Multidisciplinary Journal for Education
Social and Technological Sciences

http://polipapers.upv.es/index.php/MUSE/
e-ISSN: 2341-2593

Comprehensive educational model based on Challenge-Based Learning for the improvement of competency performance

Diego Carmona-Fernández[a*], Diego Rodríguez-Méndez[a], José L. Canito-Lobo[b], Francisco Quintana-Gragera[c], Juan P. Carrasco-Amador[b], Alfonso C. Marcos-Romero[b], Jesús M. Rodríguez-Rego[b], Laura Mendoza-Cerezo[b]

[a]Department of electrical, electronic and automatic engineering. School of Industrial Engineering. University of Extremadura. Avenida de Elvas, s/n. 06006-Badajoz. Spain

[b]Department of Graphic Expression electrical, electronic and automatic engineering. School of Industrial Engineering. University of Extremadura. Avenida de Elvas, s/n. 06006-Badajoz. Spain

[c]Department of mathematics. School of Industrial Engineering. University of Extremadura. Avenida de Elvas, s/n. 06006-Badajoz. Spain

*Correspondence: dcarmona@unex.es

Received: 14 January 2023; Accepted: 22 February 2023; Published: April 2023

Abstract

"Insanity is doing the same thing over and over again and expecting different results". This phrase, attributed to Albert Einstein, contains a message that sums up what is happening in education systems. Fortunately, an increasing number of "madmen" are choosing to do something different to "innovate" in the teaching-learning process.

This paper shows the influence of innovating in four key aspects that influence learning: instruction, methodology, space and time, if we want to improve competence performance and start to make the objectives of the Bologna Declaration a reality, through experiences carried out in the School of Industrial Engineering (EII) of the University of Extremadura.

Keywords: Learning; competences; Hiperclassrooms; ABR; Teaching methodologies.

To cite this article: Carmona-Fernández, D., Rodríguez-Méndez, D., Canito-Lobo, J.L., Quintana-Gragera, F., Carrasco-Amador, J.P., Marcos-Romero, A.C., Rodríguez-Rego, J.M., Mendoza-Cerezo, L. (2023). Comprehensive educational model based on Challenge-Based Learning for the improvement of competency performance. Multidisciplinary Journal for Education, Social and Technological Sciences, 10(1), 51-66. https://doi.org/10.4995/muse.2023.19110

http://polipapers.upv.es/index.php/MUSE/
e-ISSN: 2341-2593

1. Introduction

At the university level, the Bologna Declaration (van der Wende, 2000) marked the beginning of the well-known Bologna Process whose objectives included the establishment of the European Higher Education Area (EHEA) (Curaj et al., 2020) seeking "...to introduce a more comparable, compatible and coherent system for European higher education".

Among the objectives formulated in Bologna, three stand out: the need to "...reformulate education around student learning and not teaching based on the transmission of content", "...promote lifelong learning", and "...formulate academic, competence and professional qualification criteria that respond to the demands of the European labour market and make it possible to respond to current educational, employment and social challenges" (García & Pérez, 2008).

This commitment to a change of educational paradigm is not exclusive to the university context, but, under the term "Rethinking Education" and in accordance with the European Commission's Communication (Rethinking Education: Investing in Skills for Better Socio-Economic Outcomes, 2012), it extended to all levels of education, "from the cradle to the grave". It called on states to take immediate action to ensure that young people develop the skills and competences needed for the labour market and for their all-round development as individuals. Among these challenges, it highlighted the need to concentrate efforts on the development of transversal skills and on measuring achievement in terms of learning outcomes (and not content), among others, calling for new approaches and methodologies focused on learning as a tool to achieve this.

Some of the main weaknesses detected in this process of changing the educational paradigm which, centred "on teaching", must evolve "to learning", have to do precisely with the three aforementioned objectives, questioning in relation to them whether significant progress is really being made in them (Alonso, 2017). It is difficult to differentiate between teaching and learning (Fernández, 2018). And in this duality, as in most dualities, we tend to get lost in the belief that there is only one binary interpretation. Bologna urged us to change the mental focus by putting the student at the centre of teaching activity and for this to be centred on learning, on achievements or results, and not on the teacher as the transmitter of a series of contents where assessment measures how much of these contents have been processed, memorised, but does not undervalue the latter. It means confronting two mental models, as in Matrix©, one "traditional" and the other "current", "unreal" vs "real", trying to find, between them, a compromise adaptable to what the changing context demands at any given moment.

The difference lies fundamentally in "where to place the emphasis" (Carmona et al., 2021), teacher-student, contents-competences, subjects-projects, in short... teaching or learning; and in how to act on 4 elements considered key in learning (Gómez, 2017; Rowe & Klein, 2007): (results of) Learning, Methodology, Spaces and Times (LMST).

