive summary

This report provides guidance for the use of the proposed assessment frameworks of the effectiveness of core knowledge and competency, for a whole training center and for a single teaching unit, for their pilot implementations.

Two excel files have been developed for an easier calculation, of the 7 global indicators for the assessment a whole formation evaluation, and of the 6 metrics for the evaluation of the teaching effectiveness.

The first one is clearly described, and the use of the second one, as well as the questionnaires administrations towards the different stakeholders (students, graduates, academics and employers) are described.

The assessment of a whole formation needs accessing a lot of data, can be found on the website or directly from the institution, or from its alumni association. Once the parameters known, the effectiveness of the training center, can be quantified.

The questionnaires administration can be done using the website of the project (http://www.iteach-chemeng.eu/questionnaires/), once the different stakeholders are identified. Some face to face sessions can also be proposed to ensure good response rates. Finally, the anonymised marks of a student's cohort should also be provided, to calculate the fifth metric.

1. Introduction

This report details the applications of the frameworks for the assessment of the effectiveness of core knowledge and competency for their pilot evaluation in WP4. It follows the reports D.3.1. and D.3.2. detailing their derivation, and also contents two parts : one devoted to the evaluation of the effectiveness of a whole formation, and a second one for the evaluation of a single teaching unit.

2. Evaluation of a training center in Chemical Engineering

2.1. Introduction

The utilization of the framework here just needs accessing to the data allowing the quantification of each parameter. However, these are not easily accessible, and the difficulty might just concern the good ways of getting them : use of the training center website, of the syllabus, of some internal data or also of the employment surveys realized by the alumni associations.

2.2. Quantification of indicators

An excel file (Evaluation_Training_Center.xlsx) has been developed to quantify each parameter of an indicator. Once the parameters detailed, the global value of each indicator (on 300) can be computed. Finally, indicating the cost of the formation (taking into account salaries, housing, maintenance, and all overheads…) per year and per student and the average national salary in the last spreadsheet, the final values of the indicators can be easily obtained, for evaluation and comparison purposes.

2.2.1. Pedagogy

In the case of pedagogy, the first spreadsheet of the excel file gives :

Teaching		*Traing Center*	Mean value	Standard Deviation	*Parameters*	*Partial Sums*
	ECTS of classical lectures	*100*	100	30	*10*	
	ECTS of tutorials	*50*	50	30	*10*	
	ECTS of labs	*50*	50	30	*10*	
	ECTS of Problem & Project Based Learning	*50*	50	30	*10*	
	ECTS of non traditional teaching methodologies	*50*	50	30	*10*	*50*
Use of feedback questionnaires						
	Learning	*y*	y/n		*5*	
	Enthousiasm	*y*	y/n		*5*	
	Organization (including course materials)	*y*	y/n		*5*	
	Group interaction	*y*	y/n		*5*	
	Individual rapport	*y*	y/n		*5*	
	Breadth	*y*	y/n		*5*	
	Examinations	*y*	y/n		*5*	
	Assignments	*y*	y/n		*5*	
	Overall	*y*	y/n		*5*	
	Use of response to feedback questionnaires	*y*	y/n		*15*	*60*
Number of face to face teaching hours equivalent to one ECTS		*10*	10	5	*30*	
Total hours of face to face formation per year (as given by accreditation bodies)		*800*	800	200	*30*	*60*
Percentage of students not progressing within set timelines		*0*	0	10	*60*	*60*
Availability for teaching						
	Office on site	*y*	y/n		*10*	
	Email address	*y*	y/n		*10*	
	Percentage of time for teaching	*50*	50	10	*10*	
	Number of students/teachers	*5*	5	5	*10*	
	Percentage of permanent academics	*100*	100	10	*10*	
	Continuous professional development for academics	*y*	y/n		*10*	
	Academiv tutors	*y*	y/n		*10*	*70*
					Total	*300*

Some figures have been proposed for a (good !) training center, and the parameters values are calculated in the corresponding column. The proposed maximum score for Pedagogy is thus of 300.

