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# Rubric Elaboration to Evaluate by Competences a Practice of Physics Laboratory: Parallel-Plate Capacitor

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## Abstract

In recent years, the different educational levels continue adopting the competence-based education model as a quality assessment system; in this context, the competence evaluation becomes one of the most important tasks of the educational processes because of its formative usefulness in the students' learning.

Competence-based education is oriented towards an evaluation model linked to the training student, to encourage the development of an ability to identify, project, solve problems and make decisions. In addition, it promotes the pursuit of meaningful learning and encourages collaborative work. The rubrics for the evaluation of competences appeared as a tool that allows obtaining evidence of the acquisition of competences and application of knowledge outside the classroom.

The aim of this work is to present a proposal of rubrics for the evaluation by competences of a physics laboratory practice in which the capacitance of a parallel-plate capacitor is measured by varying the separation between the plates and then, by means of a least squares adjustment, obtain the value of the electric permittivity of the air,  $\epsilon_0$ , and the value of the constant,  $k$ , which appears in Coulomb's law.

We have designed a laboratory practice and developed the evaluation rubric applied to students of Physics for Computer Science Engineering in the Degree of Computer Engineering of the Higher Polytechnic School of the University of Castilla -La Mancha (UCLM), located on the university campus of Albacete. For the implementation of this rubric, we will select two study groups: a control group and an experimental group, the control group will develop the practice into the physics laboratory without rubric evaluation information; and the experimental group, will develop practice in the physics laboratory but with rubric evaluation information.

Finally, we will evaluate the perception of the students about use of rubrics, and we will make a comparative analysis of both groups, considering the marks obtained in the practices and the results of the evaluation perception.

Keywords: Competences-based approach, rubric, teaching-learning, and competences assessment.

## 1 INTRODUCTION

The different educational levels continue adopting the competence-based education model as a quality assessment system, from the formative approach, the learning develops the acquisition of basic competences such as team work, the creative capacity or communicate and relationship capacity [1]; for this reason, it is necessary to think in terms of students learning outcomes, that is, "the competences evaluation" that becomes one of the most important tasks of the educational processes.

The European Higher Education Area (EHEA) has promoted an educational model based on the development and assessment of professional competences [2], and the competences have become a reference curriculum to improve educational quality [3]. With this implementation the evaluation for the competences in the European Higher Education Area takes place teaching changes, modifications and innovations related to evaluation systems and procedures, for evaluation as a process to promote learning and contrast the results [4].

Competence-based education is oriented towards an evaluation model linked to the training of students, which encourage the development of skills to identify, project, solve problems and make decisions. It is the combination and integration of three attributes, namely the knowledge, skills and attitudes required to fulfill a certain role in a given context [5].

In this context, at the beginning of the 20<sup>th</sup> Century, the rubric was born as a form of objective scale of assessment, unification and homogenization [6]. The rubrics have emerged as a valuable tool for competence assessment, as an evaluative register that indicates the evaluation criteria, following quality levels and typifying performance standards [7]. An objective correction is essential, although subjectivity is sometimes desirable, especially when the professor wishes to consider the attitude of the student in class or in the laboratory.

The use of rubrics provides a more systematic evaluation by the professor and is an effective tool for the development of monitoring skills, self-evaluation and peer evaluation; which contributing to a greater understanding of the learning process and greater autonomy and self-regulation of the student [8].

The professionals participants in this process create assessment instruments that contribute to the implementation of this process. In this work, we present a proposal of rubrics for the evaluation by competences of a physics laboratory practice in which the capacitance of a parallel-plate capacitor is measured by varying the separation between the plates and then, by means of a least squares adjustment, obtain the value of the electric permittivity of the air,  $\epsilon_0$ , and the value of the constant,  $k$ , which appears in Coulomb's law.

This rubric will be applied to students of Physics for Computer Science Engineering in the Degree of Computer Engineering of the Higher Polytechnic School of the University of Castilla-La Mancha (UCLM), located on the university campus of Albacete, Spain.

The use of rubrics helps students during the learning process because it provides them with feedback, allowing them to gradually improve their marks. The rubrics can enhance both student performance but perhaps more importantly students' perceptions and use of feedback [9], therefore, it benefits professors throughout the teaching-learning process [10].

According to the purpose of the rubrics, they are classified in Holistic or global and Analytical [6], [7], [11], [12], the first ones, does not separate the parts of the activity to be evaluated, a global description is made without specifying the components of the process, and the second ones, clearly details the indicators of each activity and specify the evaluation criteria according to the level of performance of the student, allowing evaluating all or most of the teaching-learning process. In this work we present an analytical rubric, shows the criteria and levels or scales of evaluation [11]–[13].

