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Project-Based Learning and the Acquisition of Competencies and Knowledge Transfer in Higher Education

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Abstract: The aim of this paper is to contribute to the body of knowledge about Project-Based Learning (PBL) methodology in higher education by describing and analysing interrelations between competencies, and their contribution to knowledge transfer (KT) and students' rating of the project. The sample consisted of 464 students from the Universities of Huelva (N=347; 74.8%) and Murcia (N= 117; 25.2%), enrolled in the second year of a degree in either Infant or Primary Education. Data was collected through a self-administered questionnaire comprising a total of 53 items measuring General, Specific and Transversal competencies, as well as students' rating of the project. Competencies were selected from the course programmes for the degrees in Infant and Primary Education. Preliminary results showed that competencies were moderately to highly acquired after PBL, and that students reported notable KT as well as a positive assessment of the project. KT showed a high degree of association with students' ratings and was established as a key factor in learning and learner satisfaction in higher education.

Keywords: Project-Based Learning (PBL); higher education; competencies; knowledge transfer (KT); rating.

1. Introduction

In today's globalized world, students and teachers face multiple unforeseeable challenges of increasing complexity and uncertainty, the solutions to which will require creativity and self-reliance beyond the safe inflexibility of established responses. As UNESCO [1] underlines, we need to create "sustainable citizens" capable of collaborating, speaking up and acting for positive change. In this regard, Education for Sustainable Development (ESD) empowers people to change their way of thinking and to work towards the transformation of society, redirecting education and helping people to develop the knowledge, skills, values and behaviors necessary for developing a sustainable future. Among other dimensions, ESD takes into account pedagogy, learning environments, and the psychological processes involved in the end result of learning. It conceives of teaching and learning as interactive and learner-centered, promoting practices that are exploratory, transformative and oriented towards action.

In this regard, there is a general consensus that "sustainable citizens" need to have certain key (or transversal) competencies that allow them to engage constructively and responsibly with today's world. Examples of these key competencies are: collaborative work, capacity for anticipation, strategic and critical thinking, integrated problem-solving, and capacity for self-awareness [2, 3, 4]. The methodology of Project Based Learning is based on the premise that learning is a dynamic, interactive process, the final objective of which should be engagement with a real-world context. It is ideally suited to developing transversal competencies, and to enabling students to learn to adapt to the demands of an uncertain and changing environment and contribute to the fulfillment of the SDGs, so important for ensuring our survival in the future.

This paper aims to contribute to our knowledge of PBL in Higher Education by describing and analyzing the interrelations among competencies from two courses in the Degree in Education, 'Psychological Foundations of Special Education' and 'Diversity in Child Learning and Development', and the association of these with knowledge transfer (KT) and students' rating of the project. To this end, the following objectives were addressed: 1) to provide an overall description of the perceived acquisition of competencies – generic, specific and transversal – as well as students' rating of the project; 2) to analyse the relationship between students' degree of satisfaction regarding competencies acquisition and their project rating and KT; and 3) to explain project rating in terms of perceived KT and competencies acquisition.

2. Literature Review

One of the challenges currently facing higher education is the development of methodologies which empower learners to respond innovatively to the problems and challenges they will face now and in the future.

Project Based Learning (PBL) features among the methodological shifts in students' and teachers' roles promoted by the Organization for Economic Cooperation and Development (OECD) [5]. Central to the approach is the idea that the teaching process must be based on students' reconstruction of experience. Educational psychologists note that one of the underlying principles of the methodology is the change in the roles traditionally assigned to teachers and students. Teachers are not just instructors, but guides in the learning process [6], while for their part students are not just passive listeners but active learners whose actions and reflection form the foundation of solutions to problems [7]. This educational approach demands from teachers the use of instructional strategies collectively referred to as constructivist teaching methods [8, 9], and aims to promote in the students a positive attitude towards exploring and discovering knowledge, and to develop aptitudes such as critical thinking and collaborative skills while working in groups [10, 11]. Early advocates of this concept of learning and teaching, such as Kilpatrick, named it the 'Project Teaching Method' [6]. This denomination is still used today but frequently replaced by the term Project-Based Learning (PBL) [12], understood as encompassing two methods, Problem-Based Learning and PBL due to the many similarities between the two [13, 14].

Definitions of PBL identify it as a kind of collaborative work carried out by a group of people within the confines of an academic program [15, 16]. Other significant aspects include the need for

research, the importance of self-directed work, the use of various resources, the presentation of a final report and most importantly, the meaningful internalization of competencies while working [6, 17, 18, 19, 20]. PBL helps students to take responsibility for their own learning, particularly in their understanding and application of academic concepts. Furthermore, students manage authentic materials that integrate academic knowledge with real-world practices [21, 22]. The methodology focuses on the process of students' learning through research and reflection directed at solving a problem set by the teacher, in which the students' actions are coordinated towards finding solutions, and understanding and integrating concepts into a report, while working both alone and in a group [23, 24, 25]. Different authors have noted that the benefits of this methodology can be viewed from a general and a specific point of view.

