

## “Innovation, creativity and entrepreneurship” transversal competence evaluation by technical-economic analysis of commercial electrical transformers

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### Abstract

*“Innovation, creativity, and entrepreneurship” transversal competence evaluation method (CT04-UPV) used in Electrical Machines course (2<sup>nd</sup> course, Electrical Engineering Degree) is described in this paper. Its evaluation activity consists of a technical and economic analysis of different commercial electrical transformers, carried out by the students. To this end, students get in touch with electrical suppliers, obtaining real transformers data. With this data, they can calculate transformers efficiency through its energy losses and the economic cost that these losses suppose in a period of 10 years. In this way, students are able to question reality, identifying the existing necessity of evaluating not only its initial cost but also economic cost generated by its energy losses when selecting a transformer. With this method, CT04-UPV learning outcome referred to the 1<sup>st</sup> domain level is achieved: to question the reality, identifying improvement necessities and generating added value ideas. This methodology has been applied for the last three years in the course. In each year, students marks have been graded by the professor using a rubric. Results indicate that “innovation, creativity, and entrepreneurship” transversal competence learning outcome is satisfactorily reached by students. Moreover, rating survey answered by students, using Google Forms, shows that their level of satisfaction is very high.*

**Keywords:** transversal competence, evaluation, innovation, creativity and entrepreneurship.



## **1. Introduction**

Traditional university education has been focused on transferring specific knowledge to students, always directly related to the courses. The technical training that Universitat Politècnica de València (UPV) offers to the students is one of the widest and completest, as graduated students job performance has been verifying for years (“La UPV en los rankings,” 2018). However, transversal training of UPV students has not been enough worked out. For this issue, researches like (Fernández, 2011; Scallon, 2007) indicate that it is essential to develop a broad range of transversal competences, that can be defined as all the abilities associated with the personal growth, that does not depend on a specific topic, but appear in all the professional and academic performance fields (González & Wagenaar, 2003). In order to achieve this goal, Studies, Quality and Certification Vice-Rectorry from UPV launched The Transversal Competences Project (“Proyecto competencias transversales UPV,” 2005) on 2015, currently supported by UPV2020 strategic plan. In this project, thirteen transversal competences were defined. In every degree, all these thirteen competencies should be evaluated in different control point courses. Learning outcomes of the transversal competences are different, depending on the level of domain of the course: basic (1<sup>st</sup>) for 1<sup>st</sup> and 2<sup>nd</sup> years of degree, middle (2<sup>nd</sup>) for 3<sup>rd</sup> and 4<sup>th</sup> years of degree and advance (3<sup>rd</sup>) for master.

Electrical Machines course of 2<sup>nd</sup> year of Electrical Engineering Degree (Hurtado, 2018) is a control point of the transversal competence “Innovation, creativity and entrepreneurship” (CT04-UPV) (“CT04-UPV,” 2015). As this course is given during the 2<sup>nd</sup> year of the degree, the learning outcome concerns the 1<sup>st</sup> domain level: to question the reality, identifying improvement necessities and generating added value ideas. Chosen activity for evaluating this learning outcome consists of an academic work, where students develop a complete technical and economic analysis of different electrical transformers.

At the beginning, it was quite difficult for the professors of the course to find the suitable assessment method and instrument, as it was something new and unknown for them (Ramón et al., 2017; Villa, A y Poblete, 2007). The rubric “Rubric UPV CT-04. Innovation, creativity and entrepreneurship” (“Rúbrica UPV CT-04,” 2015), made by some UPV staff, meant a reference point for them, as it hugely helped professors find out the right activity to evaluate CT04-UPV in the 1<sup>st</sup> domain level. With the results compiled during three years, the present paper shows the study made to really verify the suitability between the evaluation method and the CT04-UPV learning outcome for Electrical Machines Course and its acceptance-scale among students.



