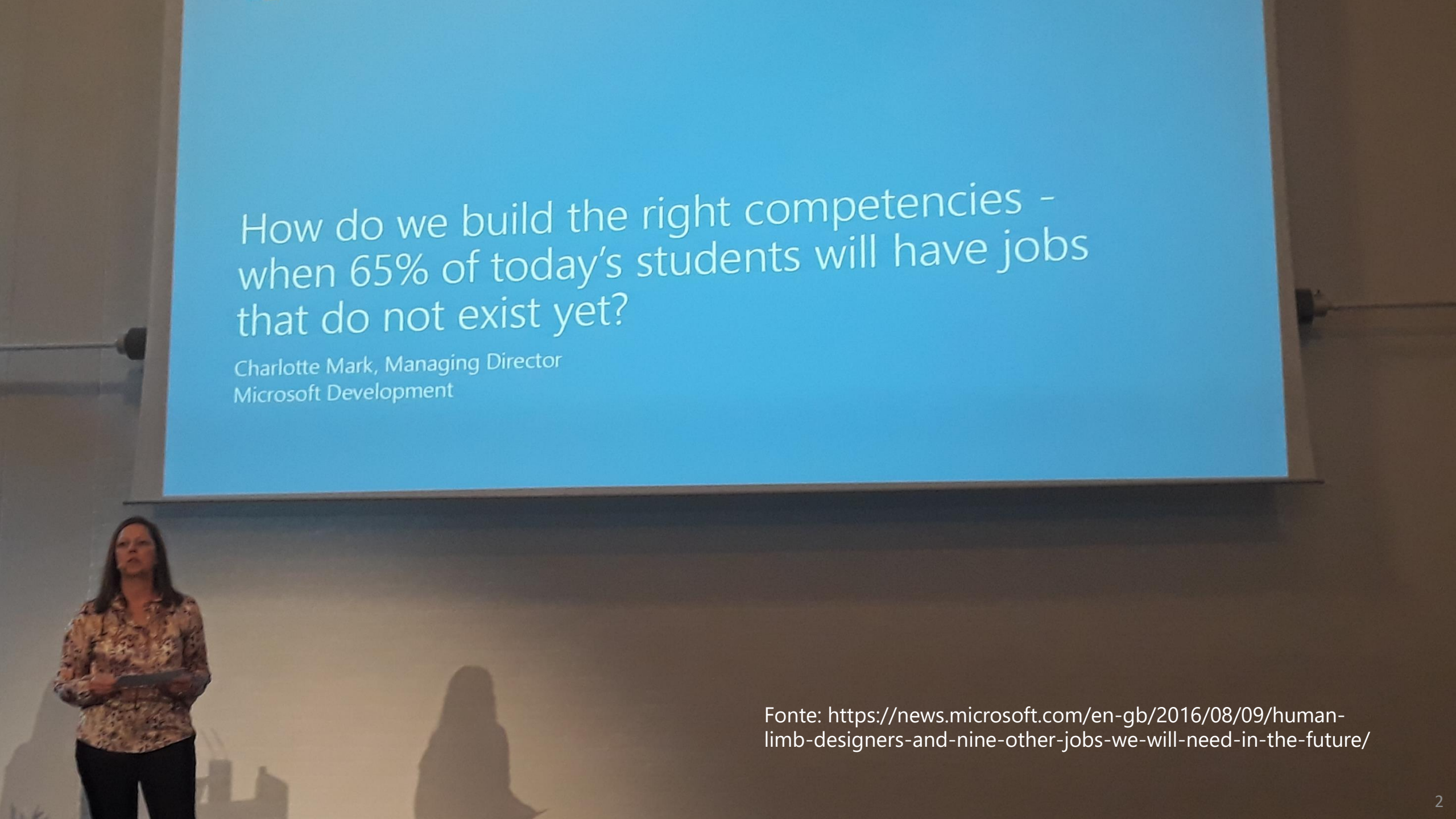
Co-funded by the
Erasmus+ Programme
of the European Union

Curriculum Development of Master's Degree Program in Industrial Engineering for Thailand Sustainable Smart Industry

The role of transversal competences for Industrial Engineering in the context of Industry 4.0

Rui M. Lima and Diana Mesquita

Universidade do Minho



Fonte: https://news.microsoft.com/en-gb/2016/08/09/human-limb-designers-and-nine-other-jobs-we-will-need-in-the-future/

https://www.microsoft.com/en-gb/athome/digitalskills/apply

Sustainable Power Innovator

Virtual Habitat Designer

IOT Data Creative

Human Body Designer

IEM – Professional Profile

Universidade do Minho

INDUSTRIAL ENGINEERING AND MANAGEMENT

Design, improvement and management of systems composed of people, materials, equipment, financial resources, information and energy, running processes for production and delivery of products and services (IIE, 2012; APICS, 2009)

Co-funded by the Erasmus+ Programme of the European Union

IEM – Job – Formation

Information

Products

Systems

People

Materials

Production Systems

Services

Curriculum ?

Customers

Organizations

Suppliers

Projects

Engineering Systems

Co-funded by the Erasmus+ Programme of the European Union

IEM – Job – Formation

Interdisciplinary

Planning

Management

Design

Communicate

Curriculum ?

Analyse

Teamwork

Evaluate

Competences

Co-funded by the
Erasmus+ Programme
of the European Union

IEM – Job – Formation

Project Management

Engineering Sciences

Costs

Operations Research

Human Factors

Curriculum ?

Production Management

Simulation

Quality

Knowledge Areas

Co-funded by the Erasmus+ Programme of the European Union

IEM – Job – Formation

Engineering Systems

Knowledge Areas

Curriculum ?