From a general perspective, PBL allows the goals of the European Higher Education Area (EHEA) to be applied, promoting and integrating a dynamic learning approach in which skills, values, attitudes and competencies for coping with real professional contexts are highly valued [26]. At a more specific level, the use of PBL methodology provides students with useful intellectual tools and improves their perception of learning. With respect to intellectual tools, these include developing effective learning strategies such as problem-solving, planning and learner autonomy while learning to research a topic [12, 27], and cross-cutting skills transferable to new situations or other academic subject areas [28, 29, 30]. In terms of perception of learning, project-based approaches have been found to increase motivation, develop competencies and content knowledge [31, 32], enhance students' perception of their learning progress [29, 33], improve group work skills, promote positive attitudes towards investing effort and interest, and develop oral skills for presenting the results of their work [31]. In addition, the competencies gained are retained for longer [34], the activation of prior knowledge is facilitated, students' abilities for working autonomously and finding reliable sources of information are improved, and their critical reasoning develops, along with their social interaction, and self-cognition skills [35, 36].

The application of PBL to higher education has also had a significant impact on training courses [22, 37, 38]. In the last few decades, the approach has shown itself to be especially effective applied to degrees in Education [29, 30, 37, 39, 40, 41, 42], as well as Psychology [43], Sports Science [44] and Educational Psychology [45]. Among the positive outcomes associated with PBL methodology, teachers and students have reported high degrees of acquisition of competencies, increased motivation, an appreciation of constructive learning environments [17, 29, 32, 46], and a better perception of the learning process [33].

Additionally, PBL promotes the recognition of the interconnectivity between academic subjects for solving problems. It forces students to turn to knowledge acquired in different courses, to integrate this and to go back to the initial problem with a more integral and dynamic view [47]. Interdisciplinary work through PBL helps to overcome students' difficulties in perceiving academic subjects not as isolated content but interrelated. Morin [48] reports that students normally receive learning in an over-compartmentalised fashion, which can impede them from integrating knowledge when this is required to solve real life problems [49]. It is clear that integration and transfer do not occur automatically, and in this respect PBL methodology is a significant tool for dealing with complex problems [50]. Various trials carried out in the fields of Education and Psychology have proved very efficient [40, 51, 52, 53, 54, 55], and have provided the foundation for more recent research and innovation programs in higher education, which have not only evaluated the project in question alongside students' perception of their acquisition of competencies [29, 43, 44], but also examined students' perception of knowledge transfer [41].

In line with previous literature, the aim of this paper is to contribute to the knowledge about the use of PBL in higher education by describing and analysing interrelations among competencies, and the associations of these competencies with both KT and students' rating of the project. To this end, the following objectives were addressed: 1) to provide an overall description of the perceived acquisition of competencies – generic, specific and transversal – as well as students' rating of the project; 2) to analyse the relationship between students' degree of satisfaction regarding competencies acquisition and their project rating and KT; and 3) to explain project rating in terms of perceived KT and competencies acquisition.

3. Methodology

3.1. Sample

The context of the study was a Higher Education Teaching Innovation Project at the Universities of Huelva and Murcia (Spain) during the 2017-18 academic year. A total of 387 students in their second year of a degree in either Infant or Primary Education (54.3% and 45.7% respectively) reported their perceptions of the benefits of learning through PBL.

3.2. Instrument

Data were collected by means of a specially designed questionnaire entitled 'Perception of the Acquisition of Academic Competencies through PBL,' which consisted of a total of 58 items, as illustrated in Table 1 below.

Table 1. Design of questionnaire 'Perception of the Acquisition of Academic Competencies through PBL'.

Section	Items	Focus	Question type	
Demographic data	1-9	n/a		
General Competencies (GC)	Group General Competencies (GGC)	teamwork	Likert scale	
	Individual General Competencies (IGC)			
	10	18-22	individual learning	Likert scale
	24-27	11-17		
23	28-35	depth of study	Likert scale	
Specific Competencies (SC)	36-40 and 50	transferrable skills	Likert scale	
Transversal Competencies (TC)	41-49		Likert scale	
Project Evaluation	51-53		0-10 scale (67)	
	67		Likert scale (59-60, 62, 64, 66)	
Knowledge Transfer (KT)	54- 66	sharing of knowledge	dichotomy scale (54, 56) open question (55, 57, 58, 61, 63, 65)	

Following a set of basic demographic questions (items 1-9), there were five sections, thus: General Competencies (GC) (items 10-27), sub-divided into Group General Competencies (GGC), focusing on team work (items 10, 18-22, and 24-27), and Individual General Competencies (IGC), focusing on individual learning (items 11-17, and 23); Specific Competencies (SC) (items 28-35), designed to evaluate the perceived depth of study; Transversal Competencies (TC) (items 36-40 and 50), measuring respondents' perception of having gained knowledge and/or skills transferrable to other courses in their degree; respondent's evaluation of the project (items 41-49, 51-53, and 67); and

Knowledge Transfer (items 54-66). Measurement of the variables varied. A five-point Likert scale (ranging from '1: Totally disagree' to '5: Totally agree') was used to analyse perceived competencies (items 10-53, 59-60, 62, 64 and 66), while a dichotomy scale was used for items 54-56. Items 55, 57, 58, 61, 63 and 65 were open and categorised posteriori according to the answers given. A ten-point scale (0-10) was used for item 67. There was also an open-ended section for respondents to write personalised evaluations of their experience of PBL. The competencies under analysis were drawn from the Curriculum Framework for the courses 'Psychological Foundations of Special Education' and 'Diversity in Child Learning and Development', both imparted in the second year of the degrees in Primary and Infant Education.