## 2. Educational Methodology

### 2.1. “Innovation, creativity, and entrepreneurship” transversal competence

The Transversal Competences Project (“Proyecto competencias transversales UPV,” 2005), launched on 2015 by Studies, Quality and Certification Vice-Rectorate from UPV, collects thirteen transversal competencies, that should all be assessed in every degree by means of different control point courses. In this paper, “Innovation, creativity and entrepreneurship” (CT04-UPV) (“CT04-UPV,” 2015) is going to be deeply analyzed since Electrical Machines course is one of its control point courses.

This competence looks for innovation as a mean of answering to the personal necessities and social claims, with the aim of adding new value with an entrepreneurship behavior (Cuenca et al., 2016). Focusing on the student, it is necessary to detect the improvement of this competence development. For this issue, three levels of domain are defined: 1<sup>st</sup> for 1<sup>st</sup> and 2<sup>nd</sup> years of degree, 2<sup>nd</sup> for 3<sup>rd</sup> and 4<sup>th</sup> years of degree and 3<sup>rd</sup> for master. In each level of domain, different indicators are defined. Depending on the scale that students achieve the different indicators of the corresponding learning outcome, they would get a different mark: A, if it is satisfactorily achieved; B if it is adequately achieved; C if it still being developed; D if it is not achieved (“Rúbrica UPV CT-04,” 2015).

### 2.2. Electrical Machines Course as a control point for “Innovation, creativity, and entrepreneurship” transversal competence

Electrical Machines course of the 2<sup>nd</sup> year of Electrical Engineering Degree (Hurtado, 2018) is a control point of the transversal competence “Innovation, creativity and entrepreneurship” (CT04-UPV) (“CT04-UPV,” 2015). This course is given during the 2<sup>nd</sup> year of the degree, so the learning outcome concerns the 1<sup>st</sup> domain level: to question the reality, identifying improvement necessities and generating added value ideas.

#### 2.2.1. Evaluation activity

As in every new situation, it was not easy for the professors of Electrical Machines to find out an activity to evaluate “Innovation, creativity, and entrepreneurship” transversal competence. Specifically, to evaluate the learning outcome referred to the 1<sup>st</sup> domain of the competence. Taking as a reference point the rubric “Rubric UPV CT-04. Innovation, creativity and entrepreneurship” (“Rúbrica UPV CT-04,” 2015) and consulting previous activities to evaluate this competence in different universities (Cuenca et al., 2016; Le Boterf, 2001; Tardif, 2006), it was possible to finally find out the suitable activity. This activity is next described:



- It is individually made. Every student should present at the end of the course an academic work.
- Firstly, students need to contact with different electrical suppliers in order to get real transformers data (initial cost, nominal voltage, short-circuit voltage, short-circuit power, no-load losses and no-load current). With three commercial electrical transformers data is enough.
- Then, with these data, they ought to make the complete technical analysis of the different electrical transformers: equivalent circuit, daily performance curve, daily electrical voltage variation curve, and daily energy losses.
- Next, students have to obtain the economic cost that these energy losses suppose for every electrical transformer in a period of 10 years.
- Finally, they have to think about the total cost of every studied transformer in a period of 10 years old (initial cost + energy losses cost). With this activity, students realized how important is to pay attention not only to the machine initial cost but also to its long period energy losses cost. Then, they have to write ideas to improve these energy losses.

In this way, learning outcome referred to the 1<sup>st</sup> domain level is achieved, since students question the reality, identifying improvement necessities and generating added value ideas.