Competences

Co-funded by the Erasmus+ Programme of the European Union

Development of Competences

Universidade do Minho

Teaching and Learning system based on the idea of **knowledge transfer**

transition

Teaching and Learning system based on the idea of **development of competences**

Capacity to mobilize resources (knowledge, abilities, experiences, values,…) in specific contexts, to formulate and solve problems.

Le Boterf (1997, 2004, 2005); Zarifian (2001)

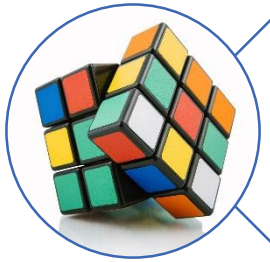
Co-funded by the Erasmus+ Programme of the European Union

Competences

Technical Competences

also known as “core” or “subject specific”

Specific of each area of knowledge (expertise)
Examples: design a production cell; developing simulation models



Transversal Competences

also known as “transferable”, “general”, “generic”, or “soft skills”

Relevant in all areas of knowledge
Examples: communication skills; teamwork; leadership.

Specific technical knowledge is not enough for engineering practice
(Nair & Mertova, 2009; Stiwne & Jungert, 2010; Tymon, 2013; Mesquita et al., 2015; Lima, Mesquita et al. 2017)

Co-funded by the Erasmus+ Programme of the European Union

Competences

The contexts of the professional practice requires the combination of both types of competences:
Technical and Transversal

An Industrial Engineer must apply his/her competences to design production systems that, in most situations, should be mobilized using tacit knowledge from production systems design (e.g. production cells); however, in some situations, knowledge from ergonomics should also be mobilized.

The same professional should be able to operate the production system (e.g. production cell), integrating a team of people to work in that cell. In this case, he/she should be able to apply leadership and teamwork competences in order to develop the most of that production system.

Co-funded by the Erasmus+ Programme of the European Union

COMPETENCES

Universidade do Minho

Co-funded by the
Erasmus+ Programme
of the European Union

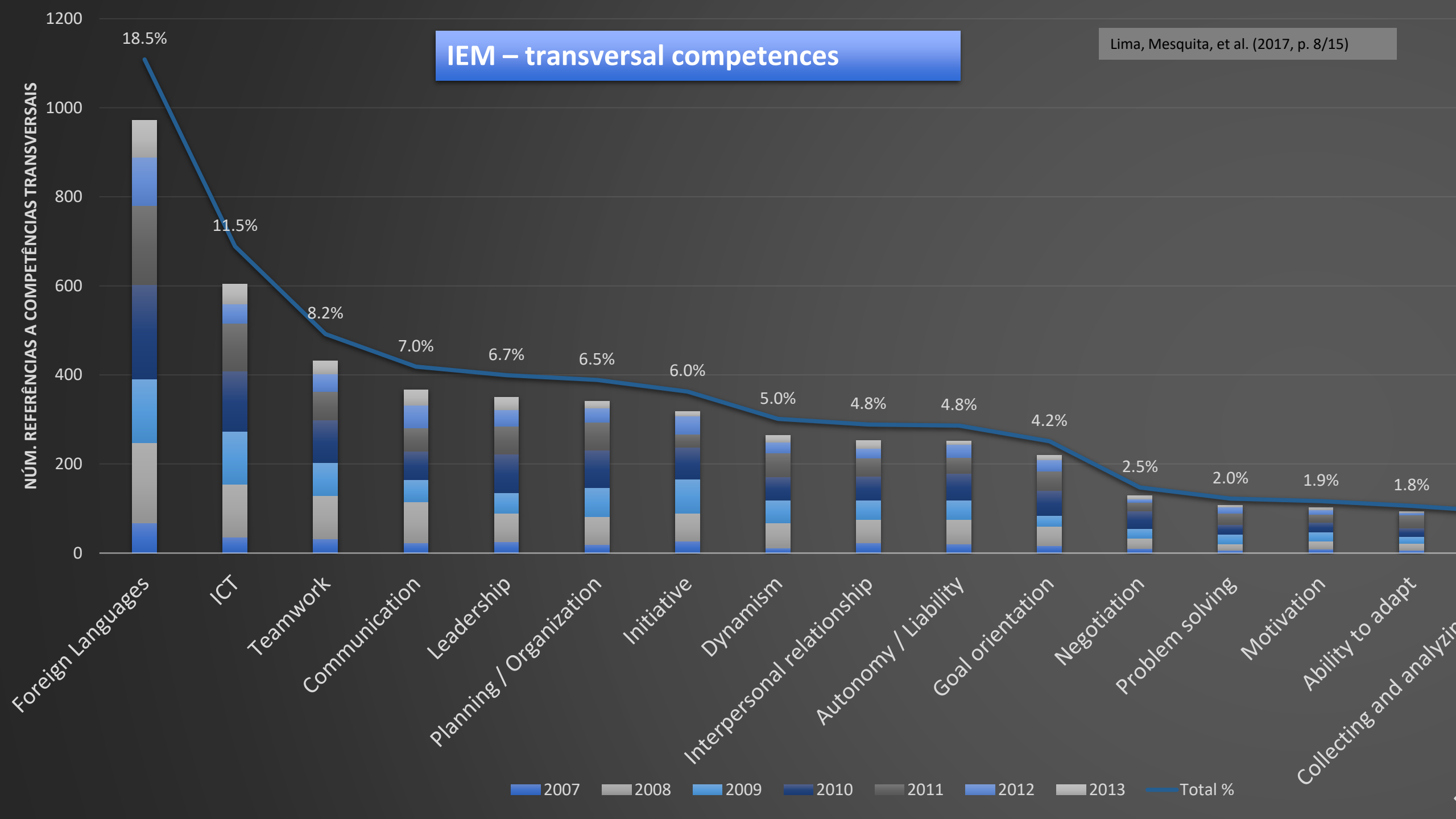
COMPETENCES

Universidade do Minho

Co-funded by the
Erasmus+ Programme
of the European Union

IEM – transversal competences

Lima, Mesquita, et al. (2017, p. 8/15)