3.3. Data analysis design

First, descriptive statistics (i.e., mean and standard deviation) and the internal consistency reliability (Cronbach α) were calculated for each of the items. Second, bivariate zero-order Pearson correlations were calculated between competencies (i.e., general, specific and transversal), KT, student rating and overall rating. Third, two hierarchical regression analyses were performed in order to analyse the effects on the student and overall ratings of demographics, competencies and KT. All the above analyses were carried out with the program SPSS 21.0. Fourth, a path analysis was conducted, based on the previous analyses, to examine the relationships between the variables. The overall model fit was examined by calculating χ^2 , CFI and RMSEA. Standardized coefficients were reported regarding the effects included in the model. These analyses were performed using the statistical program EQS 6.3.

4. Results

4.1. Objective 1: Overall description of perceived acquisition of competencies – generic, specific and transversal – and project rating

Table 2. Students' rating of the PBL project: competencies acquisition, KT and rating.

	Mean (M) ₁	Standard Deviation (SD)
General Competencies (GC) – overall	4.19	0.732
Group (GGC)	3.61	0.798
Individual (IGC)	4.17	0.845
Specific Competencies	4.13	0.827
Transversal Competencies	3.75	1.054
Knowledge Transfer	3.72	0.928
Overall Rating of PBL Project	3.68	0.977
Overall score for learning potential of PBL (0 to 10)	8.05	0.995

1. Mean Range: 1-5.

General Competencies (GC) were grouped into Group General Competencies (GGCs), in which the students rated the learning achieved through interactions within their team (variables GGC 2-7 and GGC13), and Individual General Competencies (IGCs), in which each student rated the degree to which they had constructed their own learning (variables IGC1, IGC8-12 and IGC14-17). See Table 2 for general results and Appendix A (Table A1) for specific results. The results showed that PBL methodology was positively rated by the students in terms of general competencies as a whole

(GC: M= 4.19; SD= 0.73), and both group (GGC: M= 3.61; SD= 0.79) and individual competencies (IGC: M= 4.17; SD= 0.84). The majority of students expressed agreement with the idea that PBL methodology enabled them to achieve a range of competencies, in particular individual competencies, although the most frequent option with respect to group competencies was that of “neither agree nor disagree”. The highest scores were for the items ‘PBL improved my analytical skills’ (M= 4.39; SD= 0.680) and ‘PBL made me understand the need to carry out research and/or intervention in the field of child diversity’ (M= 4.39; SD= 0.713), both of which pertained to IGC.

Specific Competencies (SC) explored students’ perceptions of the degree to which PBL methodology enabled them to gain, at an individual level, an understanding of the theoretical concepts of the courses they were studying (see Table 2 for overall results and Appendix A-Table A2 for specific results). The overall results for specific competencies showed that students were in agreement that PBL methodology represented an effective way to acquire them (SC: M= 4.13; SD= 0.827). The competencies which received the highest scores were those concerning normative/non-normative child development, learning processes, and intervention strategies (SC28: M= 4.25; SD= 0.73; SC31: M= 4.42; SD= 0.71; SC32: M= 4.19; SD= 0.82, respectively).

The items focusing on Transversal Competences (TC) were aimed at discovering the extent to which PBL methodology helped students to appreciate transversal skills (use of technology, learning in another language, collecting data, etc.) as of use to the project in which they were involved. See Table 2 for overall results and Appendix A (Table A3) for specific results. The overall results of students’ perception of the potential of PBL methodology for generalizing skills learnt in the context of the course were unclear and showed a wide deviation, with ‘neither agree nor disagree’ (M= 3.75; SD= 1.054) the most frequent option. The competency with the highest rating was the increased knowledge of data collection methodology through questionnaires, interviews and observation (TC38: M= 4.18; SD= 0.83).

With respect to perceived Knowledge Transfer (KT), most of the students (80%) perceived the knowledge acquired through the PBL methodology as applicable to other courses comprising the Degree in Education. Fewer, but still more than half the students (59.6%) considered that such contents could be applied to their daily life (see Table 3).

Table 3. Students' perceived KT.

		%	University	%	X ²	P	Phi Effect Size ₁ (ω)
Knowledge acquired in this course is applicable to other courses in the degree.	Yes	82	Huelva	81.4	0.233	0.629	
			Murcia	83.5			
	No	18	Huelva	18.6			
			Murcia	16.5			
Knowledge acquired in this course is applicable to my daily life.	Yes	59.6	Huelva	52.4	19.447	0.000	-0.225
			Murcia	76.5			
	No	40.4	Huelva	46.6			
			Murcia	23.5			

1. Phi Values range from 0, indicating a null effect size, to 1, indicating that the relationship between the variables is perfect.