## METHODOLOGY

We present an experimental study, we will work with a control group and an experimental group. For the statistical analysis of the results, we will use the software IBM SPSS Statistics (version 22) and software R Studio (version 3.5.1).

We have designed a laboratory practice and developed the evaluation rubric applied to students of Physics for Computer Science Engineering in the Degree of Computer Engineering of the Higher Polytechnic School of the University of Castilla -La Mancha (UCLM), located on the university campus of Albacete, Spain.

In this subject of physics, we had never used the rubrics of evaluation by competences, but with the work published in 2018 [11]–[13], implemented in the period September to December 2018, we identified that it was useful for the students who were part of the experimental group, as well as for the responsible professor.

For this reason, we have decided to continue with the design and implementation of rubrics, now, with this laboratory practice that has been developed by the students without the help of rubrics (figure 1), but that will also be developed with the use of the rubric to know its effectiveness.



Figure 1. Practice of Physics Laboratory: Parallel-Plate Capacitor, without rubric

For the implementation of this rubric, we will select two study groups: a control group and an experimental group, the control group will develop the practice into the physics laboratory without rubric evaluation; and the experimental group, will develop practice in the physics laboratory but with rubric evaluation, similar methodology used in the published work in 2017 [11], [12].

At the end of the process of implementation and evaluation of the rubric, we want to know if the instrument has been useful during the evaluation process; therefore, we will assess perception about use of rubrics with students and professors. With the results of the evaluation of perception and the marks obtained by the two study groups, we will make a comparative analysis to identify what is the behavior and if these improve or not.

We mentioned that in the previous semester September to December 2018 we carried out the implementation of a physics laboratory practice rubric, and the results were satisfactory, we observed an improvement; therefore, we also want to compare the previous results with these new results.

## 2 RESULTS

The laboratory practice and rubric of evaluation will be applied to the students of Physics for Computer Science Engineering in the Degree of Computer Engineering of the Higher Polytechnic School of the University of Castilla -La Mancha (UCLM), located on the university campus of Albacete, Spain.

With the development of this work, in the context of teaching-learning with a focus on competences, evaluation becomes a fundamental activity, because through it, the professor and the student, can know and demonstrate through objective evidence the competences and skills acquired. Therefore, we agree and confirm that the evaluation becomes a process that orientates the student's learning, in which there is the participation of the professor and the student, being they the protagonists on which the results depend, making possible the promotion of the development of valuable competences for the present academic and future labor [14] (figure 2).

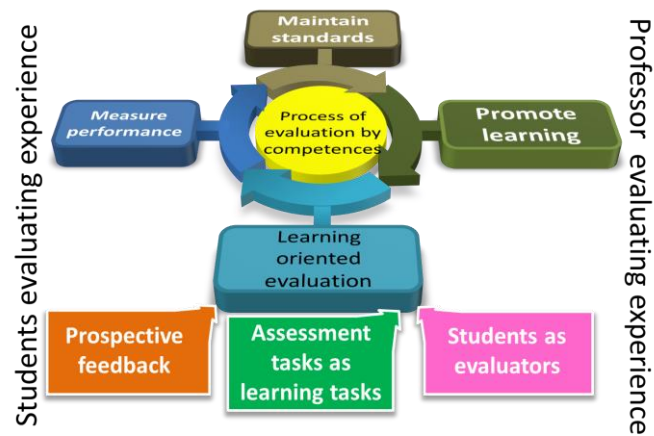


Figure 2. Process of evaluation by competences, oriented to the learning

In the table 1, we present a proposal of rubrics for the evaluation by competences of a physics laboratory practice of in which the capacitance of a parallel-plate capacitor is measured by varying the separation between the plates and then, by means of a least squares adjustment, obtain the value of the electric permittivity of the air,  $\epsilon_0$ , and the value of the constant,  $k$ , which appears in Coulomb's law.

The rubric of evaluation specifies the criteria and levels of evaluation that the student must fulfill and that the professor will evaluate to assign the corresponding marks. It is important to highlight that the rubric indicates the points that will be assigned for each level of evaluation and those that will be considered to assign the corresponding marks: Outstanding = Non-modified (10 points); Notable = Suitable with some small observation without modifications (8 points); Well = Apt with some observation with modifications (6 points); Insufficient = Not suitable with important modifications (3 points); and Very deficient = Not suitable, complete modification of the activity (0 points) or did not present.