2.2.2. Learning outcomes

For consistency with the learning outcomes, the second spreadsheet gives :

EFCE		*Traing Center*	**ECTS**	Standard deviation	Parameter	*Partial Sums*
Learning outcomes			**Min value**			
Fondamentals of sciences and natural sciences		45	**45**	15	20	
	Mathematics					
	Physics					
	Chemistry					
	Computer sciences					
	Numerical methods					
Chemical engineering fondamentals		35	**35**	15	20	
	Mass and energy balances					
	Thermodynamics					
	Fluid dynamics					
	Heat & mass transfer					
	Chemical reaction engineering					
	Separations,					
	Biomolecular and biological engineering					
Chemical engineering applications		15	**15**	10	20	
	Basic process & product engineering					
	Health, Safety & Environment					
	Analytical techniques					
Non technical subjects / Skills		10	**10**	5	20	
	Human Sciences and management					
	Languages					
First cycle Internship		15	**15**	5	20	
Extension of scientific subjects		15	**15**	5	20	
Advanced cursus, chemical engineering deepening		40	**40**	10	20	
	Advanced Chemical engineering					
	Product design					
	Biotechnological processes					
	Process management					
Second cycle Internship		30	**30**	5	20	
						160
Accreditation (CTI, IChemE…)			**y**		20	
ECTS of Active formations		100			10	
Learning outcomes of the formation clearly articulated		y	**y/n**		10	
ECTS of internships or formation outside the home institution		30	**30**	5	20	
						60
Skill & Competences						
	Ability to gather information	y	**y/n**		10	
	Ability to analyse information	y	**y/n**		10	
	Self learning ability	y	**y/n**		10	
	Ability to identify and formulate problems	y	**y/n**		10	
	Ability to solve problems	y	**y/n**		10	
	Ability to work effectively as a member of a team	y	**y/n**		10	
	Ability to communicate effectively	y	**y/n**		10	
	Appreciation of an interdisciplinary approach	y	**y/n**		10	
						80
					Total	*300*

Identically, some fictive values have been proposed for a training center, and the parameter values are calculated automatically. The maximum value for this second indicator is also 300.

2.2.3. Attractiveness

For attractiveness, one example is also presented below !

		Traing Center	Mean value	Standard Deviation	*Parameter*	*Partial Sums*
Number of applicants/place		30			30	
Registration fee/mean salary		0			10	
Housing facilities		10	y/n		10	
Size of the city		1000000			10	
Average monthly accommodation costs /mean salary		0			10	70
Existence of a marketing department (at least at the university level)		y			10	
Number of employees in the marketing department		10			10	
Implementation						
	Informations provided (website, electronical letters, hard copies...		y/n		30	
	Forums/Visit days		y/n		10	
Participation of the students			y/n			
	In activities of the marketing department		y/n		10	
	In attractivity		y/n		10	
	In associations/Students societies		y/n		10	
	In communication		y/n		10	100
Percentage v of foreign students (averaged over all study years, inclu		100			10	
International exchange agreements		100			10	
Courses in English		y	y/n		10	30
National ranking (in the subject area, averaged over the last 3 years)		1			10	
International ranking (averaged over the last 3 years)		1			10	20
Existence and influence of alumni association		y	y/n		10	10
Average mark v of incoming students		15	10	5	*50*	
Percentatge of students from disadvantaged social background		20	20	10	*10*	
Male/female ratio (%)		50	50	20	*10*	70
					Total	*300*

Some fictive values have also been proposed, and the maximum value for attractiveness is also 300.

2.2.4. Relations with research

For relations with research, the fourth spreadsheet gives :

		Traing Center	Mean value	Standard deviation	*Parameter*
ECTS of Research internship		30	30		30
Advanced courses (in ECTS) delivered by researchers co		10			10
Visits to research laboratories		10			10
Number of hours (ECTS) taught by staff exclusively on r		30			30
ECTS of innovation projects		30			30
Percentage of research active staff/number of academi		100	100		10
Number of patents /year		10			10
Joint research with industry		10			10
Creation of startups/spin-outs in the last 10 years		10			10
Volume of research contracts/mean salary		1000			10
Number of dual diplomas/degrees agreements					
	National	10			10
	International	10			10
Percentage of students with dual diplomas/degrees (w		100	100		100
Percentage of graduates undertaking a PhD		10	10	10	20
				total	300

Once again, some fictive values have been proposed, to ease the reading, and the parameter values are calculated automatically.

2.2.5. Relation with industry

The quantifications for the fifth indicator are described below.

		Traing Center	*Parameter*
ECTS of Industrial internship		30	30
Industrial tutors		y	20
Visiting lectures deliverd by Industrialists conferences		10	10
Visits to companies		10	10
Number of hours (ECTS) by industrials		10	10
ECTS of projects realised in collaboration with industry		20	20
Apprenticeship Formations		y	10
Percentage of students in apprenticeship formations		10	10
Percentage of students that form their company (5 years after g		10	10
Number of industrialists on the steering committee		10	10
Number of industrial chairs		10	10
Existence of industrial open days		y	10
	Number of industrial sectors represented	10	10
Junior enterprise		y	10
Hiring sectors			
	Bulk Chemistry	y	10
	Specialty chemistry	y	10
	Energy	y	10
	Engineering	y	10
	Pharamceuticals	y	10
	Agro & Bio industries	y	10
	Environment	y	10
Job position			
	Production	y	10
	Research	y	10
	Design engineer	y	10
	Technical assistant	y	10
	HSE & Quality	y	10
		total	300

The maximum value of this indicator remains of 300.