The overall results of perceived knowledge transfer showed that the majority of students selected ‘neither agree nor disagree’ with respect to the potential for applying the knowledge they had acquired to other contexts (M= 3.72; SD= 0.928). The most highly rated items for KT were ‘project-based learning helped me to make connections to knowledge in other subject areas in the Degree in Education (TK2: M= 3.92; SD= 0.909) and ‘Project-based learning showed me how to cite

papers following APA norms' (TK5: M= 3.90; SD= 0.840). In contrast, the least rated item was 'Experience of the methodological principles involved in the 'Project for Methodological Development' (as applied to the subjects 'The Psychological Foundations of Special Education' and 'Diversity in Child Learning and Development') has been of use to me in other subjects' (KT1: M= 3.45; SD= 1.039) (See Appendix A, Table A4).

In relation with *Students' Rating of the PBL Project*, overall results showed that the majority of students (M= 3.68; SD= 0.977) selected 'neither agree nor disagree' with respect to the PBL project (time investment, personal knowledge, classmates, materials, and learning opportunities). The most highly rated item was 'PBL helped me in my academic training' (SV8: M= 4.42; SD= 0.721), while the least rated item was 'The teaching staff devoted very little time to the course' (SV6: M= 1.82; SD= 1.147). However, the latter cannot be considered a negative rating as it implicitly suggests that there was too little time available for teachers to deliver the project (See Appendix A, Table A5).

4.2. Objective 2: To analyse the relationship between students' degree of satisfaction regarding competencies acquisition and their project rating and knowledge transfer

Table 4 shows the descriptive statistics, internal consistency reliability and Pearson bivariate correlations between variables.

Table 4. Descriptive statistics, internal consistency reliability and Pearson bivariate correlations between variables.

	M	SD	1	2	3	4	5	6
1. General Competencies	4.19	0.50	(0.91)					
2. Specific Competencies	4.13	0.58	0.72***	(0.85)				
3. Transversal Competencies	3.76	0.67	0.62***	0.65***	(0.69)			
4. Project Rating	3.92	0.51	0.54***	0.38***	0.39***	(0.63)		
5. Overall Rating	8.05	1.00	0.40***	0.27***	0.31***	0.52***	1	
6. KT	3.72	0.70	0.43***	0.43***	0.39***	0.45***	0.25***	(0.81)

*** p < 0.001

As can be seen, moderate to high means were observed across the range of competencies, the highest being general competencies and the lowest transversal. Notable scores were registered for both the project rating and overall student rating, with similar scores also being returned in respect of KT. Furthermore, good internal consistency reliability was detected for the general and specific competencies, as well as for KT, while an acceptable reliability for an instrument still in development was found for the transversal competencies and the project rating. The bivariate correlations showed positive and significant associations between all the variables. Hence, higher scores in the competencies (i.e., general, specific and transversal) were found to be associated with higher scores in both KT and the rating scales (for both the overall learning potential of PBL and the project itself). Moreover, higher KT was also related to higher ratings. The three types of competencies were positively interrelated.

4.3. Objective 3: Explanation of ratings in terms of perceived acquisition of competencies and knowledge transfer

Table 5 presents the results of two hierarchical regression analyses carried out separately to explain the scores for the overall and project rating scales on the basis of demographic data and the scores for the competencies and KT.

Table 5. Hierarchical regression analyses to examine overall and project ratings according to demographics, competencies (i.e., general specific and transversal) and KT.

Step	Variable	Overall Rating				Project Rating			
		F	R2	t	β	F	R2	t	β
1		1.89	0.03			2.34*	0.05		
	Gender			-1.92	-0.15			-0.77	-0.06
	Age			-0.24	-0.02			-1.45	-0.13
	Access to university			1.22	0.11			0.60	0.05
	Degree course			-1.04	-0.10			-1.08	-0.11
	Academic Year			-1.71	-0.12			-0.18	-0.01
	Session (a.m./p.m.)			0.91	0.09			1.85	0.19
	Minor			-1.38	-0.12			-1.05	-0.09
	Teacher			0.46	-0.05			1.27	0.13
2		5.30***	0.19			13.45***	0.41		
	Gender			-2.40	-0.18*			-1.32	-0.09
	Age			-0.08	-0.01			-1.16	-0.08
	Access to university			1.22	0.11			0.47	0.04
	Degree			-1.46	-0.14			-1.80	-0.14
	Academic Year			-1.14	-0.08			1.14	0.07
	Turn			1.06	0.10			2.37	0.20*
	Minor			-0.62	-0.05			0.21	0.01
	Teacher			-0.15	-0.01			0.57	0.05
	General Competencies			2.75	0.33**			4.07	0.42***
	Specific Competencies			0.39	0.05			0.93	0.10
	Transversal Competencies			0.61	0.06			1.59	0.14
3		5.21***	0.20			16.93***	0.49		
	Gender			-2.42	-0.18*			-1.49	-0.09
	Age			-0.14	-0.01			-1.52	-0.10
	Access to university			1.23	0.11			0.51	0.04
	Degree			-1.41	-0.13			-1.75	-0.13
	Academic Year			-1.09	-0.07			1.31	0.07
	Turn			1.08	0.10			2.60	0.20*
	Minor			-0.53	-0.04			0.46	0.03
	Teacher			-0.30	-0.03			0.19	0.01
	General Competencies			2.35	0.28*			3.20	0.31**
	Specific Competencies			0.27	0.03			0.61	0.06
	Transversal Competencies			0.47	0.05			1.31	0.10
	KT			1.87	0.14			5.60	0.34***