There are many initiatives that we find disseminated in different publication formats as a result of actions that seek to innovate in relation to the second of the four previous elements: methodology. But we do not find so many in relation to the other three, especially in relation to the two that we consider key: planning focused on learning outcomes and the physical/virtual spaces from which learning will take place.

All the actions analysed seem to have among their recorded lessons learned, one that warns of the special importance for the model of the creation of appropriately designed spaces. At present, there are numerous references that emphasise the importance of the appropriate design of the spaces used in order to achieve success in the implementation of actions that foster the acquisition of transversal competences by pupils. One example can be found in different models promoted around the world, such as the aforementioned Reinvent The Classroom (RTC) project promoted by HP (*MuyPymes*, 2022).

In these models, whose main objective is to ensure that students improve their level of performance in the skills most in demand in the 21st century, four actions are combined: a definition of spaces that make them dynamic and easily mouldable; immersive and up-to-date technology that makes learning dynamic; the necessary training for participating teachers; and the promotion of projects in which students participate with appropriate guidance and tutoring from the teaching staff.

In learning models based on active methodologies for challenge/project work, such as that represented by "no problems, Solutions" (npS) (Carmona et al., 2021), it is essential to have cutting-edge educational spaces and classrooms with a high degree of interaction, with a skilful use of technology and where there are highly trained, innovative teachers linked to the practice of their profession, as anticipated by one of the educational institutions in the world where ABR is most successfully applied: the TEC de Monterrey.

One of the configurations of spaces with the greatest potential for this type of methodology are those that have come to be known as "hyperclassrooms" (Fernández, 2019).

It is hyper (space) not only because its dimensions can be more or less large, as a hypermarket would be, but because, like a hypermarket, "it allows different configurations, and can be easily redesigned to be used by the large group or by smaller groups in the form of small work agoras, either in the form of a traditional classroom with the furniture in a linear position or in a distributed form of small work groups, or in distributions that allow for the simulation of work in series, etc.". They are therefore large and flexible spaces, which can be reconfigured very easily in all three dimensions (also in height, for example, by having different spaces within them depending on the preferred task to be carried out). They also allow flexibility in terms of the type of work to be carried out: individually or in groups, as well as temporal uses that are not necessarily sequential, with the possibility of even asynchrony. Moreover, it is hypermedia in that it allows the simultaneous use of print and digital, physical and virtual, real and simulated, in any of the possible formats in which we can store information today. It is the way in which we are able to move the classroom into the global village, broadening its horizons.

The RTC models consider four spaces necessary within the educational space to work by projects/challenges: thinking zone (where students "think", "reflect" on the project to be carried out); design zone (where ideas are shaped and work is done in teams, "creating"); maker zone (where tools are used to obtain a "model" or "prototype" in the project, it is "manufactured"); and stage zone (where projects are exhibited, presented in public, students interact with each other, ...). In these spaces, and throughout the development of the project, the students manage to improve their performance in many transversal skills, both intrapersonal and interpersonal (public speaking, resilience, solution orientation, teamwork, negotiation, problem solving and conflict resolution...), as well as in the techniques related to their studies.

At the EII of the UEx, the Teaching Innovation Group (GID) "innovaCción" ("innovate for aCtion") and with the support of the management team, has been promoting an LMST model with certain roots similar to the Tec21 model of the Tecnológico de Monterrey (Martín, 2002), taking advantage in parallel of the synergies of hyper-classroom spaces and the RTC approach, Reinvent The Classroom, promoted by HP, Intel and Microsoft, for which action has been taken on different physical spaces in the School to adapt them to the LMST model to be implemented. This work shows and quantifies with a real holistic experience the importance on the improvement of the competence performance of implementing actions where the four elements of the LMST models are worked on in an integral and coordinated way, and how each of these elements has contributed to the reduction of the competence gap.

2. Objectives

The general objective of this study has been to evaluate the improvement in competence performance that occurs in a set of technical and transversal competences when evolving from a traditional model of "teaching" to an LMST model of "learning". The specific objective was to detect and quantify the influence that each of the four elements considered key in the learning processes (learning, methodology, spaces and time) has on the improvement of competences, thus allowing us to question the convenience of including them in the final model, especially for the necessary justification of the investment to be made in the adaptation of the necessary physical spaces.

It has been carried out at the School of Industrial Engineering (EII) of the University of Extremadura (UEx) based on the work of the Teaching Innovation Group (GID) called "innovaCción", made up of more than forty teachers/researchers. The model has been applied in different scenarios of the degrees where the teaching staff of the GID teach, continuing the line of work of the group in recent years.

3. Methodology

The promoted model combines the strengths of challenge-based learning (ABR) approaches (Escamilla et al., 2015; Johnson et al., 2009; Markham, 2014), of methodologies with strong roots in Project management, such as "no problems, Solutions (npS)" (Cerezo & Bastante, 2018) of the potential of hyper-classroom spaces (Fernández, 2018) and RTC spaces, and which is not constrained to the usual temporal sequentiality of traditional processes (Fernández, 2019). This model began to be applied years ago in an informal way within the Comprehensive Orientation Plan (POI) that the Centre offers students transversally to the degrees taught there, as a pilot process for a later attempt to extrapolate it to official degrees when the "singularities" of the university world made it possible, and while modifications were being made to the spaces to create the necessary hyper-classroom spaces.

