Perception of the Acquisition of Competences for University Professors in a Context of Problem-Based Learning Methodology

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Abstract

This research evaluates the perception of the acquisition of some relevant competences before and after the PBL course for the teaching staff. The perception improves in competences related to the appropriate use of ICTs and problem-solving skills, showing statistically significant differences in the ability for organization and planning of work, autonomous learning and the appropriate use of ICTs. Finally, regarding the course evaluation, university professors remark the practical use of the training course, the teaching staff and the interest of the activity (with values about 4.5 out of 5).

Keywords: Problem-based learning (PBL); Higher education; Interdisciplinary approach; University professor;

1. Introduction

The implementation of the methodology of Problem-Based Learning (PBL) in the classroom implies a procedural change for both teachers and students, although the relevant aim is to optimize the quality of education, establishing a more integrated model and close to the problems of everyday life. The fundamental feature of the PBL methodology is that it results in a change of the training model, since it goes from a teacher-centered training model to a student-centered training model, where this is an active part of the learning process (Author, 2011; Author *et al.*, 2014a; Author *et al.*, 2014b, and Author *et al.*, 2013).

The implementation of the PBL methodology requires an important effort, from the teacher and students, because both parties must be aware that it is not an exercise or a case study, traditionally applied in the classroom. The elaboration of a PBL experience requires a careful process of information selection, so that this is not much, it has to provide non-relevant information and in no case should the sources be provided. In addition, the PBL may only be in our area, but it may also be a multidisciplinary PBL, in which our area of knowledge does not necessarily have to be predominant. Therefore, teachers must cooperate and coordinate with the rest of the knowledge areas both in the elaboration of the problem, as well as in the information provided during the resolution process, and in the evaluation thereof (Author *et al.*, 2015a; and Author *et al.*, 2015b). Thus, the student must not only acquire knowledge, but also skills and competences (know vs. know how to solve).

This method assumes a comprehensive approach to the teaching-learning process and requires the application of critical thinking as part of the interaction mechanism to

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learn. Therefore, “*PBL is an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem*” (Savery, 2006: 12).

The role of the teacher is to be a mentor to the student (Barrows, 1996, Dolmans *et al.*, 2002, Hmelo-Silver and Barrows, 2006, and Jiménez *et al.*, 2014). To do this, the teacher would have to propose to the students questions that allow indirectly orienting the search for knowledge. It may have to facilitate a learning environment focused on the student, so it would stimulate the autonomous leaning of the student, guiding the process in such a way that an integration of the acquired knowledge takes place (Leary *et al.*, 2013).

Taking into account the relevant role the tutor has in PBL (Azer *et al.*, 2013, and Wijnen *et al.*, 2017), serious attention would be given to teacher training before the implementation.

Thus, given the complexity of the implementation of the PBL methodology, as well as the advantages that it presents for both teachers and students, teacher training in this area is necessary. To this end, over the last few years the course “Introduction to Problem-Based Learning” has developed in the framework of internal training for teachers at the University of Castilla-La Mancha (Spain). The objective is that each participant in the course is trained and motivated to implement the PBL in their teaching, in order to improve the acquisition of cross-disciplinary skills of different degrees, especially those that have to do with the resolution of problems, approaching students to their future professional practice. For this, this training course provides the educational tools for its application, monitoring and evaluation of student competences.

The present research analyses the effectiveness of the course in the acquisition of

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competences by the teachers who attend it, since these same competences will have to be those that transmit to the students of our university in each of the subjects they teach (Cusack *et al.*, 2012, and Jiménez *et al.*, 2014). In particular, this paper will pay special attention to the ability to analyse and synthesize information, critical and self-critical capability, and problem-solving and decision-making skills. Likewise, it will also analyse the degree of satisfaction with the course received, with the aim of highlighting the weaknesses and strengths of the same, to improve it in future editions.

The analysis of competences acquired by the teachers in the PBL methodology is crucial for a correct implementation of the course. So, the acquisition of competences, as well as their degree of satisfaction, will be examined from a series of surveys carried out before and after the teaching of the course “Introduction to Problem-Based Learning”.