* p < 0.05; ** p < 0.01; *** p < 0.001

In step 1, demographics were found not to have any significant effect on overall rating or on the project rating scale. In step 2, general competencies showed a significant positive effect on both scales. However, the effect of the general competencies was greater on the project scale than on the overall scale, with a correspondingly higher explained variance (36% vs 16%, respectively). Finally, in step 3, KT was found to have a significant and positive effect only on the project rating scale, with an explained variance of 8%. Following these results, the scores in the project scale were used for subsequent analysis.

A path analysis was tested in which: a) general, specific and transversal competencies were interrelated; b) these competencies were found to have effects on KT; c) both KT and general competencies showed effects on project rating. The model showed good overall data fit (Satorra-Bentler χ^2 (2, N = 387) = 2.31, p = 0.315, CFI = 0.998, RMSEA = 0.02). All standardized residuals were very low (between -0.1 and 0.1) and all measurement equations were significant. The three competencies (i.e., general, specific and transversal) were positively interrelated, with a

stronger association between the general and specific competencies. The general competencies presented a positive effect on KT. Moreover, both general competencies and KT showed positive effects on the project rating. The model gave an explained variance of 22% for KT and of 36% for project rating. Figure 1 presents the standardized coefficients of the effects.

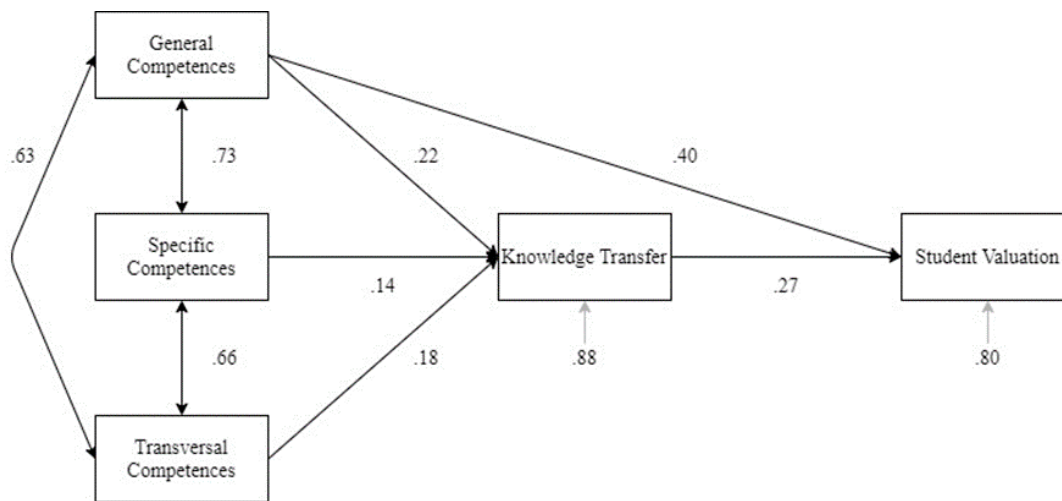


Figure 1. Path analysis of the relationships between competencies (i.e., general, specific and transversal), KT and project rating.

5. Discussion

In terms of competencies, our results are supported by various researchers, who have demonstrated that working in groups gives students the opportunity to develop generic competencies (GCs) by solving individual problems and developing their own knowledge construction through improving their ability to analyze, synthesize, and manage information [59] – in short, stimulating their capacity to learn, plan and develop scientific thinking [33, 60].

With regard to specific competencies (SCs), what the students valued most was the opportunity the project offered to study learning differences among children with normative and non-normative development, and the need for carrying out research and devising interventions. In this respect, Meneses, Moraga and Puchi [61] note that this methodology allows the student to start on the process of analyzing specific cases, deducing principles and relationships, and formulating hypotheses. As such, the main advantage of the methodology is its favorability for encouraging the acquisition of learning related to research.

The results regarding the third set of competencies, transversal competences (TC), showed that the item which rated most highly was the opportunity to learn how to use scientific tools capable of being applied to different subjects. We concur with multiple authors [62, 63, 64, 65, 66, 67, 68] that PBL methodology promotes the development of skills transfer, such as research abilities, autonomous learning and critical thinking.

Finally, with regard to students' valuation of the project, our results were consistent with various studies in which teachers and students perceived the methodology as promoting an active and responsible learning in a guided and constructive environment, especially apt for channelling students' intrinsic motivation [12, 17, 19, 69], enhancing their perception of the learning process [33], and developing their ability to transfer knowledge to other learning contexts [70].

Regarding the second aim, positive associations were found between the research variables. Specifically, as found in previous studies, greater development of the three competencies (general, specific and transversal) correlated with increased KT and higher student rating for the PBL program, while increased KT was also associated with higher student rating [29, 41]. In addition, the competencies were positively interrelated.