The LMST model shown in this paper has the following methodological characteristics:

- Learning: Challenge-Based Instruction (ABR) and/or Project-Based Instruction (ABP) (based on learning outcomes).
- Methodology: npS© (no problems, Solutions), a methodology that draws on up to twelve disciplines, techniques and tools of great educational value (Project management, flipped classroom...).
- Spaces: Hyper-classrooms with RTC spatial configuration.
- Times: Non-sequential, non-linear and not divided into uniform time units (end "at 50 minutes past the hour").

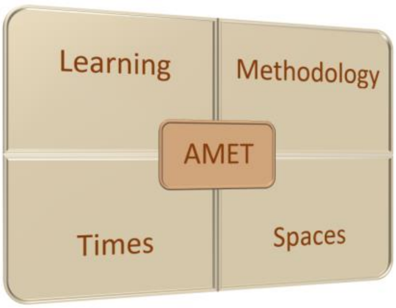

Figure 1. LMST square.

Different subjects were selected for the validation of the model. The process described and the results shown correspond to a subject in the 4th year of the Degree in Electrical Engineering (Industrial branch), as this is the subject on which the entire process was measured.

Work began on validating the model in the 2015-2016 academic year, ending in 2020-2021. At the beginning of the process, a total of three technical competences and two transversal competences were selected, which would be assessed to measure the improvement in competence performance that the total performance of the new LMST approach would make it possible to achieve.

For each of the 5 years that the action has lasted, a target sample of 15 students was selected at the beginning of the academic year to be monitored without their knowledge and without differentiating them from the rest of the class. These students were selected on the basis of the marks obtained in the EBAU or university entrance exams, so that the mean and standard deviation of the students' marks in this exam would be similar in each year, thus avoiding the bias that would occur, for example, if in some years the mean of the group's entrance exam marks were much higher than in other years or if there were a greater dispersion within the sample among the different students.

In the 2015-16 academic year we worked with the model considered traditional, i.e., predominantly content-based classes and predominantly teacher-led, as had been the case in previous years, with the subject divided into large group classes with a predominance of lectures, laboratory classes, seminars and computer practice and traditional tutorials, "packaged" in units of "50-minute hours" and conventional classrooms ("egg cupboard" classrooms). During this academic year, pilot teachers began to be instructed in the application of project-based instruction (PBL) and challenge-based instruction (RBA).

In the 2016-17 academic year, the first action was implemented, working on the A of the LMST model: learning. To this end, we began to work under instruction by challenges (ABR), challenges that students worked on in the subject from day one, although the content remained the predominant vehicle in the teaching-learning journey: the starting point.

In the 2017-18 academic year, the second action was implemented, working on the M of the model: methodology. We worked with the npS methodology (Cerezo & Bastante, 2018), carrying out a programme based on the formulation of explicit learning outcomes for the student, relating them to the competences to be improved, covering the six areas of knowledge (knowing, knowing how to say, knowing how to do, knowing how to be, knowing how to be and knowing how to want) in proportion to the objectives and aims sought, and with a clear and explicit formulation for the student of the performance criteria that would make up the assessment (rubric known at the beginning). Clearly identifying the learning outcomes to be assessed and making them explicit from the outset should improve instruction and student learning.

In the 2018-19 academic year, we worked on the third LMST element: Spaces. We worked with the students in a hyper-classroom space (still under construction, which, in theory, diminished its potential), where it was easier to implement certain activities as opposed to the classroom-room, such as those that involved working on teamwork skills, for example.

In parallel to this process of validation of the model, the GID had initiated a process of reflection, analysis and action at the EII to define and create spaces where this teaching approach could be implemented by promoting projects that would allow its impact on the improvement of the competences of the participating students to be measured. As a result, the Centre's "innovation" area was built, consisting of an individual study area, a resource hyperlibrary (a mixture of a physical and virtual library of resources other than books), a teamwork area, a Fablab, two hyperclassrooms, a researcher's area and two exhibition/meeting rooms (*EIImpresas*, 2021).

Figure 2 shows hyperclassrooms 1 and 2: two spaces with the RTC characteristics and layout indicated above for this reformulation of the classrooms, thus facilitating the application of learning-centred methodologies.