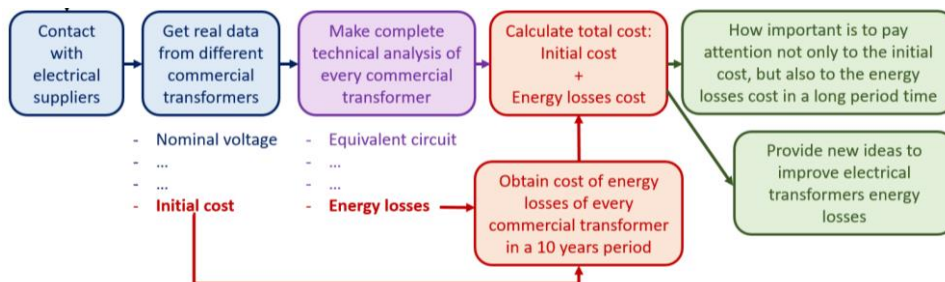


Figure 1. Flowchart of evaluation activity

### 2.2.2. Evaluation method

Finding out the right evaluation method to assess the learning outcome of the transversal competence “Innovation, creativity and entrepreneurship” in Electrical Machines course was the most difficult part of the process, even more than finding out the evaluation activity (Ramón et al., 2017; Villa, A y Poblete, 2007). Previous studies show that using a rubric as an evaluation instrument for “Innovation, creativity and entrepreneurship” would be really helpful for professors (Cuenca et al., 2016; Fernández, 2011; Masmitjà et al., 2013). Considering these researches and using “Rubric UPV CT-04. Innovation, creativity and

entrepreneurship” (“Rúbrica UPV CT-04,” 2015) as a point of reference, Electrical Machines professors have elaborated a specific rubric to evaluate the concerned learning outcome. It is shown in Figure 2.

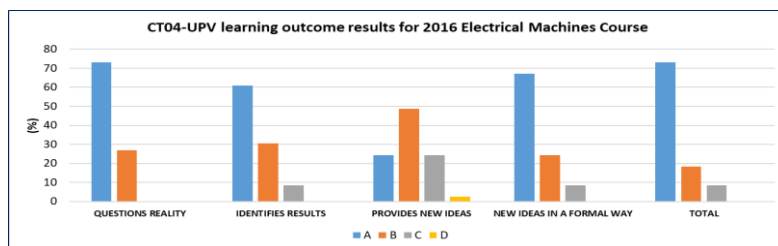
INDICATORS	DESCRIPTORS			
	A. Satisfactorily achieved	B. Adequately achieved	C. Still being developed	D. Not achieved
<b>The student questions reality</b> Does the student realize the necessity of analysing both economic factors: initial cost and long-period energy losses cost?				
<b>The student identifies results</b> Does the student identify the necessity of improving the electrical transformers energy losses?				
<b>The student provides new ideas</b> Does the student provide new ideas for improving the electrical transformers energy losses?				
<b>The student describes new ideas in a formal way</b> Are the new student’s ideas described in a formal way?				

Figure 2. Rubric for evaluating learning outcome of CT04-UPV in Electrical Machines Course.

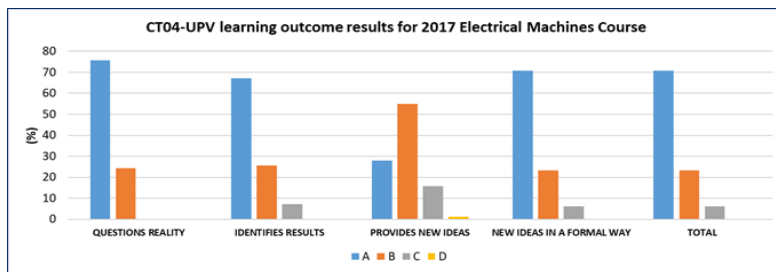
### 3. Results

#### 3.1. Transversal competence learning outcome results achieved by students

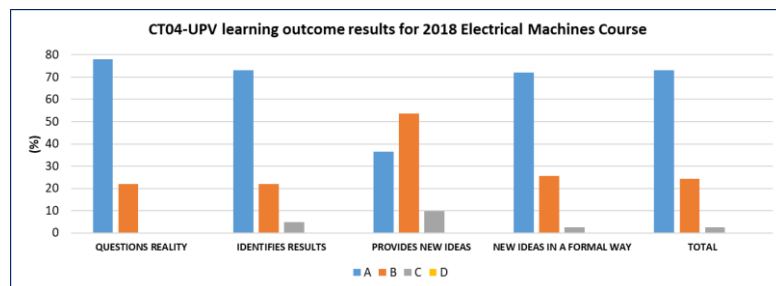
Previous rubric (Figure 2) and evaluation activity have been used in Electrical Machines Course for three years for assessing the concerning learning outcome (1<sup>st</sup> domain) of the transversal competence “Innovation, creativity and entrepreneurship” from UPV. These results are shown in Figure 3.