Finally, with respect to the third aim, the multivariate analyses indicated that: a) general competencies and KT exerted positive direct effects on student rating of PBL; and b) the effects of the

specific and transversal competencies on student rating were completely mediated by KT. The study thus provides evidence in favour of PBL as a methodological approach suitable for developing competencies and KT in higher education. In addition, PBL was highly rated by students, largely due to the degree of KT and the development of general competencies. In this regard, the study reiterates the importance of KT for learning and learning satisfaction within higher education.

This notion is widely accepted by other researchers in the field [for example, 46, 71, 72, 73, 74], who maintain that PBL methodology helps students to retain concepts, to recognise connections between different disciplines, and to apply the learning achieved to everyday situations. Further, it is a methodology that is highly compatible with one of the goals for teaching and learning proposed by the OECD for 2020 [5], which contemplates the modification of the roles of both students and teachers in the coming years.

Despite these benefits, some limitations should be acknowledged, and future lines of research suggested. First, because the study was cross-sectional, no causal relationships could be established, only associations between variables. A randomized controlled intervention, with pre- and post-assessment, would be desirable in order to test the efficacy of PBL in developing competencies and KT, and for evaluating its rating compared to other methodologies. Second, the use of self-report measures may be biased by the subjective evaluation of respondents, so it would be beneficial to include objective measures aimed at improving the validity of the assessment of PBL. Third, because a convenience sample was used, the results cannot be generalized to undergraduate samples in other universities. Fourth, more information is needed regarding the mechanisms involved in the relationships between the variables and the potential moderators. In this regard, a mixed-method design would provide qualitative data to complete the information collected through the use of self-reports.

These limitations aside, the results of the study do suggest some practical implications. These preliminary findings provide some evidence for the importance of PBL as a teaching methodology which promotes the development of competencies and KT in higher education. More research into educational innovation is needed to test the efficacy of this methodology for different degree subjects and academic years. In practical terms, student evaluation of the methodology was strongly favourable, and this undoubtedly had beneficial consequences for student motivation and engagement. An advantage of project-based methodology for university teachers is that it allows students to take control of their own learning. As Pedersen and Hoby [75] point out, the approach enables students to acquire significant learning and even to produce new knowledge. Young people are more reflective and more aware of their own learning in an active and collaborative context where new knowledge is exchanged and shared. Indeed, the roles of the teacher and student are not traditional at all, and participants are challenged to translate theoretical course content into real-world applications, thus bringing the subject closer to professional practice. In short, our study suggests that PBL could be an innovative and potentially powerful methodology to improve learning in higher education, and its implementation will require a shift in the traditional roles of students and teachers in the near future.

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Appendix A

Table A1. Description of General Competencies using PBL Methodology.

	Total Sample			University		Mean Differences (MD)	<i>t</i>	<i>p</i> ²	<i>d</i> ³
	N	Mean (M) ₁	Standard Deviation (SD)	Huelva (M; SD)	Murcia (M; SD)				
GENERAL COMPETENCIES (GC) – PBL...									
GGC1 ... improved my problem-solving ability.	386	4.02	0.658	4.06; 0.662	3.95; 0.647	0.108	1.470	0.142	
GGC2 ... helped me to work with others and to progress in my own learning.	387	4.24	0.837	4.24; 0.880	4.24; 0.730	-0.005	-0.056	0.955	
GGC3 Working in groups allowed me to express doubts and improve my knowledge.	387	4.27	0.738	4.27; 0.781	4.28; 0.627	-0.010	-0.124	0.901	
GGC4 Working in groups is beneficial for planning and organizing work.	386	4.11	0.869	4.04; 0.924	4.25; 0.709	-0.206	-2.141	0.033	Small
GGC5 Working in group is beneficial for learning to make decisions.	387	4.12	0.787	4.12; 0.785	4.13; 0.797	-0.011	-0.128	0.898	
GGC6 Working in groups is beneficial for learning to solve problems.	386	4.23	0.769	4.19; 0.792	4.33; 0.707	-0.142	-1.671	0.096	
GGC7 Working in groups is beneficial for learning to debate constructively.	386	4.22	0.842	4.17; 0.864	4.31; 0.785	-0.136	-1.459	0.145	
IGC8 ... contributed to my self-learning.	385	4.12	0.842	4.19; 0.851	3.97; 0.805	0.220	2.359	0.019	Small
IGC9 ... improved my analytical skills.	386	4.39	0.680	4.43; 0.669	4.29; 0.698	0.140	1.864	0.063	
IGC10 ... improved my ability to synthesise information.	386	4.34	0.677	4.33; 0.684	4.35; 0.663	-0.020	-0.267	0.789	
IGC11 ... increased my knowledge about how to access scientific documents.	387	4.21	0.825	4.35; 0.765	3.88; 0.866	0.475	5.373	0.000	Small