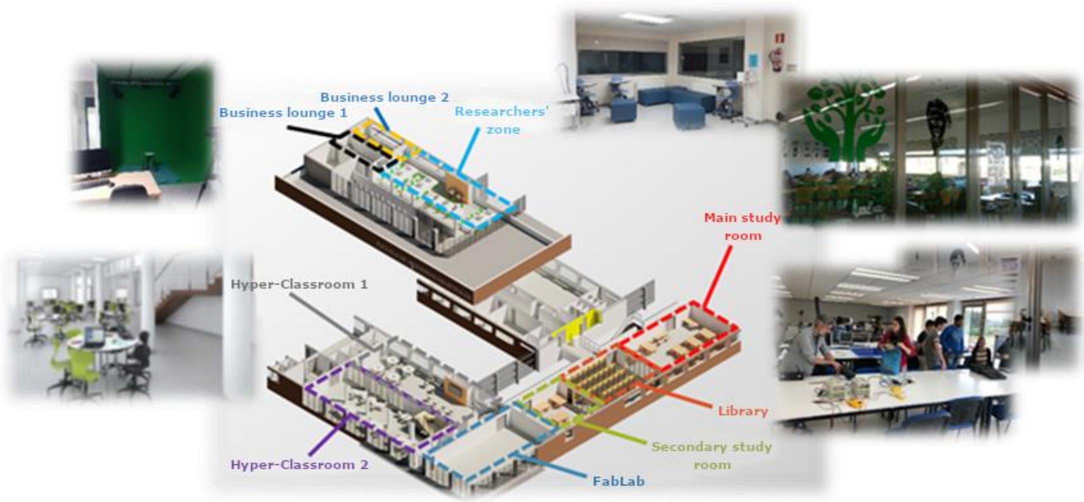

Figure 2. Hyper-classroom spaces in School of Industrial Engineering.

The physical space "innovation" is now a reality in the School of Industrial Engineering (“HOY,” 2022), guaranteeing the continuity of the model in the extension of the defined objectives to other subjects and/or degrees taught at the Centre.

Finally, in the 2019-20 academic year, we worked on the fourth element: Time. We broke away from the traditional linearity of classes with classic time intervals and large-group theoretical

http://polipapers.upv.es/index.php/MUSE/
e-ISSN: 2341-2593

classroom activities and computer, seminar and/or laboratory practicals, to move towards time divisions adapted to the activity to be carried out within the programme (if four hours were needed for an activity, we worked on it for four hours at a time), working in hackathon mode when necessary.

4. Results

In order to be able to measure the improvement of competence performance, assessments were carried out in each course using rubrics and 360º observation, at two points in time: at the beginning (first day) and at the end of the four-month period in which the subject was taught (final assessment). Two more non-binding evaluations were carried out at intermediate moments, for the control and monitoring of the activity and to motivate the students. The score for each rubric was standardised at 100 points (maximum value). The total score of the assessment could reach the maximum value of 300 points, representative of 100% competence performance.

The assessment carried out had three components: one, self-assessment, carried out by the student him/herself; another, co-assessment, carried out by classmates; and a third, heteroassessment, carried out jointly by the teacher and a "third party" (employer, another teacher, a professional related to the subject, etc.) who had not participated in the training process. The weights of these three components were, respectively: 25%, 30% and 45%.

The main results obtained are shown in the following image (the images of the tables for the transversal competence COM01: teamwork, of the five that were assessed, are shown for the academic years 2015-2016, traditional model, and 2019-2020, LMST model, as this was the one in which the worst results were obtained, with a higher improvement in the other four competences monitored).