World Economic Forum - The 10 skills you need to thrive in the Fourth Industrial Revolution

Universidade do Minho

Top 10 skills

	in 2020	in 2015
1.	Complex Problem Solving	Complex Problem Solving
2.	Critical Thinking	Coordinating with Others
3.	Creativity	People Management
4.	People Management	Critical Thinking
5.	Coordinating with Others	Negotiation
6.	Emotional Intelligence	Quality Control
7.	Judgment and Decision Making	Service Orientation
8.	Service Orientation	Judgment and Decision Making
9.	Negotiation	Active Listening
10.	Cognitive Flexibility	Creativity

https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/

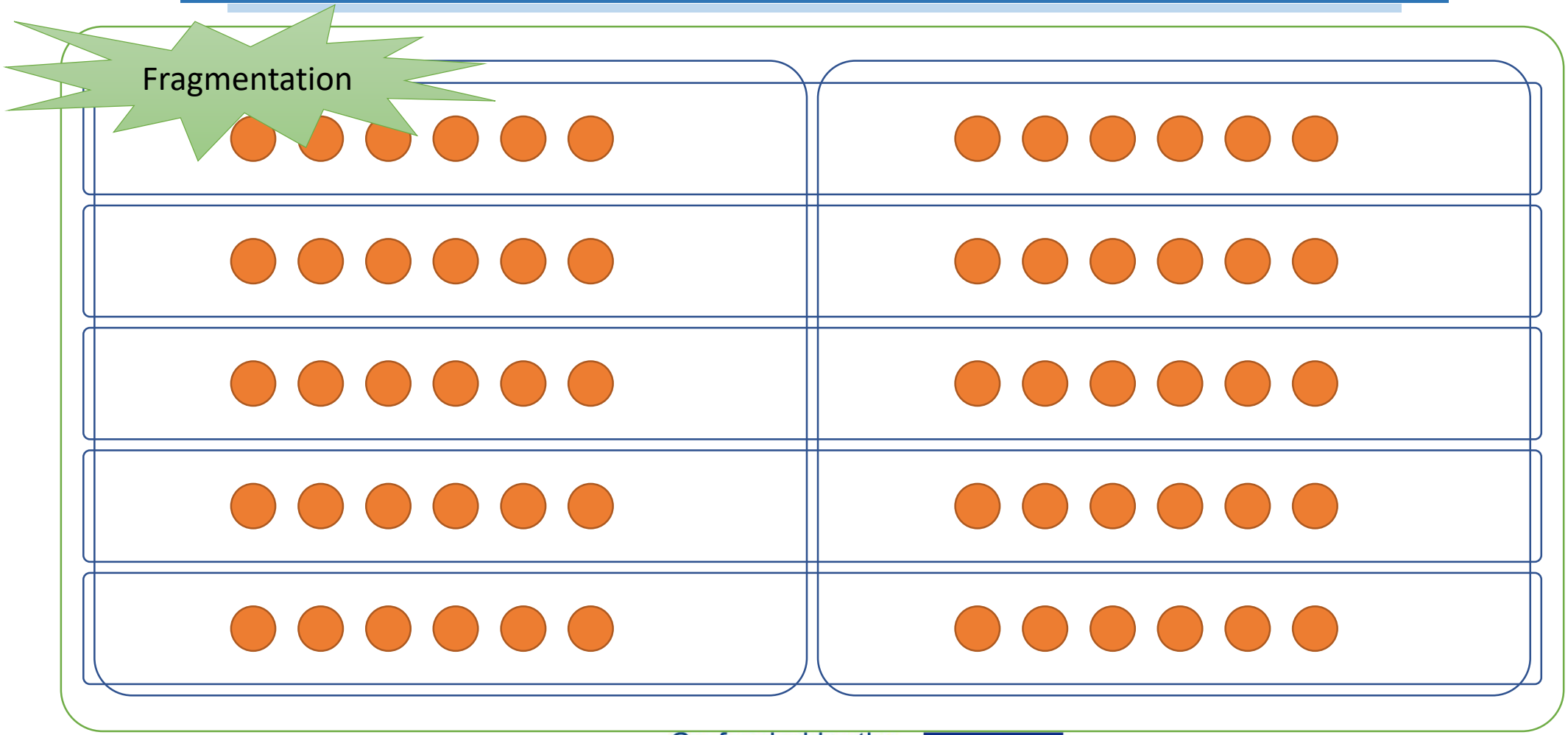
Co-funded by the Erasmus+ Programme of the European Union