IGC12 ... improved my ability to present a project with reasoned argumentation.	387	4.18	0.742	4.17; 0.778	4.21; 0.653	-0.041	-0.495	0.621	
GGC13 ... let me interact positively with my team.	387	4.32	0.744	4.28; 0.751	4.41; 0.723	-0.137	-1.663	0.097	
IGC14 ... made me understand the need to carry out research and/or intervention in the field of child diversity.	387	4.39	0.713	4.36; 0.706	4.46; 0.727	-0.095	-1.205	0.299	
IGC15 ... improved my ability to speak in public.	387	4.03	0.884	3.94; 0.890	4.25; 0.833	-0.313	-3.227	0.001	Small
IGC16 ... improved my ability to produce my own scientific texts.	386	3.98	0.834	4.09; 0.766	3.74; 0.934	0.348	3.531	0.001	Small
IGC17 ... made me aware of another mode of learning.	387	4.07	0.853	4.19; 0.820	3.79; 0.870	0.395	4.264	0.000	Small
OVERALL GENERIC COMPETENCIES SCORE	387	4.19	0.732						
OVERALL GENERIC INDIVIDUAL COMPETENCIES SCORE	387	4.17	0.845						
OVERALL GENERIC GROUP COMPETENCIES SCORE	387	3.61	0.798						

1. Mean Range: 1 -5; 2. Mean differences are significant at level 0.05; 3. Criterion for Cohen *d* interpretation: non-significant N.S. (<0.2); small ($\geq 0.2 < 0.5$); medium ($\geq 0.5 < 0.8$); big ($\geq 0.8 - 2$).

Table A2. Description of Specific Competencies using PBL Methodology.

SPECIFIC COMPETENCIES – PBL...	Total Sample			University		Mean Differences (MD)	<i>t</i>	<i>P</i> ²	<i>d</i> ³
	N	Mean (M) ₁	Standard Deviation (SD)	Huelva (M; SD)	Murcia (M; SD)				
SC28 ... deepened my understanding of normative child development.	385	4.25	0.733	4.25; 0.745	4.25; 0.709	0.003	0.034	0.973	
SC29 ... deepened my understanding of non-normative child development.	387	4.15	0.772	4.14; 0.803	4.19; 0.698	-0.053	-0.620	0.536	
SC30 ... deepened my understanding of the learning processes in children without learning problems.	384	4.11	0.821	4.17; 0.784	3.97; 0.899	0.198	2.175	0.030	N.S.
SC31 ... deepened my understanding of the learning processes in children with learning problems.	387	4.42	0.710	4.38; 0.739	4.53; 0.625	-0.149	-1.905	0.058	
SC32 ... helped me learn how to apply tests to detect and/or devise interventions for children with special needs.	385	4.19	0.826	4.29; 0.774	3.97; 0.903	0.311	3.433	0.001	Small
SC33 ... developed my basic skills in designing appropriate tools for measuring.	384	3.80	0.923	4; 0.885	3.35; 0.849	0.652	6.694	0.000	Medium
SC34 ... made me aware of the basic framework of a scientific research paper.	387	4.16	0.889	4.47; 0.693	3.42; 0.866	1.050	12.638	0.000	Big
SC35 ... showed me how to design a research project.	386	4.02	0.949	4.36; 0.731	3.23; 0.940	1.123	12.636	0.000	Big
OVERALL SPECIFIC COMPETENCIES SCORE		4.13	0.827	4.25; 0.682	3.86; 0.615	0.386			

1. Mean Range: 1 -5; 2. Mean differences are significant at level 0.05; 3. Criterion for Cohen *d* interpretation: non-significant N.S. (<0.2); small ($\geq 0.2 < 0.5$); medium ($\geq 0.5 < 0.8$); big ($\geq 0.8 - 2$).

Table A3. Description of Transversal Competencies using PBL Methodology.

TRANSVERSAL COMPETENCIES – PBL ...	Total Sample			University		Mean Differences (MD)	<i>t</i>	<i>P</i> ²	<i>d</i> ³
	N	Mean (<i>M</i>) ₁	Standard Deviation (<i>SD</i>)	Huelva (<i>M</i> ; <i>SD</i>)	Murcia (<i>M</i> ; <i>SD</i>)				
TC36 ... developed my ability to use computer resources to work on-line with my group.	386	3.92	0.992	3.93; 0.977	3.91; 1.030;	0.028	0.255	0.079	
TC37 ... developed my ability to use computer resources to work with data (Excel spreadsheets, statistics programs, PowerPoint presentations).	385	3.35	1.065	3.63; 0.967	2.71; 1.004	0.921	8.475	0.000	Big
TC38 ... increased my knowledge of data collection methodology (questionnaires, interviews, observations, etc.).	387	4.18	0.830	4.19; 0.812	4.16; 0.874	0.028	0.305	0.761	
TC39 ... developed my second language (English) skills for conducting searches on the topic of my project.	386	3.36	1.249	3.63; 1.094	2.72; 1.361	0.909	6.348	0.000	Big
TC40 ... helped me learn how to include references following APA norms.	387	3.97	0.971	4.13; 0.853	3.61; 1.125	0.571	4.435	0.000	Medium
TC41 ... developed my ability to use virtual platforms (Google classroom, Moodle, etc.) to carry out the project.	387	3.75	1.221	3.78; 1.266	3.70; 1.113	0.080	0.592	0.533	
OVERALL TRANSVERSAL COMPETENCIES SCORE		3.75	1.054	3.88; 0.998	3.46; 1.084				

1. Mean Range: 1 -5; 2. Mean differences are significant at level 0.05; 3. Criterion for Cohen *d* interpretation: non-significant N.S. (<0.2); small ($\geq 0.2 < 0.5$); medium ($\geq 0.5 < 0.8$); big ($\geq 0.8 - 2$).