http://polipapers.upv.es/index.php/MUSE/
e-ISSN: 2341-2593

TABLE 01

TRADITIONAL MODEL — 2015-2016 — COM01

Student	AC		IE								FE								Improvement	Gap
	Máx:	14,0	0,25	80,0	0,30	100,0	0,45	120,0	1,0	300,0	0,25	80,0	0,30	100,0	0,45	120,0	1,0	300,0		
	Value	%máx	Auto	%máx	Co	%máx	Het	%máx	Prom(%)	Value	Auto	%máx	Co	%máx	Het	%máx	Prom(%)	Value	pp	%
1	6,4	45,6	18,3	22,9	18,1	18,1	18,1	15,1	17,9	53,8	34,8	43,5	41,5	41,5	72,6	60,5	50,6	151,7	32,6	49,5
2	12,2	86,9	11,6	14,5	14,1	14,1	14,3	11,9	13,2	39,6	26,2	32,8	40,3	40,3	70,2	58,5	46,6	139,8	33,4	53,4
3	9,4	67,4	20,1	25,1	19,6	19,6	20,4	17,0	19,8	59,3	33,6	42,0	54,2	54,2	71,5	59,6	53,6	160,7	33,8	46,4
4	11,2	80,2	7,5	9,3	12,1	12,1	11,7	9,7	10,3	30,9	28,5	35,6	35,8	35,8	74,8	62,3	47,7	143,1	37,4	52,3
5	9,0	64,0	9,7	12,1	10,4	10,4	9,8	8,2	9,8	29,4	35,6	44,5	57,1	57,1	66,2	55,2	53,1	159,2	43,3	46,9
6	9,5	67,6	12,3	15,3	13,2	13,2	13,4	11,1	12,8	38,3	23,4	29,3	42,2	42,2	69,3	57,8	46,0	137,9	33,2	54,0
7	8,1	57,6	10,1	12,6	11,2	11,2	11,3	9,4	10,7	32,1	31,4	39,3	41,3	41,3	56,9	47,4	43,5	130,6	32,8	56,5
8	6,9	49,4	12,2	15,2	13,1	13,1	10,7	8,9	11,7	35,1	26,8	33,5	46,5	46,5	63,6	53,0	46,2	138,5	34,5	53,8
9	7,6	54,2	20,2	25,2	22,2	22,2	21,7	18,0	21,1	63,2	30,6	38,3	64,6	64,6	71,5	59,6	55,8	167,3	34,7	44,2
10	6,4	45,9	14,3	17,8	16,2	16,2	15,5	12,9	15,1	45,3	27,9	34,9	45,4	45,4	64,9	54,1	46,7	140,0	31,6	53,3
11	11,2	80,1	11,3	14,1	13,2	13,2	16,1	13,4	13,5	40,5	39,2	49,0	47,1	47,1	59,1	49,3	48,5	145,6	35,0	51,5
12	8,7	62,1	11,7	14,6	12,3	12,3	12,9	10,7	12,1	36,4	26,9	33,6	49,7	49,7	64,7	53,9	47,6	142,7	35,4	52,4
13	6,5	46,8	8,7	10,8	8,9	8,9	9,2	7,6	8,8	26,4	29,6	37,0	55,5	55,5	72,7	60,6	53,2	159,5	44,4	46,8
14	5,5	39,4	11,1	13,8	10,6	10,6	10,5	8,7	10,6	31,7	40,8	51,0	46,7	46,7	69,4	57,8	52,8	158,4	42,2	47,2
15	12,6	89,8	22,2	27,7	21,2	21,2	23,4	19,5	22,0	66,1	31,2	39,0	48,9	48,9	64,6	53,8	48,6	145,9	26,6	51,4
Prom:	8,7	62,5	13,4	16,7	14,4	14,4	14,6	12,1	14,0	41,9	31,1	38,9	47,8	47,8	67,5	56,2	49,4	148,1	35,4	50,6
TD:	2,2	15,5	4,4	5,5	4,0	4,0	4,4	3,6	4,1	12,4	4,8	5,9	7,3	7,3	5,0	4,2	3,4	10,3	4,6	3,4
VAR:	4,7	241,3	19,6	30,6	15,7	15,7	19,0	13,2	17,1	153,7	22,6	35,3	53,1	53,1	25,0	17,4	11,8	106,6	20,8	11,8
Q4-Q0:	7,1	50,4	14,7	18,4	13,3	13,3	14,2	11,8	13,2	39,7	17,4	21,8	28,8	28,8	17,9	14,9	12,2	36,6	17,7	12,2
Q2:	8,7	62,1	11,7	14,6	13,2	13,2	13,4	11,1	12,8	38,3	30,6	38,3	46,7	46,7	69,3	57,8	48,5	145,6	34,5	51,5
Q3:	10,3	73,8	16,3	20,3	17,1	17,1	17,1	14,3	16,5	49,5	34,2	42,8	52,0	52,0	71,5	59,6	52,9	158,8	36,4	53,4