2.2.6. Employment

The quantification of the indicator related to the employment is performed according to the figure below, where some fictive values have also been proposed. Its maximum value is still 300

		Mean value	Standard Deviation	*Traing Center*	*Parameter*
Average salary of graduates/mean salary		3	0,5	3	30
Time to find a job (month)		0	2	0	30
Unemployment rate after 6 month		0	100	0	60
Influence of alumni association		y/n		y	10
Percentage of additional training after graduation		10	10	10	10
Percentage of additional research training after graduation		10	10	10	10
Average salary 10 years after graduation/mean salary		10	1	10	10
Percentage of full time employment 10 years after graduatior		100	0	100	10
Level of responsibility after 10 years					
	Project manager	10		10	10
	Head of service	10		10	10
	Expert	10		10	10
	Sales manager	10		10	10
	Plant manager	10		10	10
	Executive officer	10		10	10
	Research director	10		10	10
	Director of company	10		10	10
	Director of Human ressources	10		10	10
	Professor	10		10	10
Geographic hiring areas					
	Outside the country of formation	10		10	10
	in Europe	10		10	10
	in the rest of the world	10		10	10
				total	300

2.2.7. Quality

Finally, the quantification of the last indicator is performed according to the excel sheet presented below.

		Mean value	Standard Deviation	*Traing Center*	*Parameter*
Existence of a steering committee		y	n	y	20
Composition of the committee/board					
	Industrial	10		y	10
	Number of sectors represented	10		10	10
	External teachers	10		y	10
	Internal teachers	10		y	10
	Students	10		y	10
	Researchers	10		y	10
	Alumni	10		y	10
Frequency of meetings		4		4	10
Existence of a forward planning		y		y	10
Frequency of programme/formation review (per year)		1		1	10
Staffing decision making local to the department/course unit		y		n	20
Evaluation of teaching					
	Frequency of evaluations/year	2		2	20
	Evaluation of pedagogical competences	y		n	10
	Evaluation of teaching materials	y		y	10
	Evaluation of scientific & technical contents	y		y	10
	Evaluation of skills & competences contents	y		n	10
	Feedback of evaluation to the students	y		y	10
Academic staff development regularly monitored		y		n	20
Existence of an educational committe		y		y	20
Existence of a direction board				y	10
	Industrials			y	10
	Teachers			y	10
	Students			y	10
	Local governments			y	10
				Total	300

2.2.8. Conclusion

Finally, indicating the cost of the formation and the national mean salary, some comparable values of the indicators can be obtained, as can be seen in figure 1, next page. The division by the cost of the formation related to the national mean salary allows international comparisons between universities or chemical engineering departments.

	Traing Center	*Indicator*
Pedagogy	300	34
Learning Outcomes	300	34
Attractiveness	300	34
Research	300	34
Employment	300	34
Industry	300	34
Quality	300	34
Cost of the formation per year and per student		
15000 euros		
National mean salary		
1700		

2.3. Conclusion

A global radar plot of a formation can then be obtained, such as in figure 1, below. It allows assessing the strength and weaknesses of a chemical engineering training center, allowing comparisons, and improvements.