COMPETENCES

Universidade do Minho

Co-funded by the
Erasmus+ Programme
of the European Union

IEM – Curriculum Structure



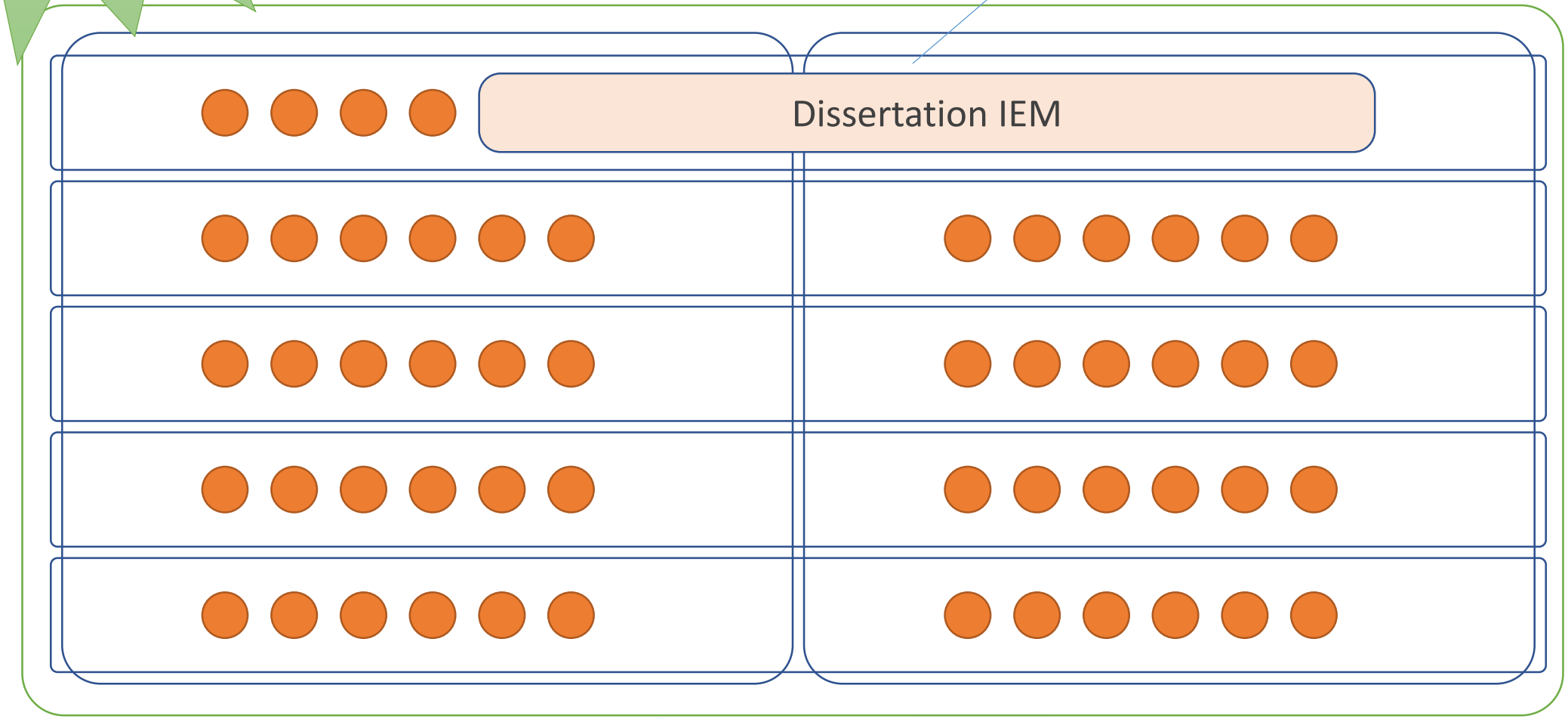
Co-funded by the
Erasmus+ Programme
of the European Union