The suitability of the PBL method for the achievement of generic competences has already been highlighted in previous studies, such as Caso *et al.* (2006), who conduct a thorough review of the studies related to applications of the PBL approach as a teaching-learning model. In the area of Business Administration and Management, there are also precedents included in Lobo *et al.* (2009), Marín *et al.* (2009), Amo *et al.* (2014) and Jiménez *et al.* (2014).

Thus, the rest of the paper is organised as follows. Section 2 describes the PBL methodology. Section 3 includes a detailed analysis of the Perception of the acquisition of competences and the evaluation of the PBL experience. Finally, section 4 remarks the concluding remarks of our analysis.

2. Problem Based Learning (PBL)

The implementation of the PBL methodology is not an easy task for the teacher,

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since not all the problems that arise in the classroom are Problem-Based Learning, although different areas of knowledge are interrelated and it is implied to involve the students in the active resolution of the same.

There are different definitions of PBL. Thus, according to Kaohsiung (2009), PBL is essentially a strategic learning system that combines different complementary educational principles for the improvement of the instructional process. It is especially aimed at promoting and optimizing a learning process focused on the student, in collaborative, integrated, self-directed and reflective contexts.

In any case, the PBL is a new model for acquiring competences (knowledge, skills or abilities). It is not just to know, it is to know how to do, to know how to be, and to know how to work with others.

The most relevant objectives in the context of PBL methodology are the following (Savery, 2006): (1) students elaborate and acquire their own knowledge base, (2) the development of their effective problem-solving skills, (3) students acquire and develop their autonomous and continuous learning abilities, (4) the development of their skills for group work, and (5) intrinsic motivation for learning.

The methodology used in the implementation of the PBL aims for the student to determine their own learning needs –what do you need to know?-, so that students build their own knowledge. In this way, they carry out a diagnosis and make a solution proposal. Students seek, understand, integrate and apply basic concepts that provide a solution to the problem.

The problem proposal by the teacher is not a traditional practical case (Savery, 2006), in which knowledge of other areas is also needed, in order to respond to it. Therefore, it is not an issue that seeks to clarify, a proposition or difficulty of doubtful

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solution or a set of facts or circumstances that hinder the achievement of some end. The problem is the approach of a situation whose unknown answer must be obtained through scientific methods.

In addition, the PBL methodology implies a series of competences. The most relevant are the following: (1) capability for analysis and synthesis, (2) capability for organization and planning, (3) ability to search for information, (4) capability to solve problems, (5) ability to make decisions, (6) capability for criticism and self-criticism, (7) autonomous learning ability, and (8) adaptability.

The resolution of a PBL proposal provides the student with integration of knowledge, interdisciplinary nature, decision-making and problem-solving skills, and approach to professional practice.

Moreover, the most important thing in the PBL methodology is that you learn by doing. In short, it is a different learning process, because there is a change of attitude in the relationship established between the teacher-student: the active part of the relationship falls on the student. In no case, it is a matter of routine work and a single solution.

Finally, some previous studies about PBL in teacher education also analyse the perception of the acquisition of competences, such as Cusack *et al.* (2012). They conclude that teamwork, collaboration, and positive professional identity and professional competency and autonomy improved significantly using PBL. Other researches analyse the success of the implementation of PBL in higher education. L'Ecuyer *et al.* (2015) remark that that PBL is an effective method for teaching inter-professional collaboration skills. Wijnen *et al.* (2017) concludes that both positive and negative aspects were reported by students (active involvement) and professors (insufficient preparation for the profession), respectively. Finally, some studies analyses

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the perception of the acquisition of competences (Author *et al.*, 2014a).

3. Perception of the acquisition of competences and evaluation of the PBL experience

The establishment of the “European Credit Transfer System” (ECTS) at the University allows the introduction of pedagogical changes in the teaching-learning process focused on students, where they do not only acquire knowledge, but fundamentally skills and competences. However, to be able to do it in the best possible way it is necessary that the teachers are properly trained, as this way they will be able to work better educational competences with their students.