TABLE 02

LMST MODEL — 2019-2020 — COM03

Student	AC		IE								FE								Improvement	Gap
	Máx:	14,0	0,3	80,0	0,3	100,0	0,5	120,0	1,0	300,0	0,3	80,0	0,3	100,0	0,5	120,0	1,0	300,0		
	Value	%máx	Auto	%máx	Co	%máx	Het	%máx	Prom(%)	Value	Auto	%máx	Co	%máx	Het	%máx	Prom(%)	Value	pp	%
1	6,2	44,1	17,2	21,5	20,0	20,0	17,7	14,8	18,0	54,0	67,3	84,1	83,3	83,3	106,0	88,3	85,7	257,2	67,7	14,3
2	7,7	55,1	15,1	18,8	14,9	14,9	19,5	16,2	16,5	49,4	70,4	88,0	74,4	74,4	101,5	84,6	82,4	247,1	65,9	17,6
3	10,1	72,1	16,3	20,4	19,4	19,4	19,9	16,6	18,4	55,1	74,9	93,7	90,9	90,9	116,0	96,7	94,2	282,5	75,8	5,8
4	7,5	53,2	4,1	5,1	9,3	9,3	10,7	8,9	8,1	24,2	69,2	86,5	83,0	83,0	108,2	90,2	87,1	261,3	79,0	12,9
5	9,5	67,9	5,4	6,8	10,5	10,5	9,2	7,7	8,3	24,9	71,5	89,4	85,4	85,4	108,7	90,6	88,7	266,2	80,4	11,3
6	7,3	52,0	22,2	27,8	17,1	17,1	22,9	19,1	20,7	62,0	68,5	85,7	81,9	81,9	105,5	87,9	85,5	256,6	64,9	14,5
7	9,7	69,6	10,4	13,0	9,7	9,7	15,6	13,0	12,0	36,0	63,1	78,8	87,3	87,3	102,0	85,0	84,1	252,4	72,1	15,9
8	9,2	65,9	22,3	27,8	21,9	21,9	21,6	18,0	21,6	64,8	71,0	88,7	86,9	86,9	104,4	87,0	87,4	262,2	65,8	12,6
9	6,0	42,8	24,8	30,9	25,3	25,3	26,4	22,0	25,2	75,7	71,7	89,6	94,1	94,1	116,6	97,2	94,4	283,2	69,2	5,6
10	11,3	80,4	19,0	23,8	21,6	21,6	20,6	17,1	20,1	60,4	67,1	83,9	79,6	79,6	104,6	87,2	84,1	252,2	63,9	15,9
11	9,6	68,2	6,6	8,2	13,5	13,5	10,9	9,0	10,2	30,5	72,4	90,5	94,3	94,3	102,1	85,1	89,2	267,6	79,0	10,8
12	9,9	70,4	9,7	12,1	9,8	9,8	10,7	8,9	10,0	29,9	70,2	87,7	88,9	88,9	107,5	89,5	88,9	266,6	78,9	11,1
13	8,4	59,6	8,6	10,7	12,5	12,5	12,0	10,0	10,9	32,8	72,2	90,3	88,9	88,9	108,2	90,2	89,8	269,5	78,9	10,2
14	7,5	53,2	15,2	19,0	17,1	17,1	19,1	15,9	17,0	51,1	72,8	91,0	92,1	92,1	108,1	90,1	90,9	272,7	73,9	9,1
15	12,2	86,8	11,5	14,3	13,1	13,1	18,0	15,0	14,3	42,8	65,8	82,2	78,4	78,4	100,7	83,9	81,8	245,5	67,6	18,2
Prom:	8,8	62,7	13,9	17,3	15,7	15,7	17,0	14,1	15,4	46,2	69,9	87,3	86,0	86,0	106,7	88,9	87,6	262,9	72,2	12,4
TD:	1,7	12,3	6,3	7,8	4,9	4,9	5,0	4,2	5,2	15,5	3,0	3,7	5,7	5,7	4,6	3,8	3,7	11,1	5,9	3,7
VAR:	3,0	150,7	39,3	61,4	24,2	24,2	25,4	17,7	26,6	239,0	8,9	13,9	32,1	32,1	21,1	14,6	13,6	122,2	34,7	13,6
Q4-Q0:	6,2	44,0	20,7	25,8	16,0	16,0	17,1	14,3	17,1	51,4	11,9	14,8	19,8	19,8	16,0	13,3	12,5	37,6	16,5	12,5
Q2:	9,2	65,9	15,1	18,8	14,9	14,9	18,0	15,0	16,5	49,4	70,4	88,0	86,9	86,9	106,0	88,3	87,4	262,2	72,1	12,6
Q3:	9,8	70,0	18,1	22,6	19,7	19,7	20,2	16,9	19,2	57,7	72,0	90,0	89,9	89,9	108,2	90,2	89,5	268,5	78,9	15,2

Figure 3. Evaluation results for the first and last year of the period under study. Competence COM1: teamwork.

The average and standard deviation statistics are shown in relation to the competence assessed, as well as the variance and quartiles at the initial moment of the assessment (IE), and at the end of the process (FE), normalising the values per student with the weightings described above and on the score of each rubric.

The image shows the improvement in competence performance (improvement) at the end of the process compared to that recorded at the beginning, with a final performance for the competence shown of 72 percentage points on average. The competence gap at the end of the process with respect to the maximum of 100% for each student can also be seen, with an average of 12% for the sample assessed.

The partial results per course for the whole process were as follows:

- Course 2015-2016 (Traditional): Final average 35.4 %. Final gap: 50.6 %.
- Course 2016-2017 (A): Final average 44.6 %. Final gap: 41.9 %.
- 2017-2018 (AM): Final average 52.8 %. Final gap: 33.7 %.
- 2018-2019 academic year (AME): Final average 61.3 %. Final gap: 25.1 %.
- 2019-2020 academic year (LMST): Final average 72.2 %. Final gap: 12.4 %.

As can be seen, excellent results are being achieved in the improvement of competence performance (together with a clear improvement in the teaching satisfaction of both students and participating teaching staff), with an improvement of almost 40 percentage points. None of the actions on the four LMST elements evaluated is clearly preferential over the rest, being the overall result of the integral model the one that is significantly relevant. This makes it easier to implement the complete model depending on the possibilities and circumstances of each training environment and the necessary prior training of the teaching staff.