Interdisciplinarity

IEM Program – UMinho

Universidade do Minho

Component Project – complete course

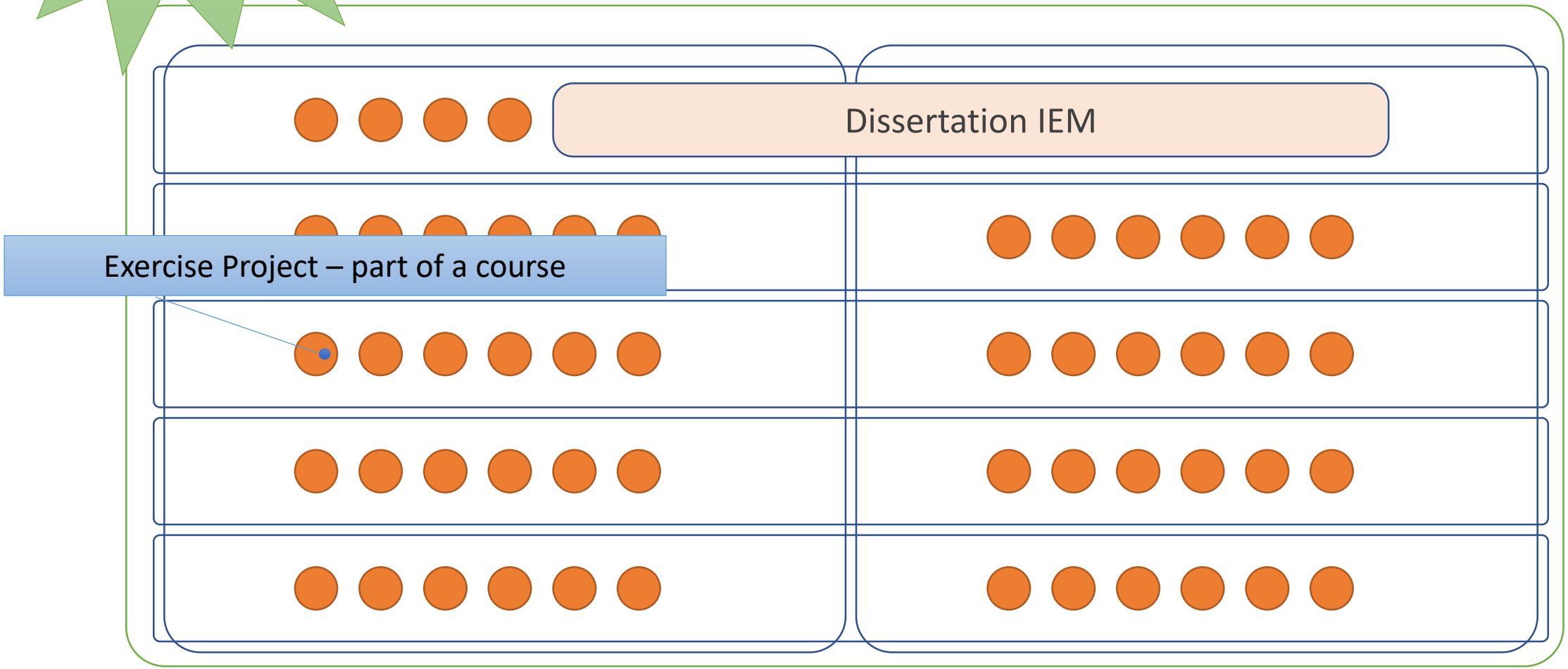


Co-funded by the
Erasmus+ Programme
of the European Union

Interdisciplinarity

IEM Program – UMinho

Universidade do Minho

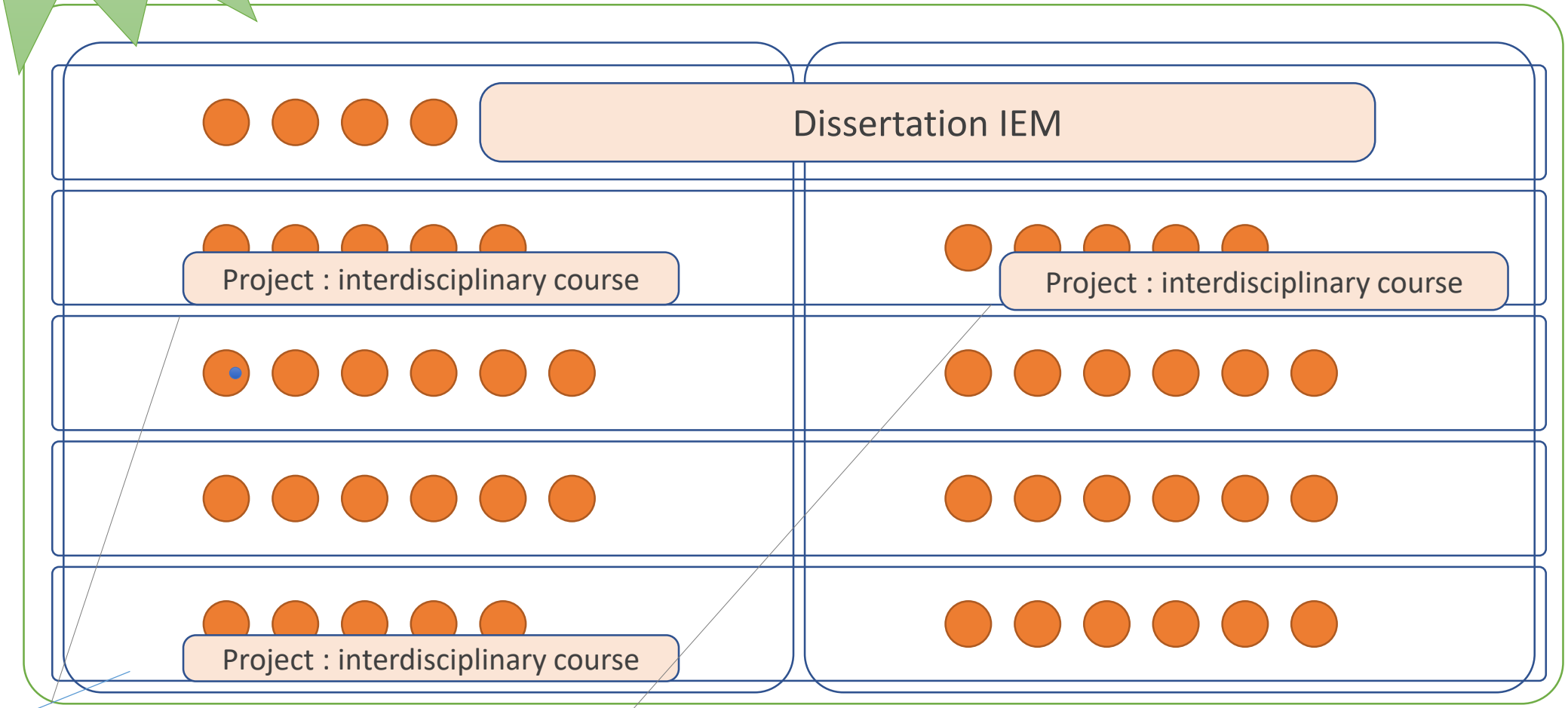


Co-funded by the
Erasmus+ Programme
of the European Union

Interdisciplinarity

IEM Program – UMinho

Universidade do Minho



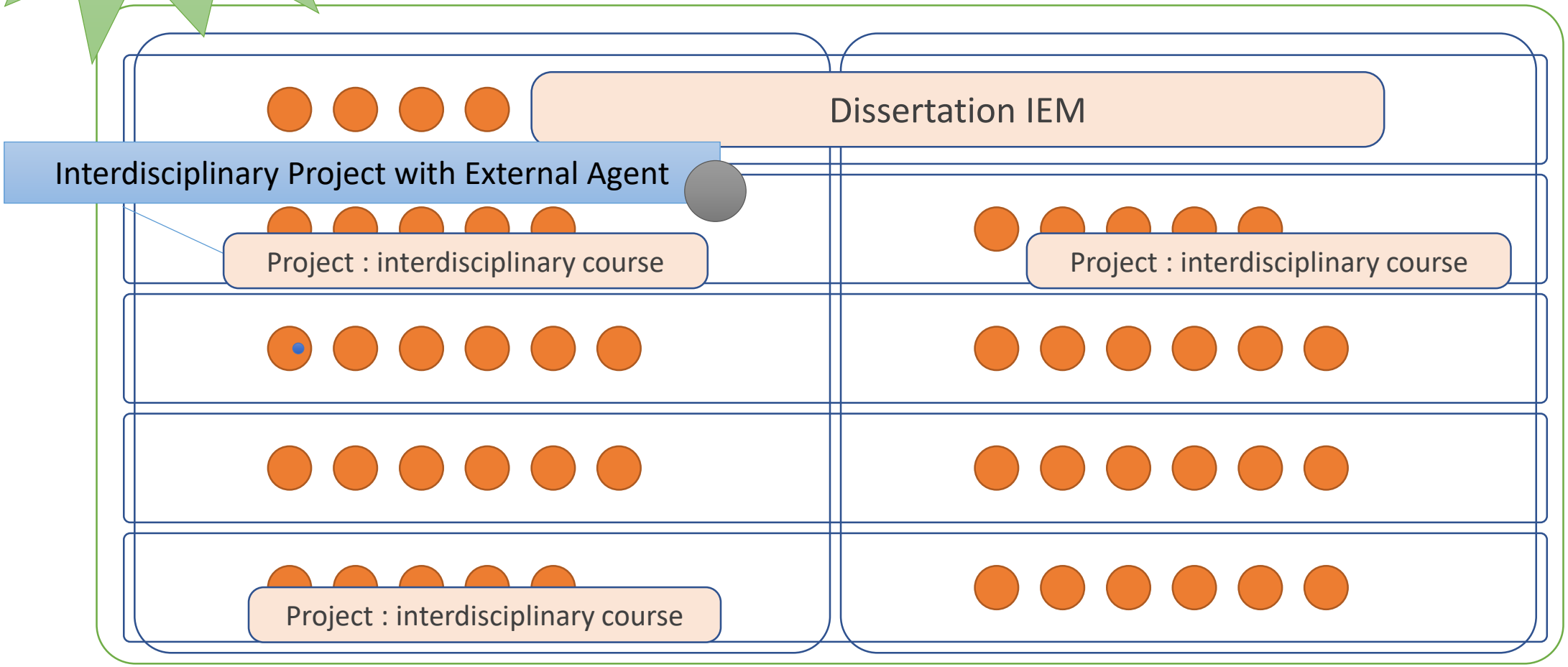
Interdisciplinary Project Approach

Co-funded by the Erasmus+ Programme of the European Union

IEM-IM – UMinho

Universidade do Minho

Interdisciplinarity



Co-funded by the Erasmus+ Programme of the European Union

COMPETENCES

Universidade do Minho

Identification → **Development** → **Assessment**