(a)



(b)



(c)

Figure 3. CT04-UPV learning outcome results

Paying attention to the individual indicators of the rubric, it is possible to observe that the highest indicator always corresponds to “The student's questions reality”. Globally, around a 75% of the students got an A and 25% a B. Referring to the evaluation activity, it is possible to deduce that most of the students realize the necessity of analyzing both economic factors of a transformer: initial cost and long-period energy losses cost.

Indicator “The student identifies results” is not as high as “The student questions reality”, but it is also adequately reached: globally, a 68% of the students got an A, 25% a B and 7% a C. The majority of the students identify the necessity of improving the electrical transformers energy losses, in a higher or lower scale (A or B). However, there is a small percentage of students that are not completely able to reach this indicator (C).

Indicator “The student provides new ideas” is, by far, the lowest one: generally, 26% of the students got an A, 52% a B, 15% a C and 1% a D. Professors of Electrical Machines understand that this is the hardest indicator to reach, as students should provide new ideas for improving the electrical transformers energy losses. Nevertheless, it is essential for them to develop this point.

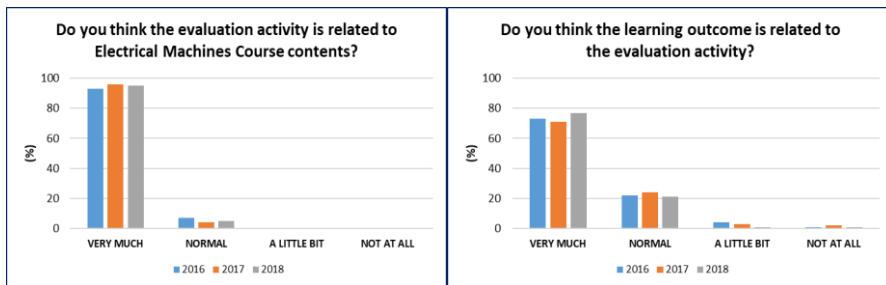
Final indicator, “The student describes new ideas in a formal way”, is adequately achieved by the student, as, in global, 70% of the students got an A, 24% a B and 6% a C.

Having the rubric allow professors evaluating the learning outcome taking into account four different indicators. In this way, they are able to observe the results of each indicator, identifying the strong and the weak points. As it is shown in Figure 3, year by year indicators have been improving, since professor has stressed on the weak points in order to improve them.

Finally, the global mark of the learning outcome is obtained as an average of the individual marks of the indicators. Figure 3 indicates that in 2016, 73% of the students got an A, 18% a B and 9% a C; in 2017, 71% of the students got an A, 23% a B and 6% a C and in 2018 73% of the students got an A, 24% a B and 2% a C. These results are very positive since they show that almost 92% students achieved the learning outcome in past years. It is also possible to observe that results are getting better year by year, as it has been explained in the previous paragraph.

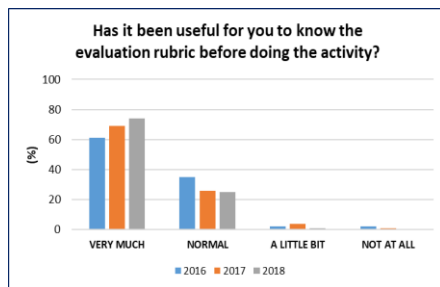
### 3.2. Students opinion

Previous results show that learning outcome in question has been satisfactorily reached during 2016, 2017 and 2018. Moreover, a growing achievement tendency is observed, as Figure 3 indicates. Even so, it is thought that knowing the student's opinion in every educational aspect is something vital, especially when new situations or changes take place (Harden, RM; Crosby, 2000). A survey made by Google Forms tool (Jhonnell & Álvarez-Andrade, 2012) has been used for knowing students' opinion about the activity and the evaluation method used to assess CT04-UPV learning outcome applied to Electrical Machines Course. The results are detailed in Figure 4.