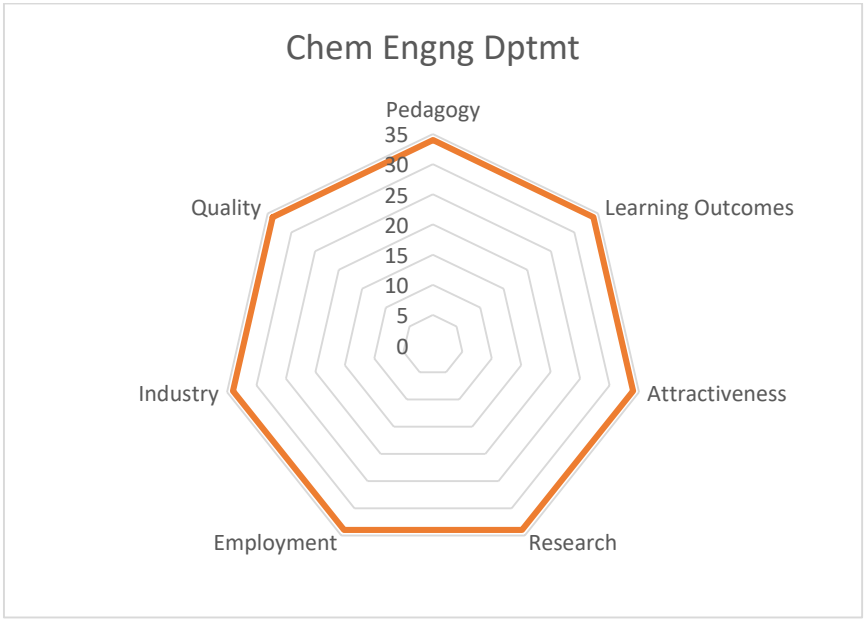

Figure 1 : Teaching effectiveness

3. Evaluation of a single teaching unit

This second paragraph deals with the instruction for using the questionnaires developed in the Work Package 3 of the iTeach project for the evaluation of a single teaching unit, according to 6 metrics, using the feedback of 4 focus groups : students, graduates, academics, and employers.

The questionnaires are developed separately for the 4 different focus groups, and are proposed as 4 separated documents. These questionnaires might be proposed to the different focus groups during face to face sessions using printed versions, or by internet using the website of the project (http://www.iteach-chemeng.eu/questionnaires/).

We do not recommend any of the methodology for the proposition of the questionnaires, the important point remains to obtain a good response rate. It might however be easier to analyse all the data if they are available under digital format… and better responses rates are of course obtained during face to face sessions !

Such an evaluation will be applied for different teaching methods of chemical reaction engineering, in different countries. Impact of design projects, labs, lectures, recorded lectures, problem based and work based learning might thus be assessed… Employability skills may also be evaluated.

3.1. Focus groups definition

The Students are those studying the programme currently and registered at the university for a given academic year. Questionnaires will be administered during a face to face session, to ensure a high response rate. If possible, use digital questionnaires ?

A Graduate is someone who completed the program in the last 3 years.

Academics are national and international teachers involved in chemical engineering teaching, particularly chemical reaction engineering.

Employers should be representative of the different hiring sectors of the training.

We need, for these 3 former focus groups, to identify representative and reliable members. Since the survey will be completed only once, theses members do not need to be involved throughout the duration of project.

Each member of the iTeach project should identify as many representative people of each focus group as possible before the beginning of the evaluation and push them to get their feedback ! Graduates may be identified with the help of the alumni association, where relevant. Academics could be selected among the different educators involved in Chemical (Reaction) Engineering Education. Employers may be members of the steering committee, of the alumni associations, recruiters of representative companies, or identified among those regularly offering internships.

3.2. Questionnaires administrations

The questionnaires may be administered to the respondents in both local language and English, to ensure absence of any translation problem. Care must be exercised when translating the questions into the local language (this should be undertaken preferably by a person conversant in chemical engineering/education). A blink backtranslation (without seeing the English original) should be carried out by an independent person (preferably a qualified translator) to ensure the accuracy of the translation. The responses in the local language should also be translated into English and then backtranslated into the original local language to ensure accuracy.

Questionnaires might be proposed to Graduates, Academics and Employers using internet. Since the questions deal with the strategic nature of the teaching unit, the relevance of the formation, and its pedagogical relevance, a description of the teaching unit, based on a syllabus for example, has also to be given !

The questionnaires and teaching unit description will be sent by the different members of the project to the focus groups by email. An additional text, such as that proposed for the first survey, has to be used. A proposition is given hereafter :

> *Dear ****
>
> *You are now aware that as part of the iTeach consortium (www.iteach-chemeng.eu) we are trying to develop a robust and objective framework for the evaluation of the effectiveness of delivering core chemical engineering knowledge and employability skills to our graduates. After the first step, we are now gathering information on the effectiveness of teaching for different teaching methods of chemical reaction engineering, in different countries. Impact of design projects, labs, lectures, recorded lectures, problem based and work based learning are thus be assessed… Employability skills may also be evaluated. We sincerely hope that you will spare about 20 minutes of your precious time to provide us with your views and fill in the appropriate questionnaire using the following link: http://www.iteach-chemeng.eu/questionnaires/. The questionnaire is relative to the teaching method of chemical reaction engineering that we use in our institution, and that is described in the attached document.*
>
> *Your responses will be invaluable in helping to validate the framework, which we hope to disseminate widely and make accessible to all chemical engineering academic institutions after successful piloting. All responses will be kept confidential and only used for the purposes of iTeach project and therefore we would appreciate your honest opinions on all the questions. Free text boxes allow you to expand on any of the issues that you wish. At the end of the questionnaire we ask you to provide us with your e-mail address if you wish to receive the results of this survey and also updates on the development of this very important framework. We will also be very happy to share with you the formulated framework if you would like to test it in your institution.*
>
> *We hope that you will be able to provide us with your views within four weeks of receiving this e-mail to allow the project to deliver its output on time.*