As previously said, the PBL methodology requires a great effort from both teachers and students, since it supposes a rupture with the traditional methodology, and both have to make a way of learning. First, the PBL technique does not only imply the presentation of a problem or practical case of the teacher to the student that the latter has to solve taking into account the conventional methodologies. Second, more than one area of knowledge may be involved, which highlights the complexity of preparing a PBL experience for teachers, as well as for the evaluation of it. In addition, third, the resolution process is different from a traditional case of a single solution, so students must work cooperatively, following an established protocol, and give the most efficient answer. Therefore, the prior training of teachers may be crucial, for example the attendance of courses for teachers focused on training in new methodologies, such as the course “Introduction to Problem-Based Learning”.

4. Method

4.1. Context

The teacher-training course, “Introduction to Problem-Based Learning” is part of a

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teacher-training plan of the University of Castilla-La Mancha (Spain).

The activity applies a semi-face-to-face learning, mainly focused on autonomous work, guided through virtual tutorials, with support from the seminar's virtual space located on Moodle (Author *et al.*, 2014a). Finally, some examples of PBL are worked in the course.

4.2. *Participants*

During the academic year 2016-17, this training course was carried out in a large University located in Spain during the second semester. In concrete, 22 teachers from different degrees –such as Law, Economics and Business Administration, Engineering, Medical Sciences...- enrolled and attended this PBL course, although only 17 professors finished it. Furthermore, only one of them had previous experience in the PBL methodology.

4.3. *Procedure*

To analyse the effectiveness of the course in the acquisition of competences by the teachers who attend it, before and after the development of the course, a survey was carried out, mandatory for all the participants.

In particular, this survey focuses on the ability to analyse and synthesize information, critical and self-critical capability, problem-solving skills and decision-making abilities. Furthermore, it also studies the degree of satisfaction with the course received, with the aim of highlighting the weaknesses and strengths of the same, to improve it in future editions.

Table 1 shows the main competences to be analysed by the course participants before and after carrying out the PBL activity. These competences are classified in specific –related to the degree- and generic –transversal skills-.

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[Please, insert Table 1 about here]

This study shows the mean and median values consigned to the competences by the teachers enrolled in this PBL course. Thus, the best competences developed in this course could be identified.

According to Author (2011) and Author *et al.* (2014), the data obtained from the survey is processed by creating a measure that allows us to analyse the perception of the university professors about the acquisition of competences before and after the PBL course. Thus, the variable called DIF is defined as follows:

$$\text{DIF} = \text{After PBL} - \text{Before PBL} \quad (1)$$

where DIF shows the difference between the (mean and median) perception of each competence for university professors before and after performing the PBL activity.

The interpretation of the value that this variable may take is:

- If $\text{DIF} > 0 \rightarrow \text{DIF POSIT} \rightarrow$ the perception of the competence has improved with the PBL course.
- If $\text{DIF} = 0 \rightarrow \text{DIF ZERO} \rightarrow$ the perception of the competence keeps constant after attending the PBL course.
- If $\text{DIF} < 0 \rightarrow \text{DIF NEGAT} \rightarrow$ the perception of the competence has deteriorated with the PBL course.

In addition, to analyse if there are statistically significant differences between the perception of the acquisition of competences for University Professors before and after the PBL course, the tests of equality of means, medians and variances are used. Specifically, the ANOVA-F test is used for the analysis of the mean, the Kruskal-Wallis test for the analysis of the median and, finally, the Levene test for the analysis of the

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variance.

4.4. Perception of the acquisition of competences: mean and median values

Once the relevant information has been extracted from the surveys conducted regarding the average perception that the teachers who participated in the course have about the acquisition of the competences listed in Table 1 before and after performing the PBL activity, the competences, in their majority, were increased or reinforced after the attendance of the course.

According to Table 2 and Figure 1, which reflects the average perception that teachers have regarding the acquisition degree of competences before and after performing the PBL activity, specifically, this positive evolution in the aforementioned perception occurs in 12 out of 14 competences on which has asked, that is 85% of the time.