Co-funded by the
Erasmus+ Programme
of the European Union

Learning Outcomes

Learning Outcomes are "statements of what a learner is expected to know, understand and/or be able to demonstrate after a completion of a process of learning". CEDEFOP (2009)

"At the end of this **course** the students must be able to…"

Description should include the competences that students are expected to develop

Suggest an action (be observable) = Statement include a verb

Co-funded by the Erasmus+ Programme of the European Union

How to define the learning outcomes?

BLOOM'S TAXONOMY

Bloom, B. (1979). Taxonomy of Educational Objectives. Handbook 1: Cognitive Domain. New York: David McKay.

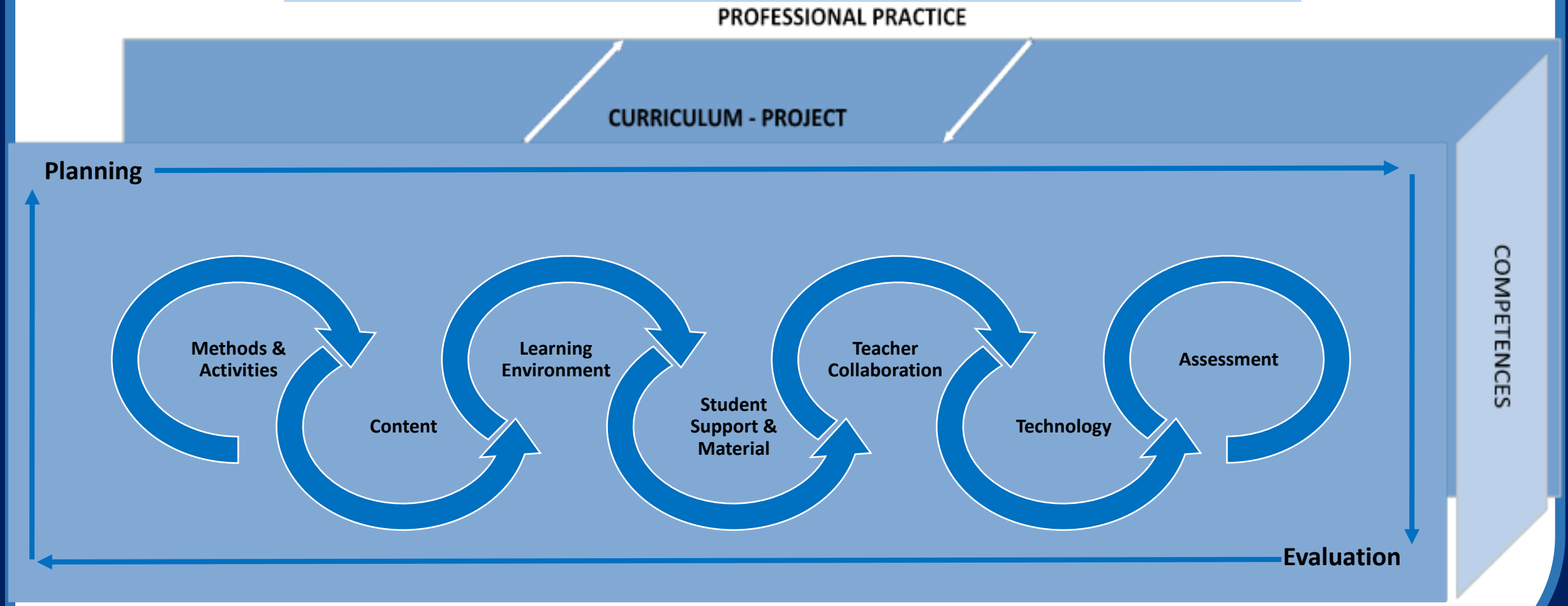
Benjamin Bloom – Original (1956; 1979) and Revised by Krathwohl (2002)