**iTeach consortium/I* thank you for your help in improving the formation of the future generations of chemical engineering graduates in Europe.*

Kind regards

We might have to send different emails to push our partners to get their responses…

The questionnaires will be proposed to the students at the end of the teaching unit, during a face to face session. If it's possible, use digital questionnaires, it will be easier then to analyse the data, but make sure of all students following the course reply ? Otherwise, use paper questionnaires, after the examination ? For example, French team used paper questionnaire before the beginning of the course of next semester, for the analysis of the methodology taught during this semester…

3.3. Evaluation of Acquisitions

Even if the Multiple Choice Questionnaires have been used by some of the partners, for assessing direct understanding of the students after each classical lecture, they will not be used for the evaluation of the acquisitions. Their comparison remains questionable, and not all of the partners had the time to introduce such MCQ.

The average marks and standard deviations of current and former years need to be provided by each of the partners, in an anonymised way if possible.

3.4. Pilot implementation

The proposed repartition was first applied for Chemical Reaction Engineering courses in the different institutions. Some other pedagogical approaches have also been tested, in some countries, for different subjects (Heat Exchangers by self-instruction delivery, or Chemical Reaction Engineering II by Project Based Learning for instance…)

3.4.1. P1(UNEW) – recorded lectures, problem based learning

3.4.2. P2 (UL) – problem based learning, self-instruction delivery

3.4.3. P3 (IBU) – work-based learning, traditional lectures

3.4.4. P4 (FEUP) – recorded lectures, practical instruction via labs

3.4.5. P5 (STU) – traditional lectures, practical instruction via labs

3.4.6. P6 (TUDO) - work-based learning, problem based learning

3.5. Conclusion

An excel file has also been developed by the partners from FEUP (P4) responsible of the pilot implementation for a single teaching effectiveness. This document allows the comparison of teaching effectiveness in different countries, using different pedagogical approaches, such as presented below.

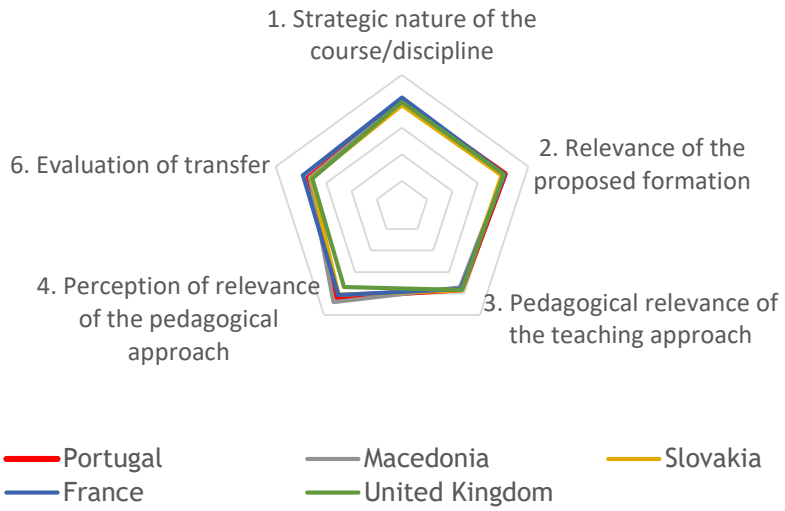

Figure 2 : Single Teaching Unit effectiveness for Chemical Reaction Engineering

No major differences can be seen among the partner institutions, since Chemical Reaction Engineering can be seen as an important subject in all universities, and for all partners.

4. Conclusion

The two frameworks will still be applied during the 6 last months of the project, to compare some whole formations, and the teaching effectiveness of different units.

All partners will thus administer the new questionnaire to the new cohort of students and where possible the marks for Metric 5 for both 2015/16 and 2016/17 should be provided so that they could be compared. For the other metrics we will just keep the academic, graduate and employer.

Each partner will also look for a Chemical Engineering course delivered in first semester to test. Ideally this would be a module where a change in pedagogic approach is introduced by the lecturer and hopefully no other changes. For this new module, a questionnaire would need to be sent out to academics, graduates and employers for the other metrics. Obviously questionnaires from students and marks for this course would also be required.

if possible we'll also try to convince some colleagues in other Chemical Engineering institutions in our countries to run the framework too. We will also look for a willing colleague either in a different engineering or any other discipline and see if they would try the framework.