Table 1. Rubric of Physics Laboratory Practice: Parallel Plate Capacitor

CRITERIA TO EVALUATE		QUALITATIVE/QUANTITATIVE EVALUATION LEVELS			
Dimension	Subdimension	Very Deficient: 0 points	Insufficient: 3 points	Well: 6 points	Notable: 8 points
Comprehension and observation to be able to take the data	Value of $d$ , $C$ y $1/d$ with their errors	In the tables, it does not show any of the 30 values of these three variables $d$ , $c$ and $1/d$ . (0 points)	The tables show incorrectly the 30 values of these three variables $d$ , $c$ and $1/d$ (10 values of each variable). (0.2 points)	In the tables, only 15 values of these three variables $d$ , $c$ and $1/d$ are shown correctly (5 values of each variable). (0.6 points)	In the tables it correctly shows only 27 values of these three variables $d$ , $c$ and $1/d$ (7 values of each variable). (0.8 points)
Analysis and values calculation	Least squares adjustment (compatibility)	It does not show any of these values: $m$ , $\epsilon_a(m)$ , $b$ , $\epsilon_a(b)$ , $r$ of the least squares adjustment line $y = mx + b$ , nor does it make the two requested comments. (0 puntos)	Correctly shows only 1 of these values: $m$ , $\epsilon_a(m)$ , $b$ , $\epsilon_a(b)$ , $r$ of the least squares adjustment line $y = mx + b$ and very briefly makes the two comments requested. (0.6 points)	It correctly shows only 2 of these values: $m$ , $\epsilon_a(m)$ , $b$ , $\epsilon_a(b)$ , $r$ of the least squares adjustment line $y = mx + b$ and makes the two requested comments very briefly. (1.2 point)	Correctly shows only 3 of these values: $m$ , $\epsilon_a(m)$ , $b$ , $\epsilon_a(b)$ , $r$ of the least squares adjustment line $y = mx + b$ , and very briefly makes the two comments requested. (1.7 points)
	Value of $\epsilon_0$ well expressed with its error	It does not obtain the value of $\epsilon_0$ , nor its corresponding error. (0 points)	It incorrectly obtains the value of $\epsilon_0$ with its correct exponent, without calculating the error. (0.4 points)	It obtains the value of $\epsilon_0$ with its correct exponent but miscalculates its error. (0.7 points)	It obtains the value of $\epsilon_0$ with its correct exponent, and incorrectly expresses its error. (0.8 points)
	Value of $k$ well expressed with its error	It does not obtain the value of $k$ , nor its corresponding error. (0 points)	It incorrectly obtains the value of $k$ with its correct exponent, without calculating the error. (0.4 points)	Obtains the value of $k$ with its correct exponent but miscalculates its error. (0.7 points)	Obtains the value of $k$ with its correct exponent, and incorrectly expresses its error. (0.8 points)
	Graph (with its axes)	It does not show the experimental points in the graph from the equation $y = mx + b$ , nor the requested points. (0 points)	Incorrectly shows the experimental points in the graph from the equation $y = mx + b$ , does not show the magnitudes represented in the two axes and their respective units; nor the least squares adjustment line. (0.9 points)	It correctly shows the experimental points in the graph from the equation $y = mx + b$ but does not show the magnitudes represented in the two axes and their respective units; nor the least squares adjustment line. (1.8 point)	It correctly shows the experimental points in the graph from the equation $y = mx + b$ but does not clearly indicate the magnitudes represented in the two axes and their respective units; nor the least squares adjustment line. (2.4 points)
Reflection to obtain conclusions	Answer to the 4 questions	Does not respond well to any question. (0 points)	Answer only 1 question well. (0.5 points)	Answer 2 questions well. (1 point)	Answer 3 questions well (1.5 points)

The interpretation of the evaluation levels to assign marks are as follows:

- **Outstanding** = Non-modified (value 10).
- **Notable** = Suitable with some small observation without modifications (value 8).
- **Well** = Apt with some observation with modifications (value 6).
- **Insufficient** = Not suitable with important modifications (value 3).
- **Very deficient** = Not suitable, complete modification of the activity (value 0) or did not present.

### 3 CONCLUSIONS

Changes and improvements in the teaching-learning process in educational institutions are made to ensure educational quality, therefore, the evaluation processes must be modified and adapted to the new teaching models; this, also due to labor market conditions that evolve and are increasingly demanding. In this scenario, students are forced to be more competent and versatile, able to solve situations that arise in the workplace.