[Please, insert Table 2 about here]

[Please, insert Figure 1 about here]

Only the C15 and C17 competences, related to the ethical commitment and the capability for autonomous learning (highlighted in red) have shown a negative evolution compared to the perception of the participants before and after the completion of the course ($DIF < 0$). Surprise the evidence in the C17 competence, because this is necessary for the learning process, following a PBL methodology, to develop satisfactorily. However, this result is not conclusive, because one of the competences in which the perception of teachers has increased the most after completing the course is the G1, which refers to possessing skills for continued learning, self-directed and autonomous. The same goes for the C15 and G2 competences.

In a positive sense, the increase that has taken place in the perception that the

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teachers have on the domain of the C2 and G4 competences after carrying out the PBL activity (in comparison with their perception before it) stands out. Specifically, these competences refer to the capability for organization and planning of work (which is fundamental in the development of a PBL methodology), as well as to the appropriate use of ICTs (since this course has been developed in a semi-face-to-face learning).

One of the questions that teachers were asked about is their perception of the ability to solve problems before and after completing the course. As can be seen in Figure 1, the perception of the competence domain C7 has increased after carrying out the PBL activity.

Other competences that teachers have perceived to have worked throughout the course have been those that refer to the ability to seek information from diverse sources (C6), capability for analysis and synthesis (C1), ability for criticism and self-criticism (C14), written communication (C3 and G3), ability for adapting to new situations (C18), initiative and entrepreneurship (C21), as well as the ability to understand the ethical responsibility with my work (G2).

In terms of their ability to adapt to new situations, this has also increased after the development of the course, in some cases, valuing with a great difference the capacity before and after teacher training.

[Please, insert Table 3 about here]

[Please, insert Figure 2 about here]

Regarding the median of the answers given by the teachers regarding the degree of competence mastery before and after the ABP activity (Table 3 and Figure 2), only the C17 competence (as seen in the mean analysis), related to the capability for autonomous learning shows a lower median value after performing the activity ($DIF <$

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0). As shown in the previous analysis, this result is not conclusive, since the G1 competence, which refers to skills for continuous, self-directed and autonomous learning, has shown an increase in the perception that teachers have about their domain after completing the course. This result could show that the participants of the course have not well understood the analysed competence.

In a positive sense, the acquisition of the C2, C1, G1 and G4 competences, related to the capability of organization and planning of the work, ability of analysis and synthesis, to possess abilities for the continuous learning, self-directed and autonomous, as well as for the proper use of ICTs.

4.5. Analysis of the differences in the perception of the acquisition of competences

Finally, although there are differences between the perception that teachers have regarding the degree of mastery of the competences analysed before and after completing the course, it would be interesting to check whether these differences are statistically significant.

To that aim, this section analyses whether the differences found in mean, median and, additionally, also in variance between the perception of the participants before and after performing the PBL activity are statistically significant.

Thus, our analysis uses standard statistics for the analysis of mean (Anova-F Test), median (Kruskal-Wallis test) and variance (Levene test). These differences are shown in Table 4, distinguishing between specific competences in Panel A and generic competences in Panel B.

[Please, insert Table 4 about here]

As can be seen, the differences in mean, in general, do not present statistical significance, except for some specific cases. There are only statistically significant

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differences in the C2 competence, which refers to the ability for organization and planning of work. This result had already been advanced in the previous section, since there was an important jump between the valuation before and after the completion of the PBL activity. In addition, in this case the result confirms that this experience has improved the perception that students have regarding the domain of the competence.

Regarding the median values, there are just statistically significant differences in the G1 competence, related to the skills for continuous, self-directed and autonomous learning. Again, this difference shows positive sign, which means that participants perceive that the domain of the competence has increased considerably with this PBL activity.

Finally, some differences in variance are statistically significant, and they are related to the ethical commitment (C15), written communication (G3) and the appropriate use of ICTs (G4).

4.6. Experience evaluation

Regarding the evaluation of the PBL course by the participants, Figure 3 shows the main results. In general, the assessment that teachers give to the course is very positive, since the average score is between 4 and 4.5 –on a Likert scale of 1 to 5–.