Framework to promote higher forms of thinking in education

Helps teachers to design valid assessment tasks and strategies considering the objectives defined **(curriculum alignment)**

Co-funded by the Erasmus+ Programme of the European Union

Curriculum Alignment

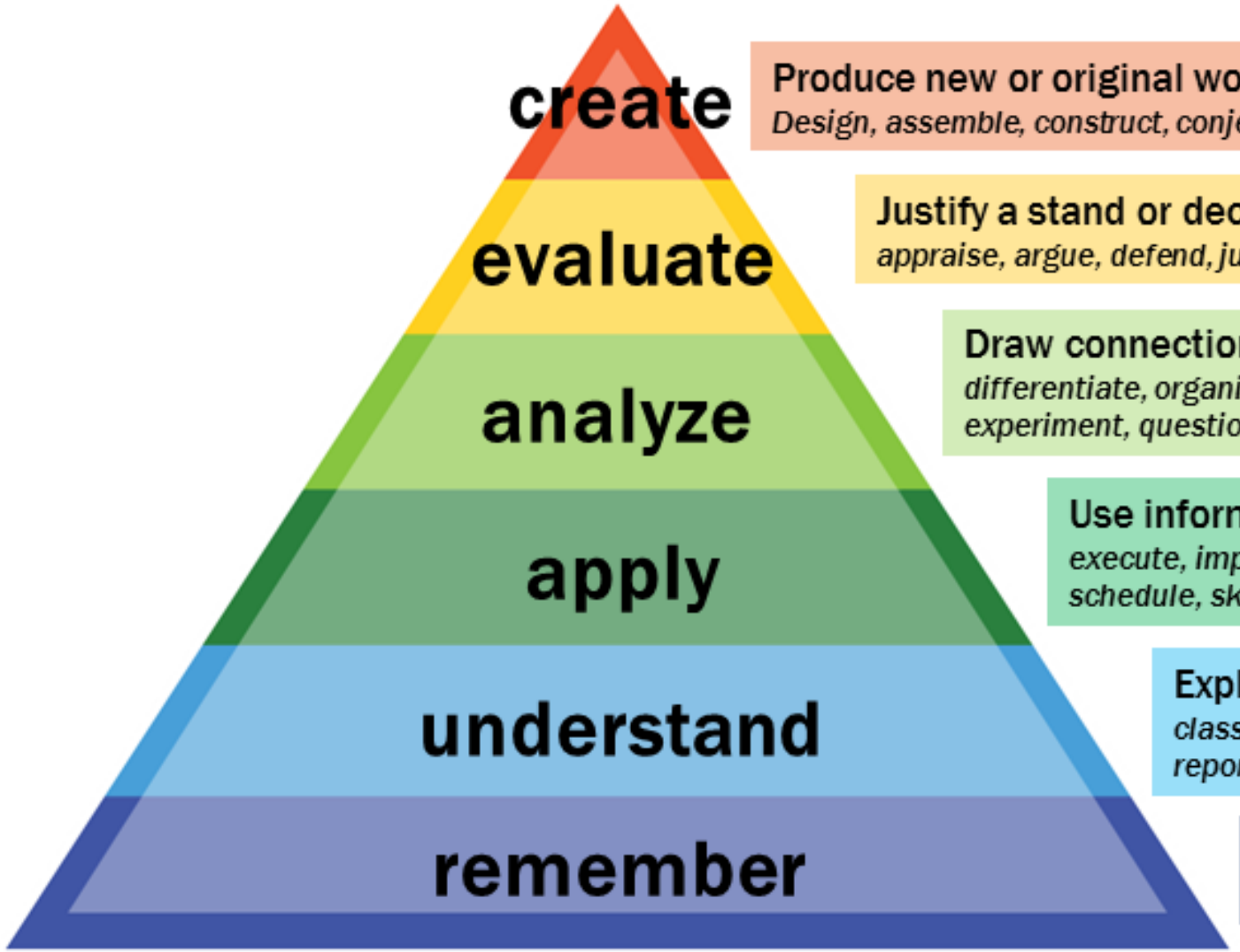


Mesquita (2015) - Model of Curriculum Development for HE

Erasmus+ Programme of the European Union

Source: cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Bloom's Taxonomy



Produce new or original work
Design, assemble, construct, conjecture, develop, formulate, author, investigate

Justify a stand or decision
appraise, argue, defend, judge, select, support, value, critique, weigh

Draw connections among ideas
differentiate, organize, relate, compare, contrast, distinguish, examine, experiment, question, test

Use information in new situations
execute, implement, solve, use, demonstrate, interpret, operate, schedule, sketch

Explain ideas or concepts
classify, describe, discuss, explain, identify, locate, recognize, report, select, translate

Recall facts and basic concepts
define, duplicate, list, memorize, repeat, state

Learning Outcomes Description (example) Integrated Production Management IEM-UMinho

Universidade do Minho

- **Identify** the requirements for implementing the functions of Integrated Production Management (IPM).
- **Discuss** the implications of different methods and functions of Integrated Production Management.
- **Identify, describe and analyse** processes of Integrated Production Management.
- **Integrate** organizational processes and techniques of Integrated Production Management.
- **Select** software tools to support processes of Integrated Production Management.