After the validation of the model, from the 2020-21 academic year, the teachers of the GID and others from other faculties/schools involved have been trained in the ABR methodology and in the conception and potential of these spaces, being instructed in the different phases of the definition of a challenge under ABR and how to take it to the classroom. Since then, the model has been applied from conception to development by different subjects and even a complete master's degree programme.

But beyond the importance of the data and the information they contain, it is worth highlighting the motivational boost that this type of models and spaces provide for the entire university community in general. One example can be found in the results obtained after the i-days hackathon at the end of 2021, a student competition to tackle health-related challenges, from the EIT Health programme of the European Institute of Innovation and Technology (EIT), where participating students and teaching staff were able to experience, as well as enjoy, the evolution from idea to solution, taking advantage of the work and knowledge acquired during the course in the different subjects, working on a collaborative technological challenge, which opens up immense possibilities for the successful development of university-business training actions.

This activity took advantage of the "innovaCción" spaces recently set up in the School of Industrial Engineering, with a fully active participation of more than 80 students from different degrees and centres/faculties. The students were grouped into teams on the condition that they did not know each other previously and that no team had more than two students with experience in the LMST model applied. The challenge was announced on the day of the hackathon. The times had to be modified at the request of the students, due to the interest aroused, and were extended by 3 hours per day, in total work days that exceeded 12 hours per day, for two consecutive days. A clear indicator of the motivational nature of the model.

All the teams managed to find a solution to the challenge (objective achieved) and focused on all the phases of the RTC models (thinking, design, maker and stage), with 89% of the participants giving priority, at the end of the hackathon, to the experiential learning achieved, leaving in the background, in most cases, the objective of the final prize of the competition.

In terms of the maximum possible score to be obtained in the competency assessment carried out (108 points), all the teams achieved, in percentage terms, a score higher than 5 (the team with the worst score obtained an average score of 56.5, so that, in percentage terms, it would have a score of 5.23, or 52.31% of the maximum score). The team with the highest score achieved a score of 82.41%.

The participating companies expressed their desire to participate again in the following years if new editions were held and their interest in the new spaces configured. The teachers who asked to attend the event as simple observers found that the attention and motivation of the participants was very high, and they were able to witness a clear example of the importance of active methodologies when students consider that learning is essentially experiential. An additional 20% of teachers requested, from that moment on, reservations for the spaces created.

5. Conclusions

If we want to "put the accent" on the student, we must act on the four key elements of learning, because of their high influence on it. Acting on the methodology to orient it towards active versions is a necessary but not sufficient condition. It is necessary to act on spaces and times in order to take advantage of the potential of active instructions and methodologies.

Competency-based approaches require us to change our mental approach, we have to change where we place the accent, or rather the accent, whether on the "í" of the characteristics of the traditional model or on those of other models such as the one proposed in this paper, which is the result of combining the benefits of a set of disciplines, techniques and tools, with a strong presence of experiential, situational learning, which covers the four components of the HPL framework (student-centred, knowledge-centred, evaluation-centred and community-centred), and which, under the foundations of project management, enable the improvement of competency performance in the management of any situation to be resolved by turning it into a project.

And in these characteristics, the reconfiguration of spaces is one of those that requires the most attention in the short term, since many innovative, "crazy" teachers who want to bring active methodologies to their classrooms find that the characteristics of the space and the furniture do not allow it or, at the very least, favour it. There is no evidence in favour of the traditional classroom-room system, while there is increasing data and evidence of the superiority of hyper-classrooms, whether in terms of satisfaction, interest, performance, collaboration or combinations of these (Fernández, 2019).

It has been shown that during the i-Days work has been done on finding solutions to real-life challenges by working in teams with participants from different disciplines with the aim of encouraging and promoting innovation and entrepreneurship among students.

The dissemination of training activities with a longer timeframe has been increased on social networks.

A high level of interest in this type of initiative has been aroused among different social agents, from companies to the media.

The synergy created by the students themselves has been used to reinforce active methodologies in the classroom.

However, as "data beats narrative", this work has shown the results of one of the five competences evaluated in a 4th Degree subject in Electrical Engineering, during a five-year period of teaching activity, of the one in which the improvement in performance has been the least, reaching the conclusion that, both in technical competences and in transversal competences, the LMST model implemented is successful, with a reduction in the competence gap of almost 40 percentage points. The model has been implemented in other subjects and even in the programming and definition of a Master's degree as a whole.

So... blessed "madness".

Acknowledgements: This work has been carried out within the framework of the European reference project 211252 – HEI TRUE - Transforming Universities towards Entrepreneurship, a project whose main objective is to generate an impact on the educational ecosystem to rebuild the wide gap that still exists between entrepreneurship, teaching and research, the result of the consortium of 8 institutions that they seek to promote the accessibility of students and academic and non-academic staff to educational, complementary and other tools in this context. The researchers would like to thank TRUE for the framework generated to enable work like this.