[Please, insert Figure 3 about here]

One of the issues most valued by the university teachers is the practical use of the training course (about 4.5 out of 5), as well as the teaching staff (more than 4.5 out of 5) and the interest of the activity (about 4.5 out of 5). These results may show that the course would be useful and valuable for university teachers to acquire active learning tools.

4. Conclusions

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The implementation of the Problem-Based Learning (PBL) procedure implies a methodological change for teachers and students. Therefore, teachers must be properly trained to be able to apply this type of work methodology in the classroom (and outside it).

With the aim of covering this need, the course “Introduction to Problem-Based Learning” emerges in the framework of internal training for teachers at a large University in Spain (University of Castilla-La Mancha).

After analysing the perception that participants have regarding the acquisition of different specific and generic competences before and after completing the PBL course, and after observing the assessment that teachers give to the course, the following implications for practice can be drawn:

These results may demonstrate the need to carry out teaching activities in class that enable students to practice professionally, according to the PBL methodology developed in the first sections of this study.

Furthermore, to be able to carry out this sort of activities, the training of teachers in active methodologies such as PBL would be required. Hence, this experience may encourage the implementation of this kind of training courses for professors in Higher Education.

On the other hand, the main implications for research of our results are the following:

The participants would perceive that the acquisition of the competences worked in the course has increased considerably in most cases. Therefore, these results would also inspire University professors to apply active learning methodologies, such as PBL, in the sphere of higher education.

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Concretely, the perception mainly improves in competences related to the appropriate use of ICTs and problem-solving abilities, among others. Thus, this PBL methodology may improve students' skills related to the professional activity.

Moreover, there are statistically significant differences between the perception before and after the PBL course in competences such as the ability for organization and planning of work, autonomous learning and the appropriate use of ICTs. Therefore, there are also evidence in favour of using this sort of methodology for the professional practice.

Finally, regarding the evaluation of the activity, university professors may remark the practical use of the training course, the teaching staff and the interest of the activity, with assigned values about 4.5 out of 5. Therefore, it may have been satisfactory.

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Table 1. Main competences evaluated before and after the PBL activity

Competences	Description
C2	Ability to organize and plan my work
C6	Ability to search information from different sources
C1	Capability for analysis and synthesis
C14	Ability for criticism and self-criticism
C3	Written communication in Spanish
C7	Ability to solve problems
C15	Ethical commitment with my work
C17	Capability for autonomous learning
C18	Ability for adapting to new situations
C21	Initiative and entrepreneurship
G1	Possession of the skills needed for continuous, self-led, independent learning
G2	Ability to understand the ethical responsibility with my work
G3	To develop oral and written communication skills in order to prepare reports
G4	Ability to use and develop information and communication technologies

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Table 2. Mean values of the competence perception before and after performing the PBL activity

Panel A: Specific Competences

	C2	C6	C1	C14	C3	C7	C15	C17	C18	C21
Before (B)	6.83	7.83	7.61	8.00	8.06	8.06	8.89	8.61	7.61	8.00
After (A)	7.59	8.06	7.88	8.12	8.29	8.29	8.76	8.35	8.00	8.06
DIF = A – B	0.75	0.23	0.27	0.12	0.24	0.24	-0.12	-0.26	0.39	0.06

Panel B: Generic Competences

	G1	G2	G3	G4
Before (B)	7.61	8.50	8.17	7.39
After (A)	8.18	8.53	8.29	8.18
DIF = A – B	0.57	0.03	0.13	0.79

Legend: The variable called DIF is defined as follows: $DIF = \text{After PBL} - \text{Before PBL}$, where DIF shows the difference between the (mean and median) perception of each competence for university professors before and after performing the PBL activity. Thus, the interpretation of the value that this variable may take is: (1) if $DIF > 0 \rightarrow DIF \text{ POSIT} \rightarrow$ the perception of the competence has improved with the PBL course; (2) if $DIF = 0 \rightarrow DIF \text{ ZERO} \rightarrow$ the perception of the competence keeps constant after attending the PBL course, and (3) if $DIF < 0 \rightarrow DIF \text{ NEGAT} \rightarrow$ the perception of the competence has deteriorated with the PBL course.