Co-funded by the Erasmus+ Programme of the European Union

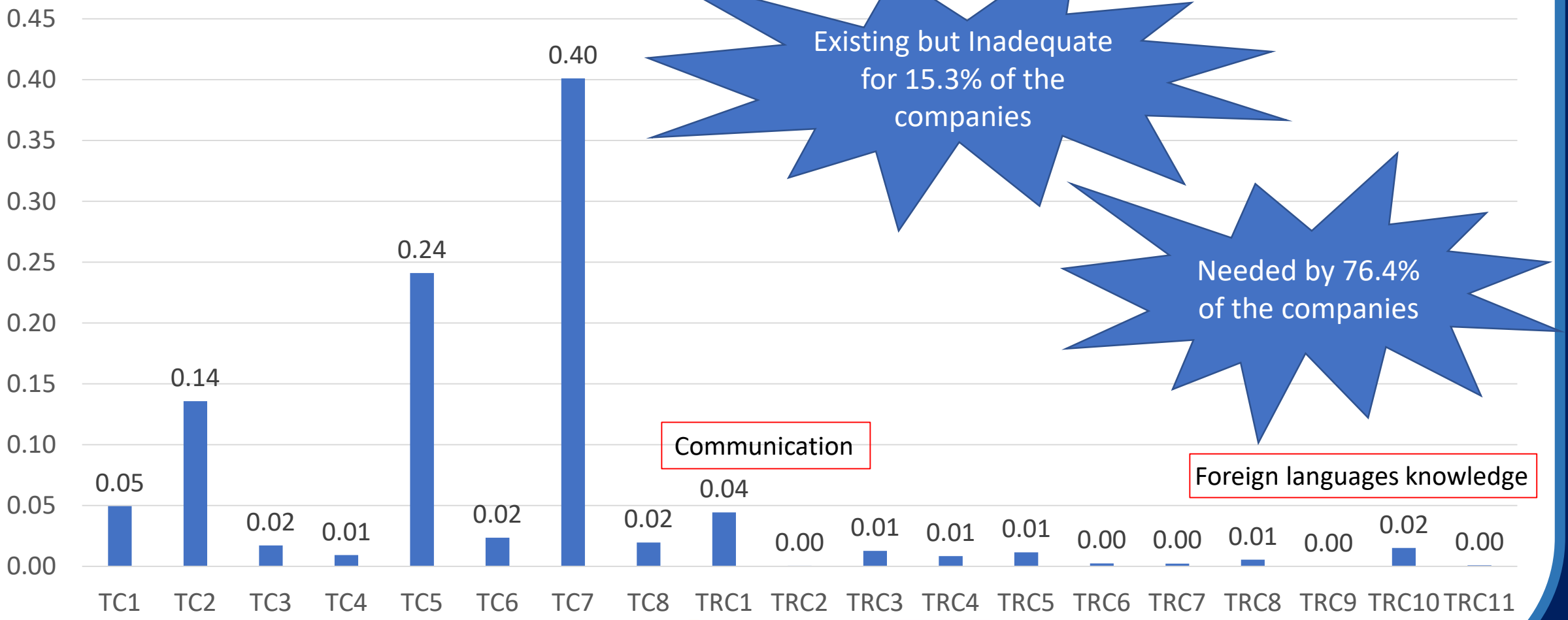
Learning Outcomes Graph from an UMinho program

Universidade do Minho

Industrial Engineering and Managementspecific classification	ECTS	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TRC1	TRC2	TRC3	TRC4	TRC5	TRC6	TRC7	TRC8	TRC9	TRC10	TRC11
IEM – Automation	7,5		3			3	3	6												
IEM - Computer and Information Systems	5	1				2	1	2												
IEM - Economics Engineering	5		1		1	2														
IEM - Ergonomics and Human Factors	17,5	2	3	1		8	4	9												
IEM – Logistics	5	1		1		2		2	2											
IEM – Maintenance	5	3	1	1		3		2												
IEM - Operations Research	18	3	3			6	3	5												
IEM - Product Design	5		1			3		1	1											
IEM - Production Management	27,5	4	3	3	2	9	6	15	3	4										
IEM – Project	10		2	2	2	4	2		2	2	2	2	2	2		2		2		
IEM - Project Management	10	3	1	1	1	4	2	5	1	2		1								
IEM – Quality	12,5	1	1			6	3	10	1											
IEM – Simulation	5	1	1			1	1													
IEM – Sustainability	2,5	1	1					2												
IEM – IEM	41		2	1	1	2		7	2	1			2							
Grand Total	176,5	20	23	10	7	55	25	66	12	9	2	3	4	2	0	2	0	2	0	0
		8,3%	9,5%	4,1%	2,9%	22,7%	10,3%	27,3%	5,0%	3,7%	0,8%	1,2%	1,7%	0,8%	0,0%	0,8%	0,0%	0,8%	0,0%	0,0%

Co-funded by the Erasmus+ Programme of the European Union

Learning Outcomes Graph from MSIE4.0 project - selected European programs



Co-funded by the Erasmus+ Programme of the European Union

Final Remarks

1. Engineering Practice: implies technical and transversal
2. Development of competences: different approaches (PBL)
3. Learning Outcomes: transversal competences might be “invisible”

Co-funded by the Erasmus+ Programme of the European Union

References

- Bloom, B. (1979). *Taxonomy of Educational Objectives. Handbook 1: Cognitive Domain. New York: David McKay.*
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111(23), 8410-8415. doi:10.1073/pnas.1319030111*
- Krathwohl, D. R. (2002). A Revision of Bloom's Taxonomy: An Overview. *Theory Into Practice, 41(4), 212-218.*
- Mesquita, D., Lima, R. M., Flores, M. A., Marinho-Araujo, C., & Rabelo, M. (2015). Industrial Engineering and Management Curriculum Profile: Developing a Framework of Competences *International Journal of Industrial Engineering and Management, 6(3), 121-131.*

Co-funded by the Erasmus+ Programme of the European Union

MSIE 4.0

Co-funded by the
Erasmus+ Programme
of the European Union

Thank You

Universidade do Minho

Curriculum Development

of Master's Degree Program in

Industrial Engineering for Thailand Sustainable Smart Industry