Author Contributions:

All authors have contributed equally. All authors have read and agreed to the published version of the manuscript.

Funding: This research did not receive specific external funding for its realization, beyond the general funding provided by the 211252 HEI TRUE project referenced in the acknowledgments section.

Conflicts of Interest: The authors declare no conflict of interest.

References

Alonso, I. (2017). 15 years after Bologna. Development, current situation and challenges of the European Higher Education Area. *Revista Iberoamericana de Educacion Superior*, *8*(23), 199–213. https://doi.org/10.22201/IISUE.20072872E.2017.23.3018

Carmona, D., Rodríguez, D., & Román, S. (2021). Experiencias disruptivas en entornos educativos. In D. Carmona, D. Rodríguez, & S. Román (Eds.), *Experiencias disruptivas en entornos de aprendizaje*. Octaedro Editorial. https://doi.org/10.36006/16282

Cerezo, A., & Bastante, M. J. (2018). *Herramientas y experiencias para la evaluación por competencias en Dirección de Proyectos* (A. Cerezo & M. J. Bastante, Eds.; Vol. 2). UCA. https://publicaciones.uca.es/herramientas-y-experiencias-para-la-evaluacion-por-competencias-en-direccion-de-proyectos-2/

Curaj, A., Deca, L., & Pricopie, R. (2020). European Higher Education Area: Challenges for a New Decade. In A. Curaj, L. Deca, & R. Pricopie (Eds.), *European Higher Education Area: Challenges for a New Decade* (1st ed.). Springer Nature. https://doi.org/10.1007/978-3-030-56316-5

EIImpresas.(2021).https://www.unex.es/conoce-la-uex/centros/eii/archivos/ficheros/docs/boletines/boletiin-eiimpresas-01-vf.pdf

Escamilla, J., Quintero, E., Venegas, E., Fuerte, K., Fernández, K., & Román, R. (2015). *Aprendizaje Basado en Retos*. https://eduteka.icesi.edu.co/pdfdir/edutrends-aprendizaje-basado-en-retos.pdf

Rethinking Education: Investing in skills for better socio-economic outcomes, Pub. L. No. 52012DC0669, 20 (2012). http://ec.europa.eu/europe2020/index_en.htm

Fernández, M. (2018). Hacia el aprendizaje colaborativo en el propio ejercicio profesional. *Cuadernos de Pedagogía*, *489*, 1. https://redined.educacion.gob.es/xmlui/handle/11162/186849

Fernández, M. (2019, March 31). *The Conversation*. Hiperaulas: Así Es La Escuela Que Desbancará al Colegio Tradicional. https://theconversation.com/hiperaulas-asi-es-la-escuela-que-desbancara-al-colegio-tradicional-113795

García, J. V., & Pérez, M. C. (2008). Espacio Europeo de Educación Superior, competencias profesionales y empleabilidad. *Revista Iberoamericana de Educación*, *46*(9), 1–12. https://doi.org/10.35362/RIE4691886

Gómez, M. M. (2017, September 28). *e-Learning Masters*. ¿Cómo Funciona El Proceso de Enseñanza-Aprendizaje?http://elearningmasters.galileo.edu/2017/09/28/proceso-de-ensenanza-aprendizaje/

HOY. (2022, November 18). *La Escuela de Ingenierías Industriales Abre Dos Hiperaulas En Su Espacio "Innovacción"*.https://www.hoy.es/extremadura/escuela-ingenierias-industriales-20221118131946-nt.html

Johnson, L. F., Smith, R. S., Smythe, J. T., & Varon, R. K. (2009). Challenge-Based Learning: An Approach for Our Time. In *New Media Consortium*. New Media Consortium. 6101 W. Courtyard Drive Building One Suite 100, Austin, TX 78730. Tel: 512-445-4200; Fax: 512-445-4205; Web site: http://www.nmc.org.

Markham, T. (2014, March 24). *KQED*. How to Reinvent Project Based Learning to Be More Meaningful.https://www.kqed.org/mindshift/34618/moving-towards-inquiry-how-to-reinvent-project-based-learning

Martín, M. (2002). *El Modelo Educativo del Tecnológico de Monterrey*. Instituto Tecnológico y de Estudios Superiores de Monterrey.

MuyPymes. (2022, April 25). HP Amplía Su Iniciativa Global Reinvent the Classroom International (RTCi).https://www.muypymes.com/2022/04/25/hp-iniciativa-reinvent-classroom-international-rtci

Rowe, C., & Klein, S. (2007). A study of challenge-based learning techniques in an introduction to engineering course. *ASEE Annual Conference and Exposition, Conference Proceedings*, 12.125.1-12.125.15. https://doi.org/10.18260/1-2--1520

van der Wende, M. C. (2000). The Bologna Declaration: Enhancing the Transparency and Competitiveness of European Higher Education. *Higher Education in Europe*, *25*(3), 305–310. https://doi.org/10.1080/713669277