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Table 3. Median values of the competence perception before and after performing the PBL activity

Panel A: Specific Competences

	C2	C6	C1	C14	C3	C7	C15	C17	C18	C21
Before (B)	7.00	8.00	7.00	8.00	8.00	8.00	9.00	9.00	8.00	8.00
After (A)	8.00	8.00	8.00	9.00	8.00	8.00	9.00	8.00	8.00	8.00
DIF = A – B	1.00	0.00	1.00	1.00	0.00	0.00	0.00	-1.00	0.00	0.00

Panel B: Generic Competences

	G1	G2	G3	G4
Before (B)	8.00	9.00	8.00	7.50
After (A)	9.00	9.00	8.00	8.00
DIF = A – B	1.00	0.00	0.00	0.50

Legend: The variable called DIF is defined as follows: $DIF = \text{After PBL} - \text{Before PBL}$, where DIF shows the difference between the (mean and median) perception of each competence for university professors before and after performing the PBL activity. Thus, the interpretation of the value that this variable may take is: (1) if $DIF > 0 \rightarrow DIF \text{ POSIT} \rightarrow$ the perception of the competence has improved with the PBL course; (2) if $DIF = 0 \rightarrow DIF \text{ ZERO} \rightarrow$ the perception of the competence keeps constant after attending the PBL course, and (3) if $DIF < 0 \rightarrow DIF \text{ NEGAT} \rightarrow$ the perception of the competence has deteriorated with the PBL course.

Table 4. Differences in mean, median and variance, before and after performing the PBL activity**Panel A: Specific Competences**

	C1	C2	C3	C6	C7	C14	C15	C17	C18
Mean (μ):									
<i>Anova F – test</i> ($H_0: \mu_M = \mu_F$)	0.3928	3.0103*	0.3692	0.2175	0.4057	0.0417	0.0950	0.5318	0.7753
Median (M):									
<i>Kruskal-Wallis (tie-adj.) test</i> ($H_0: M_M = M_F$)	0.9139	2.1129	0.9811	0.1926	0.9694	0.1925	0.0297	0.2740	0.9045
Variance (σ^2):									
<i>Levene's test</i> ($H_0: \sigma^2_M = \sigma^2_F$)	0.5580	1.4579	2.1419	0.0035	0.0827	0.8827	3.1886*	0.1329	0.3677

Panel B: Generic Competences

	G1	G2	G3	G4
Mean (μ): <i>Anova F – test</i> ($H_0: \mu_M = \mu_F$)	1.8917	0.0041	0.0976	2.2726
Median (M): <i>Kruskal-Wallis (tie-adj.) test</i> ($H_0: M_M = M_F$)	2.9837*	0.0754	0.3440	2.0392
Variance (σ^2): <i>Levene's test</i> ($H_0: \sigma^2_M = \sigma^2_F$)	0.2876	0.0797	3.4894*	2.8905*

Legend: **Cj**: Specific Competence *j*, **Gj**: Generic Competence *j*. The null-hypothesis for the *Anova F-test*, *Kruskal-Wallis (tie-adj.) test*, and *Levene's test* is that the difference in mean, median and variance between the perception of the competences before and after the PBL activity is equal to zero. *p-values*: * $p < 0.10$

Figure 1. Average perception of competence acquisition before and after attending the PBL course

Legend: This Figure shows the mean perception that teachers have regarding the acquisition degree of competences before (in blue) and after (in red) performing the PBL activity.

Figure 2. Median perception of competence acquisition before and after attending the PBL course

Legend: This Figure shows the median perception that teachers have regarding the degree of competence acquisition before (in blue) and after (in red) performing the PBL activity.

ACQUISITION OF COMPETENCES IN A PBL EXPERIENCE

Figure 3. Evaluation of the PBL activity by the participants

Legend: This Figure exhibits the assessment that teachers enrolled in this PBL experience give to the course. Furthermore, this Figure distinguishes between several other aspects such as the interest, practical utility and content of the PBL activity, the development, duration and materials used in this activity, and, finally, the teaching staff and the interaction with them.