Table A4. Description of Knowledge Transfer using PBL Methodology.

	Total Sample		University		Mean Differences (MD)	<i>t</i>	<i>p</i> ²	<i>d</i> ₃
	N	Mean (M) ₁	Standard Deviation (SD)	Huelva (M; SD)				
KNOWLEDGE TRANSFER								
KT1 I have experience of the 'Project for Methodological Development', as carried out in the subjects 'The Psychological Foundations of Special Education' and 'Diversity in Child Learning and Development', from previous subjects.	386	3.45	1.039	3.51;1.085	3.32; 0.913	0.184	1.707	0.089
KT2 Project-based learning helped me to make connections to knowledge in other subject areas in the Degree in Education.	383	3.92	0.909	3.94; 0.888	3.85; 0.956	0.102	0.932	0.352
KT3 The project carried out in this course enabled me to acquire competencies from other subjects.	385	3.77	0.899	3.84; 0.788	3.61; 1.106	0.228	2.008	0.046 Small
KT4 Project-based learning enabled me to understand other subjects better.	383	3.57	0.954	3.61; 0.884	3.48; 1.099	0.124	1.073	0.285
KT5 Project-based learning showed me how to cite papers following APA norms.	383	3.90	0.840	3.96; 0.940	3.78; 0.087	0.100	1.710	0.089
GLOBAL KNOWLEDGE TRANSFER COMPETENCES SCORE		3.72	0.928	3.77; 0.917	3.43; 0.832			

1. Mean Range: 1 -5; 2. Mean differences are significant at level 0.05; 3. Criterion for Cohen *d* interpretation: non-significant N.S. (<0.2); small ($\geq 0.2 < 0.5$); medium ($\geq 0.5 < 0.8$); big ($\geq 0.8 - 2$).

Table A5. Students' rating of the PBL Methodology Project.

STUDENTS' RATING OF THE PBL PROJECT	Total Sample			University		Mean Differences (MD)	<i>t</i>	<i>p</i> ²	<i>d</i> ³
	N	Mean (M) ₁	Standard Deviation (SD)	Huelva (M; SD)	Murcia (M; SD)				
SR1 Enough time was dedicated to the project.	384	3.87	1.023	3.81;1.084	4.01; 0.853	-0.195	-1.881	0.061	
SR2 My knowledge of this subject helped me to carry out the project.	385	3.86	0.931	3.80; 0.997	4.02; 0.737	-0.217	-2.371	0.018	Small
SR3. I think I need more prior knowledge to be able to work on a project.	386	3.53	1.171	3.72; 1.196	3.10; 0.990	0.615	4.868	0.000	Medium
SR4 Small groups still have many participants.	383	2.27	1.319	2.30; 1.438	2.19; 0.981	0.102	0.799	0.425	
SR5 The teacher spent enough time on the project.	385	3.86	1.033	3.84; 1.077	3.92; 0.925	-0.086	-0.749	0.493	
SR6 The teaching staff devoted very little time to the course.	384	1.82	1.147	1.71; 1.180	2.06; 1.028	-0.351	-2.926	0.004	Small
SR7 The materials used in the course were useful.	382	3.87	0.950	3.79; 1.010	4.04; 0.764	-0.252	-2.659	0.008	Small
SR8 PBL helped me in my academic training.	387	4.42	0.721	4.37; 0.768	4.55; 0.580	-0.183	-2.298	0.022	N.S.
SR9 PBL provided a good foundation of knowledge for my future professional life.	385	4.37	0.790	4.29; 0.838	4.57; 0.623	-0.280	-3.222	0.001	Small
SR10 PBL allowed me to learn more than traditional methodologies.	387	3.92	1.018	3.93; 1.071	3.91; 0.884	0.025	0.219	0.827	
SR11 PBL methodology deepened my knowledge of the theoretical foundations of the subject on which my project is based.	386	4.19	0.814	4.14; 0.846	4.30; 0.725	-0.161	-1.786	0.075	
SR12 I enjoyed going deeper into the theoretical aspects of the subject.	386	4.23	0.809	4.16; 0.818	4.39; 0.766	-0.229	-2.565	0.011	
Overall rating for the learning possibilities of PBL (0 to 10)	385	8.05	0.995						
OVERALL RATING OF THE PBL PROJECT		3.68	0.977	3.65; 1.026	3.755; 0.821				

1. Mean Range: 1 -5; 2. Mean differences are significant at level 0.05; 3. Criterion for Cohen *d* interpretation: non-significant N.S. (<0.2); small ($\geq 0.2 < 0.5$); medium ($\geq 0.5 < 0.8$); big ($\geq 0.8 - 2$).

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