For this reason, professionals involved in the educational process propose new instruments that help students to acquire and demonstrate the necessary skills of a subject, activity or subject. With the development of this work, and as part of the follow-up evaluation of competence, and, applied in science subjects such as physics, which is a complex subject.

In this first stage, we have completed the design of the evaluation rubric that will be implemented in this academic period 2018/2019, and its usefulness will be evaluated through a comparative analysis between the control group and the study group. We are also interested in sharing this work with other professors from the Physics Department of both the Computer Engineering degree and in the future, inviting other professors from other grades, to work with this type of evaluation and instrument.

### REFERENCES

- [1] J. R. Prieto Garcia, D. Alarcon Rubio, y C. B. Fernandez Portero, «Learning and assessment about competences in Social Sciences university students», *Redu-Rev. Docencia Univ.*, vol. 16, n.º 1, pp. 193-210, jun. 2018.
- [2] European Commission, «Tuning Educational Structures in Europe Education and Culture, Socrates», p. 52, 2006.
- [3] «Ley Orgánica 8/2013, de 9 de diciembre, para la mejora de la calidad educativa», *Ley Orgánica 8/2013, de 9 de diciembre, para la mejora de la calidad educativa*, 2013. [En línea]. Disponible en: <https://www.boe.es/eli/es/lo/2013/12/09/8>. [Accedido: 18-ene-2019].
- [4] E. Martínez-Figueira, F. Tellado-González, y M. R. Rivas, «La rúbrica como instrumento para la autoevaluación: un estudio piloto», *REDU Rev. Docencia Univ.*, vol. 11, n.º 2, pp. 373-390, ago. 2013.
- [5] Villa, A. y Poblete, M., «Aprendizaje basado en competencias: Una propuesta para la evaluación de competencias genéricas [Competence-based Learning: A Proposal for Assessing Generic Competences]», 2007. [En línea]. Disponible en: <https://innovacioneducativa.upm.es/node/1203>. [Accedido: 18-ene-2019].
- [6] I. Soto Calzado, «Design of rubrics for Printmaking higher education», *Rev. Electron. Interuniv. Form. Profr.*, vol. 21, n.º 1, pp. 173-184, ene. 2018.
- [7] E. Cano, «The rubrics as an assessment tool of competency in higher education: use or abuse?», *Profr.-Rev. Curric. Form. Profr.*, vol. 19, n.º 2, pp. 265-280, ago. 2015.
- [8] D. D. Stevens y A. J. Levi, *Introduction to Rubrics: An Assessment Tool to Save Grading Time, Convey Effective Feedback, and Promote Student Learning: An Assessment Tool to Save Grading Time, Convey Effective Feedback, and Promote Student Learning*, 2 edition. Sterling, Va: Stylus Publishing, LLC, 2012.
- [9] A. Cockett y C. Jackson, «The use of assessment rubrics to enhance feedback in higher education: An integrative literature review», *Nurse Educ. Today*, vol. 69, pp. 8-13, oct. 2018.
- [10] Tellado, F., Martínez, M.E., Raposo, M., y Doval, M.I., «Porcentaje de cambio en la evaluación y autoevaluación mediante la utilización de rúbricas», *II Congr. Int. Sobre Eval. Por Competencias Mediante Erúbricas Málaga*, p. 18, oct. 2012.
- [11] R. Ramirez-Vazquez *et al.*, «Elaboration of Rubrics for the Evaluation by Competences of Physics in the University», en *12th International Technology, Education and Development Conference*



(inted), L. G. Chova, A. L. Martinez, y I. C. Torres, Eds. Iated-Int Assoc Technology Education & Development, 2018, pp. 1887-1893.

- [12] R. Ramirez-Vazquez *et al.*, «Evaluando competencias en física mediante rúbricas», *Rev. Programa Doutorado Rede Amaz. Educ. Em Ciênc. E Matemát*, vol. 6, n.º 1, p. 10, jun. 2018.
- [13] E. Arribas *et al.*, «Teaching and Learning Active Physics Within Framework of Competencies», en *Inted2017: 11th International Technology, Education and Development Conference*, L. G. Chova, A. L. Martinez, y I. C. Torres, Eds. Valenica: Iated-Int Assoc Technology Education & Development, 2017, pp. 17-25.
- [14] M. S. Ibarra Sáiz, G. Rodríguez Gómez, y M. Á. Gómez Ruiz, «La evaluación entre iguales: beneficios y estrategias para su práctica en la universidad», *Rev. Educ.*, vol. 359, n.º 359, pp. 206-231, 2011.