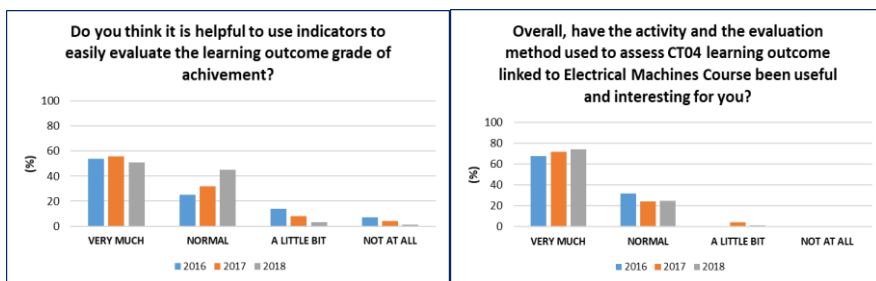


(a)

(b)



(c)



(d)

(e)

Figure 4. Students' opinion

As Figure shows, students' opinion is approximately the same in 2016, 2017 and 2018. The great majority of them (around 95%) considers that the concerned activity is hugely related to Electrical Machines contents. Additionally, approximately 95% of the students think the learning outcome is linked to the evaluation activity in different scales: 73% very linked and 22% normally linked. Knowing the evaluation rubric before doing the activity has also been useful for almost students: for around 69% very useful and for 26% just useful. They also consider that using indicators makes easy the learning outcome grade of achievement evaluation: for around 56% of students in a great way and for around 32% in a normal way. Finally, most of the students consider that the activity and the evaluation method have been very useful and interesting (72%) or useful and interesting (24%) for them.

These results prove that the activity and the evaluation method used to assess CT04-UPV learning outcome in Electrical Machines course has great acceptance among students. With their answers, it can also be observed how greatly fits the chosen methodology with the learning outcome and the course contents.



## **4. Conclusions**

The introduction of The Transversal Competences Project in 2015 by Studies, Quality and Certification Vice-Rectorate from UPV supposed a new way of understanding university studies. This project highlighted the importance of developing a broad range of transversal competences on UPV students since it would make easier their labor insertion. Thirteen transversal competences were defined. Every degree had to evaluate all of them by means of control point courses, considering the specific learning outcome too. With this project, professors had to face a new challenge: assessing transversal competences learning outcomes.

Electrical Machines course of the 2<sup>nd</sup> year of Electrical Engineering Degree is a control point of the transversal competence “Innovation, creativity and entrepreneurship” (CT04-UPV). As this course is given during the 2<sup>nd</sup> year of the degree, the learning outcome concerns the 1<sup>st</sup> domain level: to question the reality, identifying improvement necessities and generating added value ideas. Finding out the right activity to evaluate the corresponding learning outcome, that should also be linked to Electrical Machines contents, and the suitable evaluation method were not easy for the professors. With the help of previous studies and the “Rubric UPV CT-04. Innovation, creativity and entrepreneurship”, made by some UPV staff, professors finally found out the suitable activity and evaluation method. The concerned activity consists of realizing the importance of considering not only the initial cost of machines but also its total cost in a long period of time due to its energy losses. This activity is related to the learning outcome in question. Using a rubric with 4 indicators and 4 descriptors, professors are able to assess the learning outcome achievement grade of students.

Collected results show the importance of using a rubric. As it is divided in four indicators, professors can observe weak and strong points of the students during the process of reaching the learning outcome. In this way, they can focus on the weak points in order to improve them. These results show besides that, generally, most of the students reach the learning outcome (around 95%): satisfactorily (around 73%) or adequately (around 22%). Year by year these results are improving, as professors can highlight the weak points thanks to the rubric indicators marks.

Having feedback from every educational activity, especially from new activities or situations, is essential for professors. That is why every year since 2016 students answer a survey about the evaluation of CT04-UPV learning outcome. Collected results show in general terms that the activity and the evaluation method have great acceptance among students: 72% of students consider they are very useful and interesting and 24 % think they are useful and interesting.



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